

INDIA STATE OF FOREST REPORT 2019



Forest Survey of India
Ministry of Environment, Forest & Climate Change
Government of India

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11

Chapter

Forest & Tree Resources in States and Union Territories

11 INTRODUCTION

In the ISFR 2019, information on forest and tree resources for each State and UT of the country, as assessed by FSI in the 16th biennial cycle is being presented in Volume II of the report. ISFR 2019 presents additional information of two new studies undertaken at the national level and several new parameters derived from National Forest Inventory (NFI). This has led to increase in the number of pages of the document and therefore for better readability and presentation, a separate volume of the report has been necessitated. The Volume II of ISFR 2019 contains Chapter 11 entitled 'Forest & Tree Resources in States and Union Territories' wherein information on each State and UT has been presented as a separate sub-chapter. Apart from the regular features of ISFR like forest cover and its change, tree cover, growing stock, forest carbon, bamboo resource, the new information for each State & UT presented in the ISFR 2019 include biodiversity in terms of species richness and Shanon-Weiner Index, map and forest cover under different categories of fire proneness, forest cover in different slope classes, extent of TOF, major NTFPs, major invasive species, dia-class distribution of dominant forest species and dependence of people living in forest fringe villages. The State/UT sub chapters also present general information about the State/UT like physiography, forest types, climate, population etc. A brief overview of forestry scenario for each State & UT has also been given.

11.1

ANDHRA PRADESH

11.1.1 Introduction

The Andhra Pradesh Reorganization Act, 2014 bifurcated the erstwhile State of Andhra Pradesh into two separate States of Andhra Pradesh & Telangana in June, 2014. Andhra Pradesh, now the 8th largest State of the country is situated along the Bay of Bengal on the southeast coast of the country. Geographical area of the State is 1,62,968 sq km which is 4.96% of the geographical area of the country. The State lies between 12°37' N to 19°55' N latitude and 76°45' E to 84°46' E longitude and is bordered by Odisha & Chhattisgarh in the north, Telangana & Karnataka in west and Tamilnadu in the south. Bay of Bengal is on the East to the State. After Gujarat, the State of Andhra Pradesh has the second longest coastline among the States of India. Physiographically, the State can be divided into Coastal Andhra and the comparatively drier Rayalaseema regions. The State experiences hot and humid climate. The annual rainfall ranges between 1,100 mm to 1,250 mm and the annual temperature varies from 15°C to 45°C. The State is drained by number of rivers, main rivers are the Godavari, Krishna and Penna. There are 13 districts in the State, out of which five are tribal districts. As per the 2011 census, Andhra Pradesh has a population of 49.39, million which is 4.08% of India's population. The urban & rural population constitute 29.58% and 70.42% respectively. The Tribal population is 5.32%. The population density of the State is 308 persons per sq km which is lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 56.10 million for the undivided State of Andhra Pradesh.

TABLE 11.1.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	16,276	
Reporting area for land utilization	16,276	100.00
Forests	3,663	22.51
Not available for land cultivation	3,353	20.60
Permanent pastures and other grazing lands	214	1.32
Land under misc. tree crops and groves	159	0.98
Culturable wasteland	391	2.40
Fallow land other than current fallows	858	5.27
Current fallows	1,402	8.61
Net area sown	6,236	38.31

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.1.1.1 A Brief Overview of Forestry Scenario

The State has variety of vegetation types rich in flora and fauna. It's varied topography ranging from the hills of Eastern Ghats and Nallamala to the shores of Bay of Bengal, supports varied ecosystems. The forests in the State can broadly be divided into four major biotic provinces viz Deccan Plateau, Central Plateau, Eastern Highland and the East Coastal Plains. As per the Champion & Seth Classification of Forest Types (1968), the forests in Andhra Pradesh belong to five Type Groups which are further categorized into 20 Forest Types. Eastern Ghats region of the State is home to dense tropical forests, while the vegetation becomes sparse as the Ghats give way to the Deccan Plateau, where shrub vegetation is more common. The vegetation is largely dry deciduous type with a mixture of Teak, and species of the genera *Terminalia*, *Dalbergia*, *Pterocarpus*, *Anogeissus* etc. Red Sanders (*Pterocarpus santalinus*) is endemic to Andhra Pradesh and is highly valued for its rich red colour and grain pattern. Andhra Pradesh is one of the pioneer States to adopt Joint Forest Management and about one-third of the forest area of the State is under JFM.

The State is also ranked 8th in terms of the Recorded Forest Area (RFA) which is 37,258 sq km. Reserved Forest, Protected Forest and Unclassed Forest constitute 31,959 sq km, 5,069 sq km and 230 sq km of the RFA respectively. In Andhra Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 3,474.57 hectares of forest land has been diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

As per the information received from the State, during that last two years, 15,107 ha of plantations have been raised.

Andhra Pradesh has 3 National Parks and 13 Wildlife Sanctuaries covering an area of 7,311.08 sq km which is about 4.49% of the geographical area of the State. The long sea coast provides the nesting ground for sea turtles, the back water of Pulicat lake are the feeding grounds for Flamingo & Grey Pelican, the estuaries of river Godavari and Krishna support rich mangrove forests.

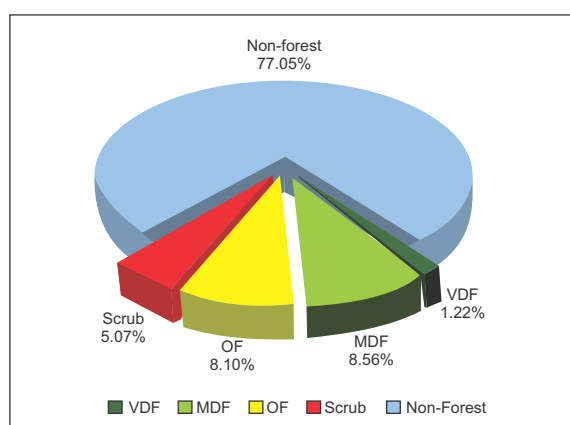
11.1.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Oct 2018, Forest Cover in the State is 29,137.40 sq km which is 17.88 % of the State's geographical area. In terms of forest canopy density classes, the State has 1,994.22 sq km under Very Dense Forest (VDF), 13,938.36 sq km under Moderately Dense Forest (MDF) and 13,204.82 sq km under Open Forest (OF). Forest Cover in the State has increased by 990.40 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.1.2 Forest Cover of Andhra Pradesh

(in sq km)		
Class	Area	% of GA
VDF	1,994.22	1.22
MDF	13,938.36	8.56
OF	13,204.82	8.10
Total	29,137.40	17.88
Scrub	8,254.84	5.07

FIGURE 11.1.1 Forest Cover of Andhra Pradesh



11.1.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 37,258 sq km which is 22.86 % of its geographical area. The reserved, protected and unclassified forests are 85.78 % and 13.60 % and 0.62 % of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 37,920.24 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.1.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Andhra Pradesh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1,965	12,821	9,333	24,119	29	1,117	3,872	5,018
8.15%	53.16%	38.69%		0.58%	22.26%	77.16%	

*in case of Andhra Pradesh RFA boundaries have been used.

FIGURE 11.1.2 Forest Cover inside and outside RFA in Andhra Pradesh

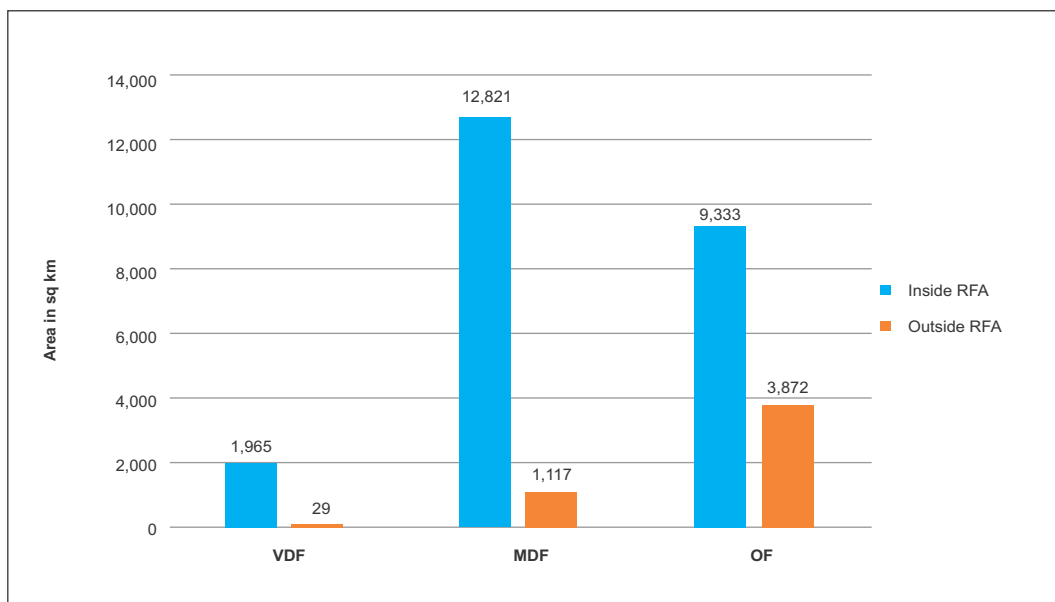


TABLE 11.1.4 District-wise Forest Cover in Andhra Pradesh

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Anantapur	19,130	0.00	213.14	773.69	986.83	5.16	-0.17	1,116.68
Chittoor	15,152	0.00	1,245.67	1,954.76	3,200.43	21.12	-0.57	1,281.85
East Godavari ^T	12,805	1,103.72	2,589.00	1,301.38	4,994.10	39.00	268.10	142.12
Guntur	11,391	1.00	291.32	595.68	888.00	7.80	10.00	451.17
Krishna	8,727	38.00	139.58	472.60	650.18	7.45	167.18	25.13
Kurnool	17,658	87.00	1,509.92	575.65	2,172.57	12.30	-1.43	680.38
Prakasam	17,626	254.22	1,802.61	1,247.01	3,303.84	18.74	12.84	1,194.36
Sri Potti Sriramulu Nellore	13,076	27.00	628.59	686.07	1,341.66	10.26	10.66	689.47
Srikakulam ^T	5,837	0.00	149.27	670.04	819.31	14.04	39.31	421.63
Visakhapatnam ^T	11,161	66.65	1,876.52	1,813.26	3,756.43	33.66	64.43	869.64
Vizianagaram ^T	6,539	0.00	230.91	821.08	1,051.99	16.09	189.99	354.85
West Godavari ^T	8,507	376.63	554.61	673.16	1,604.40	18.86	246.40	2.31
YSR Kadapa/ Cuddapah	15,359	40.00	2,707.22	1,620.44	4,367.66	28.44	-16.34	1,025.25
Grand Total	1,62,968	1,994.22	13,938.36	13,204.82	29,137.40	17.88	990.40	8,254.84

TABLE 11.1.5 Forest Cover Change Matrix for Andhra Pradesh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1,952	0	0	0	5	1,957
Moderately Dense Forest	40	13,630	51	54	276	14,051
Open Forest	2	163	10,955	288	731	12,139
Scrub	0	30	760	7,622	1,148	9,560
Non Forest	0	115	1,439	291	1,23,416	1,25,261
Total ISFR 2019	1,994	13,938	13,205	8,255	1,25,576	1,62,968
Net Change	37	-113	1,066	-1,305	315	

Main reasons for the increase in forest cover in the State are plantation and conservation activities and as well as improvement in interpretation.

TABLE 11.1.6 Altitude-wise Forest Cover in Andhra Pradesh

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	1,35,122	1,082	8,556	10,032	19,670 (67.51%)	6,286
500-1000	25,747	840	5,223	3,017	9,080 (31.16%)	1,668
1000-2000	2,099	72	159	156	387 (1.33%)	301
Total	1,62,968	1,994	13,938	13,205	29,137	8,255

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.1.7 Forest Cover in different slope classes in Andhra Pradesh

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,31,263	525	4,224	5,903	10,652 (36.56%)	4,277
5-10	10,695	374	2,321	1,876	4,571 (15.69%)	1,305
10-15	6,738	324	2,068	1,568	3,960 (13.59%)	911
15-20	5,500	288	1,893	1,404	3,585 (12.30%)	723
20-25	4,285	239	1,600	1,157	2,996 (10.28%)	537
25-30	2,718	154	1,076	778	2,008 (6.89%)	323
>30	1,769	90	756	519	1,365 (4.69%)	179
Total	1,62,968	1,994	13,938	13,205	29,137	8,255

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.1.3 Forest Cover Map of Andhra Pradesh

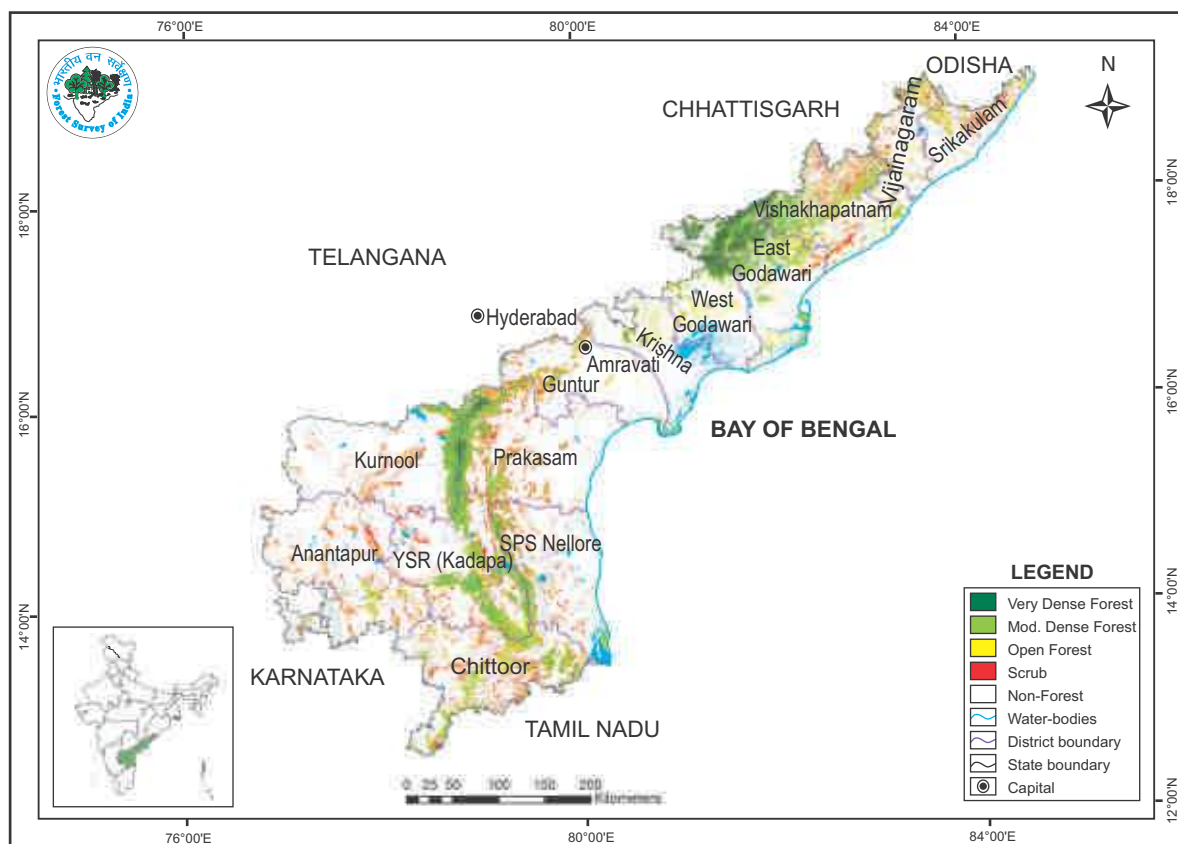


TABLE 11.1.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Andhra Pradesh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	2
Waterlogged	3	6
River/Stream	95	9,794
Sub - Total	99	9,802
Inland Wetlands -Man-made		
Reservoir/Barrage	219	18,011
Tank/Pond	339	1,944
Waterlogged	1	1
Sub - Total	559	19,956
Coastal Wetlands - Natural		
Lagoon	1	35
Creek	29	2,366
Sand/Beach	22	2,139
Intertidal mud flat	60	8,090
Salt Marsh	3	254
Mangrove	98	29,413
Sub -Total	213	42,297
Wetlands (<2.25 ha)	303	303
Total	1,174	72,358
Total Recorded Forest (or Green Wash) Area (in ha)		37,92,024
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.91%

(analysis based on the National Wetland Atlas: India, 2011)

11.1.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Andhra Pradesh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.



TABLE 11.1.9 Percentage area under different forest types of in Andhra Pradesh

Sl.No.	Forest Type	% of Forest cover
1.	3B/C2 Southern Moist Mixed Deciduous Forest	5.20
2.	4A/L1 Littoral Forest	0.22
3.	4B/TS2 Mangrove Forest	1.07
4.	5A/C1b Dry Teak Forest	1.57
5.	5A/C2 Dry Red Sanders-Bearing Forest	2.63
6.	5A/C3 Southern Dry Mixed Deciduous Forest	42.97
7.	5B/C1c Dry Peninsular Sal Forest	0.00
8.	5B/C2 Northern Dry Mixed Deciduous Forest	0.00
9.	5B/DS1 Dry Deciduous Scrub	31.58
10.	5B/DS2 Dry Savannah Forest	0.15
11.	5B/DS4 (Dry Grassland)	0.97
12.	5/E4 <i>Hardwickia</i> Forest	0.04
13.	5/E9 Dry Bamboo Brake	0.82
14.	5/2S1 Secondary Dry Deciduous Forest	2.11
15.	6A/C1 Southern Thorn Forest	5.03
16.	6A/C2 Karnatak Umbrella Thorn Forest	0.07
17.	6A/DS1 Southern Thorn Scrub	0.12
18.	6A/DS2 Southern <i>Euphorbia</i> Scrub	0.00
19.	7/C1 Tropical Dry Evergreen Forest	1.40
20.	7/DS1 Tropical Dry Evergreen Scrub	0.05
21.	Plantation/TOF	4.00
	Total	100.00

11.1.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.1.10 and table 11.1.11 in respect of Andhra Pradesh.

TABLE 11.1.10 Assessment of Biodiversity in Andhra Pradesh

Plant Type	Number of Species
Tree	242
Shrub	64
Herb	58

TABLE 11.1.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Andhra Pradesh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	3.15	2.13	2.89
2.	Group 4- Littoral and Swamp Forests	*	1.43	*
3.	Group 5- Tropical Dry Deciduous Forests	4.07	2.92	2.63
4.	Group 6- Tropical Thorn Forests	3.74	2.37	2.25
5.	Group 7- Tropical Dry Evergreen Forests	3.28	2.55	2.07

*adequate number of sample plots were not available

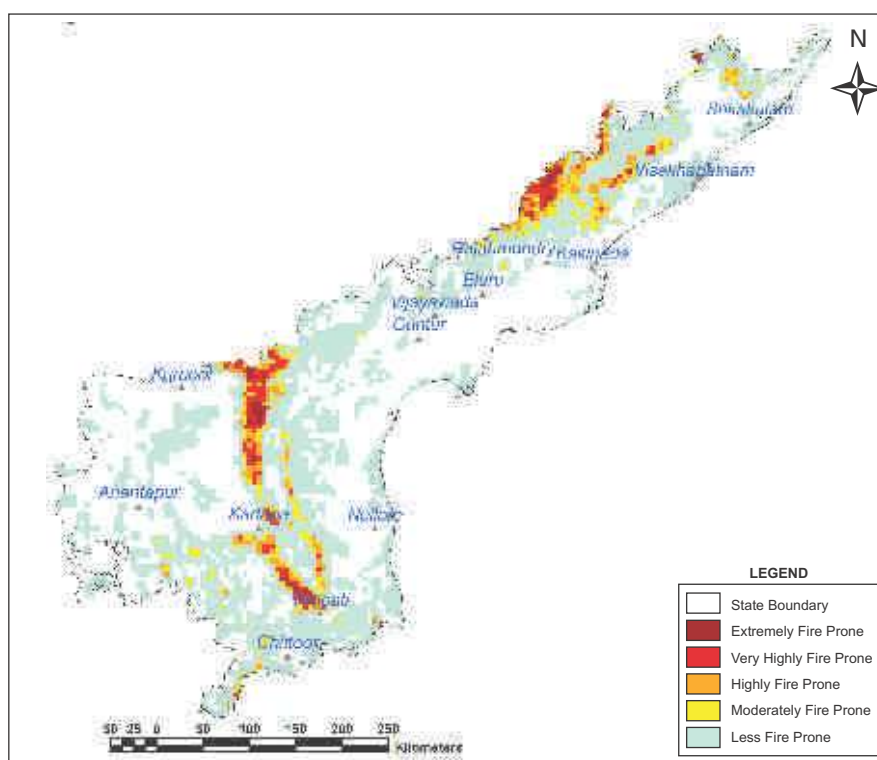
11.1.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.1.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	1,147.69	4.26
2	Very highly fire prone	3,784.74	13.04
3	Highly fire prone	5,017.28	15.27
4	Moderately fire prone	7,172.12	18.72
5	Less fire prone	64,626.70	48.71
	Total	81,748.53	100.00

FIGURE 11.1.4 Fire prone forest areas under different fire prone classes



11.1.5 Tree Cover

Forest cover presented in the section 11.1.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Andhra Pradesh has been estimated as given in table 11.1.13.

TABLE 11.1.13 Tree Cover in Andhra Pradesh (in sq km)

Tree Cover	Area
	3,914

Tree cover of Andhra Pradesh has increased by 161 sq km as compared to the previous assessment reported in ISFR2017.

11.1.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.1.14 Extent of TOF in Andhra Pradesh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
5,018	3,914	8,932

11.1.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Andhra Pradesh is given in the table 11.1.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.1.16

TABLE 11.1.15 Growing Stock in Andhra Pradesh (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	119.02	2.79
Growing Stock in TOF	67.68	4.12

TABLE 11.1.16 Diameter class distribution of top five species inside RFA in Andhra Pradesh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Xylia xylocarpa</i>	42,011	6,137	536
2.	<i>Anogeissus latifolia</i>	58,060	1,845	0
3.	<i>Chlorozylon swietenia</i>	32,011	865	0
4.	<i>Pterocarpus santalinus</i>	30,344	0	89
5.	<i>Lannea coromandelica</i>	21,713	2,562	0

11.1.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 219.53 million tonnes (804.94 million tonnes of CO₂ equivalent) which is 3.08 % of total forest carbon of the country. Pool wise forest carbon in Andhra Pradesh is given in the following table

Table 11.1.17 Forest Carbon in Andhra Pradesh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
60,972	24,206	629	3,074	13,0647	2,19,528

11.1.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.1.18

TABLE 11.1.18 Growing Stock of Bamboo in Andhra Pradesh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	7,003	4.38
Total number of culms (in millions)	1,820	4.61
Total equivalent green weight (in 000' tonnes)	16,157	5.82

11.1.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Andhra Pradesh in Rural and Urban areas are given in the table 11.1.19 and table 11.1.20 respectively

TABLE 11.1.19 Top five tree species in TOF (Rural) in Andhra Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	29.44
2.	<i>Borassus flabelliformis</i>	11.72
3.	<i>Azadirachta indica</i>	9.84
4.	<i>Cocos nucifera</i>	7.95
5.	<i>Anacardium occidentale</i>	5.20

TABLE 11.1.20 Top five tree species in TOF (Urban) in Andhra Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	16.46
2.	<i>Azadirachta indica</i>	11.66
3.	<i>Mangifera indica</i>	7.69
4.	<i>Tectona grandis</i>	7.23
5.	<i>Bongamia glabra</i>	6.88

11.1.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.1.21 and table 11.1.22 respectively.

TABLE 11.1.21 Major NTFP species in the state of Andhra Pradesh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Solanum nigrum</i>	Herb	98.98
2.	<i>Acacia concina</i>	Shrub	0.72
3.	<i>Oscimum bassilicum</i>	Herb	0.20
4.	<i>Nervilia aragoana</i>	Herb	0.10

TABLE 11.1.22 Major invasive species in the state inside the RFA/Green Wash in Andhra Pradesh (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	518
2.	<i>Ageratum conyzoides</i>	375
3.	<i>Chromolaena odorata</i>	202
4.	<i>Cuscuta spp.</i>	100
5.	<i>Prosopis juliflora</i>	94

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.1.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Andhra Pradesh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Andhra Pradesh is given in the table 11.1.23

TABLE 11.1.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Andhra Pradesh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
27,89,052	2,50,42,838	14,739	81,808



11.2

ARUNACHAL PRADESH

11.2.1 Introduction

Arunachal Pradesh is known as the land of the rising sun with reference to its position as the eastern most State of India. It gained Union Territory status on 20th January 1972 and was renamed Arunachal Pradesh on 15th August 1975. Arunachal Pradesh got full statehood on the 20th February 1987. It is the largest State in the North Eastern region and 15th largest in the country with an area of 83,743 sq km, which is 2.54% of the geographical area of the country. The State lies between 26°28' N to 29°30' N latitude and 91°30' E to 97°30' E longitude and stretches from snow-capped mountains of the Eastern Himalayas in the north to the plains of Brahmaputra valley in the south. The State shares international boundaries with Bhutan to the West, China to the North & Northeast and Myanmar to the east. The States of Assam & Nagaland share the Southern border of Arunachal Pradesh. The five major rivers viz Kameng, Subansiri, Siang, Lohit and Tirap divide the State in to five major valleys. Climate varies from temperate in the northern part to warm and humid in the southern part. The annual rainfall ranges between 2,000 mm to 8,000 mm and the annual temperature varies from below 0°C to 31°C. There are 16 districts in the State and all are classified as hill and tribal districts. As per the 2011 census, Arunachal Pradesh has a population of 1.38 million which is only 0.11% of country's population. The rural and urban population constitute 77.06% and 22.94% respectively. The Tribal population is 68.79%. The population density of the State is 17 persons per sq km which is lowest in the country. The 19th Livestock census 2012 has reported a total livestock population of 1.41 million in the State.

TABLE 11.2.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	8,374	
Reporting area for land utilization	7,228	100.00
Forests	6,725	93.03
Not available for land cultivation	62	0.86
Permanent pastures and other grazing lands	18	0.25
Land under misc. tree crops and groves	35	0.49
Culturable wasteland	62	0.86
Fallow land other than current fallows	65	0.89
Current fallows	36	0.50
Net area sown	225	3.12

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.2.1.1 A Brief Overview of Forestry Scenario

Arunachal Pradesh is a forest rich State in Eastern Himalayan region of the country. The State has about 20% species of country's fauna, about 4,500 species of flowering plants, 400 species of pteridophytes, 23 species of conifers, 35 species of bamboos, 20 species of canes, 52 species of Rhododendron and more than 500 species of orchids. As per the Champion & Seth Classification of Forest Types (1968), the forests in Arunachal Pradesh belong to 11 Type Groups which are further divided into 23 different Forest Types.

Forests are the mainstay of the economy and the livelihoods of local people have been closely linked and heavily dependent on forest resources since time immemorial. Cane and bamboo are found in abundance. However, with increasing population, developmental activities and practices like jhuming, the pressure on forest resources is consistently increasing, leading to their degradation and affecting regeneration and productivity. Tropical rain forests are found in the foothills and hills in the east along the border with Myanmar. The northern parts of the State is covered with Alpine forests. The diversity of topographical and climatic conditions has favoured the growth of luxuriant forests, which are home to myriad plant and animal forms, adding beauty to the landscape.

Recorded Forest Area (RFA) in the State is 51,407 sq km of which 10,589 sq km is Reserved Forest, 9,779 sq km is Protected Forest and 31,039 sq km is Unclassed Forest. In Arunachal Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 451.37 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Two National Parks and 11 Wildlife Sanctuaries constitute the Protected Area network of the State covering 11.68% of its geographical area.

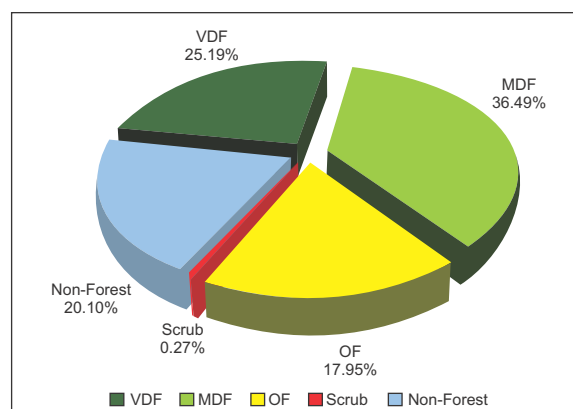
11.2.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Mar 2018, the Forest Cover in the State is 66,687.78 sq km which is 79.63 % of the State's geographical area. In terms of forest canopy density classes, the State has 21,095.43 sq km under Very Dense Forest (VDF), 30,556.50 sq km under Moderately Dense Forest (MDF) and 15,035.85 sq km under Open Forest (OF). Forest Cover in the State has decreased by 276.22 sq km as compared to the previous assessment reported in ISFR2017.

TABLE 11.2.2 Forest Cover of Arunachal Pradesh
(in sq km)

Class	Area	% of GA
VDF	21,095.43	25.19
MDF	30,556.50	36.49
OF	15,035.85	17.95
Total	66,687.78	79.63
Scrub	229.46	0.27

FIGURE 11.2.1 Forest Cover of Arunachal Pradesh



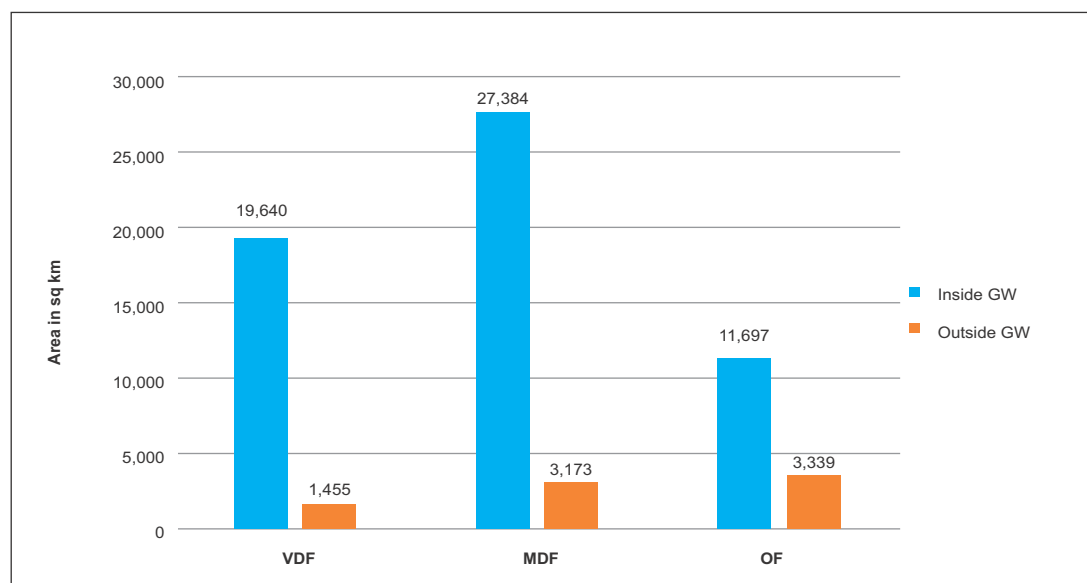
11.2.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 51,407 sq km which is 61.39% of its geographical area. The reserved, protected and unclassified forests are 20.60 % and 19.02% and 60.38% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 63,838.03 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.2.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Arunachal Pradesh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
19,640	27,384	11,697	58,721	1,455	3,173	3,339	7,967
33.45%	46.63%	19.92%		18.27%	39.81%	41.92%	

*in case of Arunachal Pradesh Green Wash boundaries have been used.

FIGURE 11.2.2 Forest Cover inside and outside Green Wash in Arunachal Pradesh**TABLE 11.2.4** District-wise Forest Cover in Arunachal Pradesh (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Changlang TH	4,662	1,789.84	1,351.70	845.22	3,986.76	85.52	-5.24	4.30
Dibang Valley TH & Lower Dibang Valley TH	13,029	1,697.51	4,930.62	2,579.77	9,207.90	70.67	-24.10	7.11
East Kameng TH & West Kameng TH	11,556	3,425.53	4,636.85	2,171.74	10,234.12	88.56	-43.88	27.35
East Siang TH	3,603	876.38	1,264.08	728.64	2,869.10	79.63	-10.90	9.46
Kurung Kumey TH & Lower Subansiri TH	9,548	3,150.78	3,844.00	1,375.34	8,370.12	87.66	-11.88	30.21
Lohit TH & Anjaw TH	11,402	2,053.68	3,895.61	1,638.31	7,587.60	66.55	-13.40	8.82
Papum Pare TH	3,462	989.07	1,481.79	714.05	3,184.91	92.00	-6.09	2.87
Tawang TH	2,172	336.08	453.58	384.49	1,174.15	54.06	-2.85	28.64
Tirap TH	2,362	740.00	657.21	463.78	1,860.99	78.79	-74.01	65.35
Upper Siang TH	6,590	1,558.87	2,486.02	1,315.84	5,360.73	81.35	-8.27	16.74
Upper Subansiri TH	7,032	1,830.28	2,617.85	1,104.87	5,553.00	78.97	-18.00	24.56
West Siang TH	8,325	2,647.41	2,937.19	1,713.80	7,298.40	87.67	-57.60	4.05
Grand Total	83,743	21,095.43	30,556.50	15,035.85	66,687.78	79.63	-276.22	229.46

TABLE 11.2.5 Forest Cover Change Matrix for Arunachal Pradesh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	20,363	299	15	0	44	20,721
Moderately Dense Forest	708	30,093	16	1	137	30,955
Open Forest	24	165	14,893	3	203	15,288
Scrub	0	0	13	222	12	247
Non Forest	0	0	99	3	16,430	16,532
Total ISFR 2019	21,095	30,557	15,036	229	16,826	83,743
Net Change	374	-398	-252	-18	294	

A decrease of 276.22 sq km observed in the forest cover of the state can be attributed to the shifting cultivation and developmental activities.

TABLE 11.2.6 Altitude-wise Forest Cover in Arunachal Pradesh

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	11,136	1,432	3,391	2,330	7,153 (10.73%)	28
500-1000	11,082	2,696	4,101	3,433	10,230 (15.34%)	34
1000-2000	23,752	8,003	9,918	4,426	22,347 (33.51%)	47
2000-3000	17,965	6,752	8,813	1,615	17,180 (25.76%)	8
3000-4000	13,370	2,164	4,115	2,819	9,098 (13.64%)	66
>4000	6,438	48	219	413	680 (1.02%)	46
Total	83,743	21,095	30,557	15,036	66,688	229

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.2.7 Forest Cover in different slope classes in Arunachal Pradesh

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	7,629	708	1,897	1,106	3,711 (5.57%)	26
5-10	5,608	1,431	1,997	889	4,317 (6.47%)	16
10-15	8,588	2,507	3,034	1,427	6,968 (10.45%)	27
15-20	11,278	3,358	4,005	1,935	9,298 (13.94%)	34
20-25	12,494	3,657	4,499	2,189	10,345 (15.51%)	35
25-30	12,172	3,439	4,518	2,207	10,164 (15.24%)	32
>30	25,974	5,995	10,607	5,283	21,885 (32.82%)	59
Total	83,743	21,095	30,557	15,036	66,688	229

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.2.3 Forest Cover Map of Arunachal Pradesh

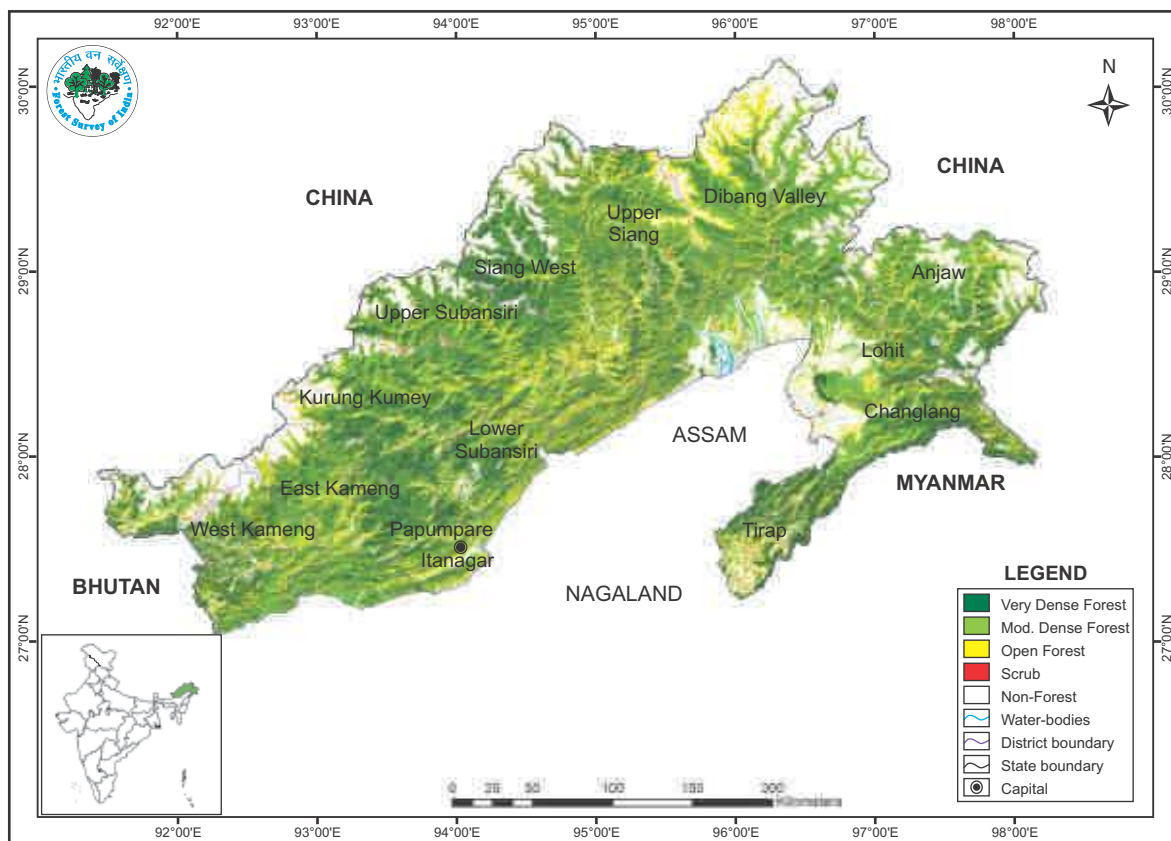


TABLE 11.2.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Arunachal Pradesh (in ha)

Wetland Category	No. of Wetlands	Total Wetlands Area
Inland Wetlands - Natural		
Lake/Pond	3	18
Ox-bow lake/Cut-off meander	26	366
Riverine wetland	345	2,392
Waterlogged	86	3,874
River/Stream	47	60,446
Sub - Total	507	67,096
Inland Wetlands -Man-made		
Reservoir/Barrage	3	40
Tank/Pond	29	82
Sub - Total	32	122
Wetlands (<2.25 ha)	804	804
Total	1,343	68,022
Total Recorded Forest (or Green Wash) Area (in ha)		63,83,803
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.07%

(analysis based on the National Wetland Atlas: India, 2011)

11.2.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Arunachal Pradesh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.2.9 Percentage area under different forest types of Arunachal Pradesh

Sl.No.	Forest Type	% of Forest Cover
1.	1B/C1 Assam Valley Tropical Wet Evergreen Forest (<i>Dipterocarpus</i>)	2.13
2.	1B/C2a Kayea Forest	0.36
3.	1/2S1 Pioneer Euphorbiaceous Scrub	0.20
4.	2/2S1 Secondary Moist Bamboo Brakes	3.70
5.	2B/C1a Assam Alluvial Plains Semi-Evergreen Forest	4.84
6.	2B/1S1 Sub-Himalayan Light Alluvial Semi-Evergreen Forest	6.60
7.	2B/2S2 Eastern Alluvial Secondary Semi-Evergreen Forest	3.44
8.	2B/C1b Eastern Sub-Montane Semi-Evergreen Forest	3.32
9.	3/1S2b <i>Terminalia-Duabanga</i> Forest	1.24
10.	3C/C3/2S2 (Secondary Euphorbiaceous Scrub)	0.00
11.	8B/C1 East Himalayan Sub-Tropical Wet Hill Forest	24.35
12.	8B/C2 Khasi Sub-Tropical Wet Hill Forest	0.04
13.	9/C2 Assam Sub-Tropical Pine Forest	0.59
14.	9/C2/DS1 Assam Subtropical Pine Savannah	0.08
15.	11B/C1 East Himalayan Wet Temperate Forest	22.92
16.	12/C1f Low-Level Blue Pine Forest (<i>P. wallichiana</i>)	0.71
17.	12/C3a East Himalayan Mixed Coniferous Forest	1.95
18.	12/DS3 Himalayan Temperate Pastures	0.22
19.	13/C6 Eastern Himalayan Dry Temperate Coniferous Forest	2.19
20.	14/C2 East Himalayan Sub-Alpine Birch/Fir Forest	13.46
21.	15/C1 Birch/ <i>Rhododendron</i> Scrub Forest	0.21
22.	15/C3 (Alpine Pastures)	6.73
23.	16/C1 Dry Alpine Scrub	0.63
24.	Plantation/TOF	0.09
	Total	100.00

11.2.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.2.10 and table 11.2.11 in respect of Arunachal Pradesh.

TABLE 11.2.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	110
Shrub	435
Herb	192

TABLE 11.2.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Arunachal Pradesh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	3.18	3.62	2.99
2.	Group 2- Tropical Semi-Evergreen Forests	3.33	4.50	4.05
3.	Group 3- Tropical Moist Deciduous Forests	2.13	3.81	3.09
4.	Group 8- Subtropical Broadleaved Hill Forests	1.49	3.57	2.96
5.	Group 9- Subtropical Pine Forests	*	3.09	2.01
6.	Group 11- Montane Wet Temperate Forests	0.93	*	*
7.	Group 12- Himalayan Moist Temperate Forests	2.06	3.11	2.41
8.	Group 13- Himalayan Dry Temperate Forests	*	2.80	1.76
9.	Group 14- Sub Alpine Forests	*	3.16	1.88
10.	Group 15- Moist Alpine Scrub	*	1.60	*

* adequate number of sample plots were not available

11.2.4 Fire Prone Forest Areas

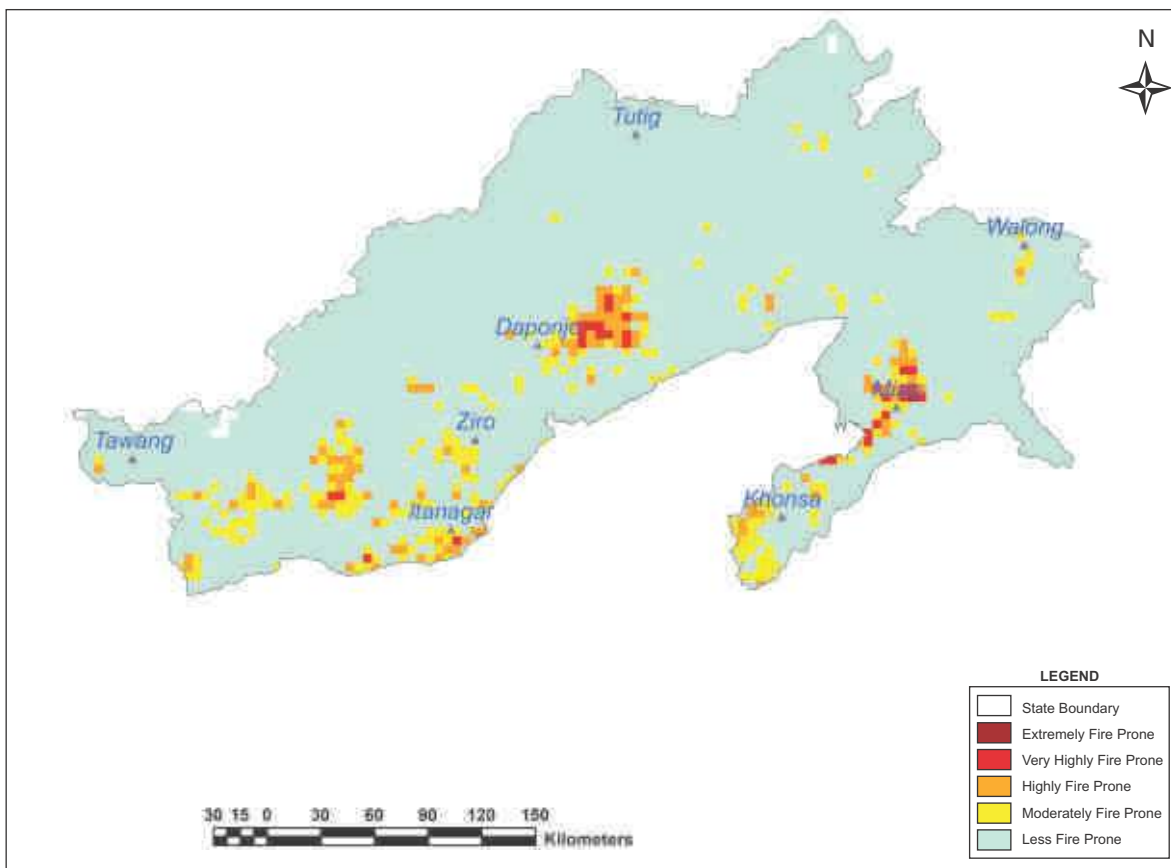
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.2.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geo graphical Area	% of Total forest cover
1	Extremely fire prone	25.50	0.01
2	Very highly fire prone	750.74	0.97
3	Highly fire prone	2,639.79	3.49
4	Moderately fire prone	5,591.97	6.87
5	Less fire prone	74,295.14	88.66
	Total	83,303.14	100.00



FIGURE 11.2.4: Fire prone forest areas under different fire prone classes



11.2.5 Tree Cover

Forest cover presented in the section 11.2.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Arunachal Pradesh has been estimated as given in table 11.2.13.

TABLE 11.2.13 Tree Cover in Arunachal Pradesh (in sq km)

Tree Cover	Area
	848

Tree cover of Arunachal Pradesh has increased by 41 sq km as compared to the previous assessment reported in ISFR2017.

11.2.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.2.14 Extent of TOF in Arunachal Pradesh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
7,967	848	8,815

11.2.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Arunachal Pradesh is given in the table 11.2.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.2.16

TABLE 11.2.15 Growing Stock in Forest (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	458.00	10.72
Growing Stock in TOF	75.08	4.57

TABLE 11.2.16 Diameter class distribution of top five species inside RFA in Arunachal Pradesh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Terminalia myriocarpa</i>	30,984	18,665	3,294
2.	<i>Callicarpa arborea</i>	39,823	0	0
3.	<i>Macaranga species</i>	31,095	1,098	0
4.	<i>Albizia species</i>	15,774	7,685	0
5.	<i>Castanopsis species</i>	55,994	8,783	0

11.2.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 1,051.32 million tonnes (3,854.84 million tonnes of CO₂ equivalent) which is 14.76% of total forest carbon of the country. Pool wise forest carbon in Arunachal Pradesh is given in the following table

TABLE 11.2.17 Forest Carbon in Arunachal Pradesh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
3,30,856	1,00,379	7,816	15,436	5,96,836	1,051,323

11.2.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.2.18

TABLE 11.2.18 Growing Stock of Bamboo in Arunachal Pradesh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	14,981	9.36
Total number of culms (in millions)	5,769	14.62
Total equivalent green weight (in 000' tonnes)	27,932	10.06

11.2.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Arunachal Pradesh in Rural and Urban areas are given in the table 11.2.19 and table 11.2.20 respectively

TABLE 11.2.19 Top five tree species in TOF (Rural) in Arunachal Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus wallichiana</i>	22.57
2.	<i>Phoebe goalparensis</i>	3.51
3.	<i>Shorea assamica</i>	3.22
4.	<i>Callicarpa arborea</i>	3.03
5.	<i>Macaranga species</i>	2.95

TABLE 11.2.20 Top five tree species in TOF (Urban) in Arunachal Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Gmelina arborea</i>	11.61
2.	<i>Grevillea robusta</i>	6.74
3.	<i>Areca catechu</i>	6.07
4.	<i>Mangifera indica</i>	5.56
5.	<i>Artocarpus integrifolia</i>	4.53

11.2.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.2.21 and table 11.2.22 respectively

TABLE 11.2.21 Major NTFP species in the State of Arunachal Pradesh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Diplagium species</i>	Herb	69.20
2.	<i>Swertia chiraita</i>	Herb	11.26
3.	Thatch Grass	Herb	5.75
4.	<i>Thysanolaena maxima</i>	Herb	4.14
5.	<i>Cyperus rotundus</i>	Herb	3.68

TABLE 11.2.22 Major invasive species in the State inside the RFA/Green Wash in Arunachal Pradesh

(in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	499
2.	<i>Mikania micrantha</i>	468
3.	<i>Ageratum conyzoides</i>	124
4.	<i>Lantana camara</i>	107
5.	<i>Acacia farnesiana</i>	90

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.2.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Arunachal Pradesh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Arunachal Pradesh is given in the table 11.2.23

TABLE 11.2.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Arunachal Pradesh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
44,049	5,27,529	398	1,314

11.3

ASSAM

11.3.1 Introduction

Assam the second largest State in North Eastern India, is situated south of the Eastern Himalayas along the Brahmaputra and Barak river valleys. The State has a geographical area of 78,438 sq km, which is 2.39% of the geographical area of the country. The State lies between 24°07' N to 28°00' N latitude 89°42' E to 96°02' E longitude. The State can be broadly divided into 3 physiographic domains viz. Brahmaputra valley, Central Assam Hills (Mikir Hills in Karbi Anglong and North Cachar Hill districts) and Barak valley. The State has subtropical climate and the annual rainfall ranges between 1,500 mm to 3,800 mm and the annual temperature varies from 5°C to 32°C. Brahmaputra is a major river draining the State. The State is bordered by Arunachal Pradesh in the north, Meghalaya, Tripura & Mizoram in the south, Nagaland and Manipur in the east and West Bengal in west. The State also has international borders with Bhutan in the North and Bangladesh in the South. The State has 27 districts, among which 19 are tribal and 3 are hill districts. As per the 2011 census, Assam has a population of 31.21 million accounting to 2.58% of India's population. The State's urban and rural population is 14.10% & 85.90% respectively. The Tribal population is 12.45 %. The average population density is 398 persons per sq km which is slightly higher than the national average. The Livestock population as per 19th Live Stock Census 2012 is 19.08 million.

TABLE 11.3.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	7,844	
Reporting area for land utilization	7,844	100.00
Forests	1,853	23.62
Not available for land cultivation	2,460	31.37
Permanent pastures and other grazing lands	167	2.13
Land under misc. tree crops and groves	220	2.80
Culturable wasteland	142	1.81
Fallow land other than current fallows	87	1.11
Current fallows	87	1.11
Net area sown	2,827	36.05

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.3.1.1 A Brief Overview of Forestry Scenario

Assam is the land of enchanting aesthetic beauty with lush green hills, pastures, tea gardens, river plains and wilderness. Running and cascading through the entire length and breadth of the State are mighty rivers; the Brahmaputra in the north and the Barak in the south, which along with their tributaries nourish a wide range of precious flora and fauna in the State. The Kaziranga National Park, a UNESCO World Heritage site in the State is home to two-thirds of the world's population of the one-horned Rhinoceros. The one-horned Rhino which was almost extinct in India, with only a dozen left at the turn of last century, now stands restored to scientifically sustainable level. As per the Champion & Seth Classification of Forest Types (1968), the forests of Assam belong to seven Forest Type Groups further divided into 25 different Forest Types. Assam can boast of possessing a host of endangered and rare mammals, avian and amphibian species. These include pigmy hog, hispid hare, white winged wood duck and great Indian hornbill among many others.

Recorded Forest Area (RFA) in the State is 26,832 sq km of which 17,864 sq km is Reserved Forest and 8,968 sq km is Unclassed Forest. In Assam, during the period 1st January 2015 to 5th February 2019, only 1 hectare of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Five National Parks and 18 Wildlife Sanctuaries constitute the Protected Area network of the State covering 4.87% of its geographical area.

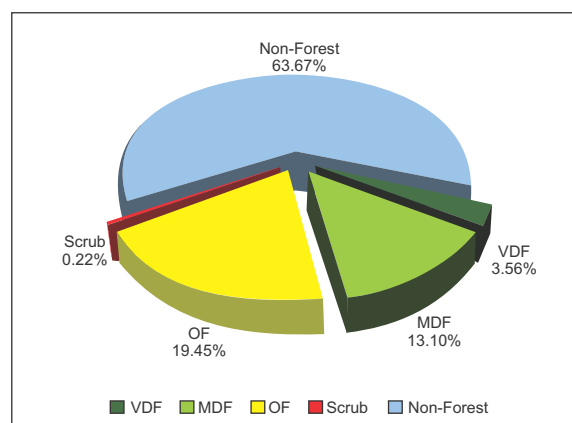
11.3.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Feb 2018, the Forest Cover in the State is 28,326.51 sq km which is 36.11 % of the State's geographical area. In terms of forest canopy density classes, the State has 2,794.86 sq km under Very Dense Forest (VDF), 10,278.91 sq km under Moderately Dense Forest (MDF) and 15,252.74 sq km under Open Forest (OF). Forest Cover in the State has increased by 221.51 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.3.2 Forest Cover of Assam
(in sq km)

Class	Area	% of GA
VDF	2,794.86	3.56
MDF	10,278.91	13.10
OF	15,252.74	19.45
Total	28,326.51	36.11
Scrub	173.43	0.22

FIGURE 11.3.1 Forest Cover of Assam



11.3.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 26,832 sq km which is 34.21% of its geographical area. The reserved and unclassified forests are 66.58% and 33.42% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 27,547.84 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.3.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Assam (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
2,540	8,840	8,764	20,144	255	1,439	6,489	8,183
12.61%	43.88%	43.51%		3.11%	17.59%	79.30%	

*in case of Assam Green Wash boundaries have been used

FIGURE 11.3.2 Forest Cover inside and outside Green Wash in Assam

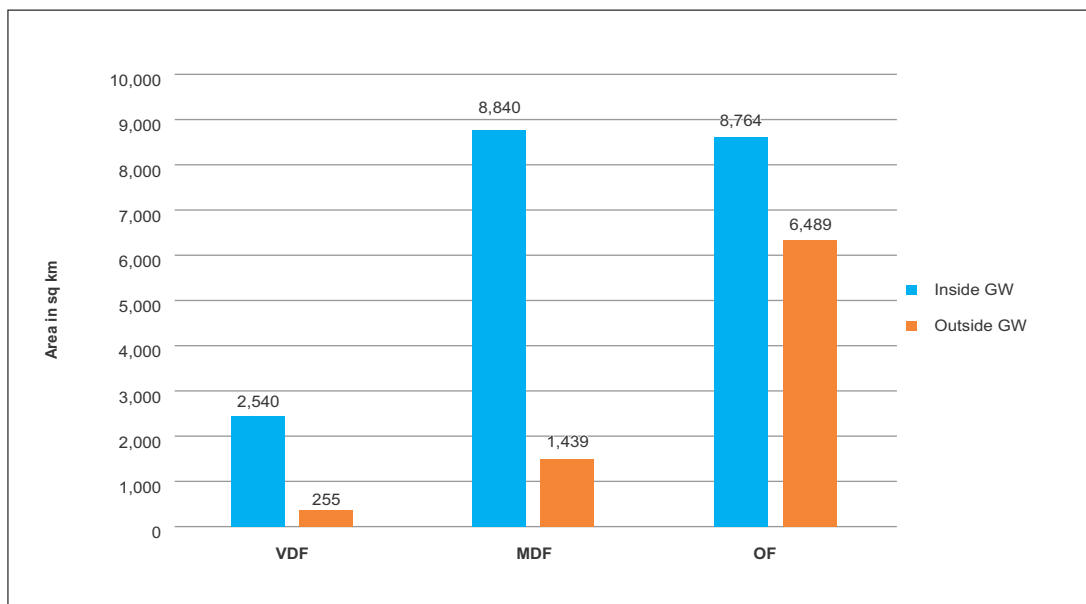


TABLE 11.3.4 District-wise Forest Cover in Assam

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Baksa ^T	2,457	156.00	130.01	273.66	559.67	22.78	3.67	6.00
Barpeta ^T	2,282	0.00	33.21	81.97	115.18	5.05	10.18	1.00
Bongaigaon	1,093	0.00	62.18	187.95	250.13	22.88	14.13	0.00
Cachar ^T	3,786	93.00	1,077.58	1,051.76	2,222.34	58.70	-0.66	17.45
Chirang	1,923	402.00	110.45	187.39	699.84	36.39	5.84	3.00
Darrang ^T	1,585	0.00	13.89	75.54	89.43	5.64	3.43	1.00
Dhemaji ^T	3,237	68.00	124.66	152.14	344.80	10.65	6.80	4.00
Dhubri ^T	2,176	1.00	22.44	75.02	98.46	4.52	8.46	4.00
Dibrugarh ^T	3,381	105.86	68.10	581.27	755.23	22.34	-1.77	1.00
Dima Hasao ^H	4,888	209.00	1,519.73	2,478.20	4,206.93	86.07	-3.07	4.00
Goalpara ^T	1,824	14.00	137.66	244.08	395.74	21.70	97.74	1.72
Golaghat	3,502	21.00	119.30	529.61	669.91	19.12	18.91	4.00
Hailakandi	1,327	13.00	366.04	395.30	774.34	58.35	1.34	1.48
Jorhat ^T	2,851	12.00	103.00	445.10	560.10	19.65	6.10	4.00
Kamrup ^T	3,105	50.00	455.95	457.52	963.47	31.03	44.47	3.00
Kamrup Metropolitan ^T	955	0.00	225.00	235.05	460.05	48.17	0.05	1.00
Karbi-Anglong ^H	10,434	583.93	3,766.62	3,538.63	7,889.18	75.61	-93.82	84.38
Karimganj	1,809	3.00	300.23	548.20	851.43	47.07	35.43	0.76
Kokrajhar ^T	3,296	438.00	270.19	458.38	1,166.57	35.39	8.57	1.00
Lakhimpur ^T	2,277	29.00	85.88	191.69	306.57	13.46	11.57	0.96
Morigaon ^T	1,551	10.00	42.00	122.11	174.11	11.23	0.11	4.00
Naogaon ^H	3,973	50.00	363.00	498.26	911.26	22.94	1.26	9.00
Nalbari ^T	1,052	0.00	30.84	76.27	107.11	10.18	13.11	0.00
Sibsagar ^T	2,668	9.00	152.83	528.13	689.96	25.86	1.96	2.40
Sonitpur ^T	5,204	108.97	257.53	703.11	1,069.61	20.55	14.61	3.38
Tinsukia ^T	3,790	410.10	353.92	818.55	1,582.57	41.76	3.57	9.90
Udalguri ^T	2,012	8.00	86.67	317.85	412.52	20.50	9.52	1.00
Grand Total	78,438	2,794.86	10,278.91	15,252.74	28,326.51	36.11	221.51	173.43

TABLE 11.3.5 Forest Cover Change Matrix for Assam

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	2,795	0	0	0	2	2,797
Moderately Dense Forest	0	10,149	3	0	40	10,192
Open Forest	0	7	14,923	10	176	15,116
Scrub	0	0	51	163	3	217
Non Forest	0	123	276	0	49,717	50,116
Total ISFR 2019	2,795	10,279	15,253	173	49,938	78,438
Net Change	-2	87	137	-44	-178	

An increase of 221.51 sq km in the forest cover is mainly due to plantations mostly outside of forest areas.

TABLE 11.3.6 Altitude-wise Forest Cover in Assam (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	72,348	2,287	7,876	12,825	22,988 (81.15%)	136
500-1000	5,315	362	2,108	2,153	4,623 (16.32%)	36
1000-2000	775	146	295	2,75	716 (2.53%)	1
Total	78,438	2,795	10,279	15,253	28,327	173

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.3.7 Forest Cover in different slope classes in Assam (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	61,901	1,767	3,887	8,608	14,262 (50.34%)	108
5-10	6,929	366	2,323	2,515	5,204 (18.37%)	30
10-15	4,156	229	1,688	1,802	3,719 (13.13%)	17
15-20	2,643	176	1,118	1,169	2,463 (8.69%)	10
20-25	1,511	124	654	654	1,432 (5.06%)	5
25-30	759	74	338	315	727 (2.57%)	2
>30	539	59	271	190	520 (1.84%)	1
Total	78,438	2,795	10,279	15,253	28,327	173

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.3.3 Forest Cover Map of Assam

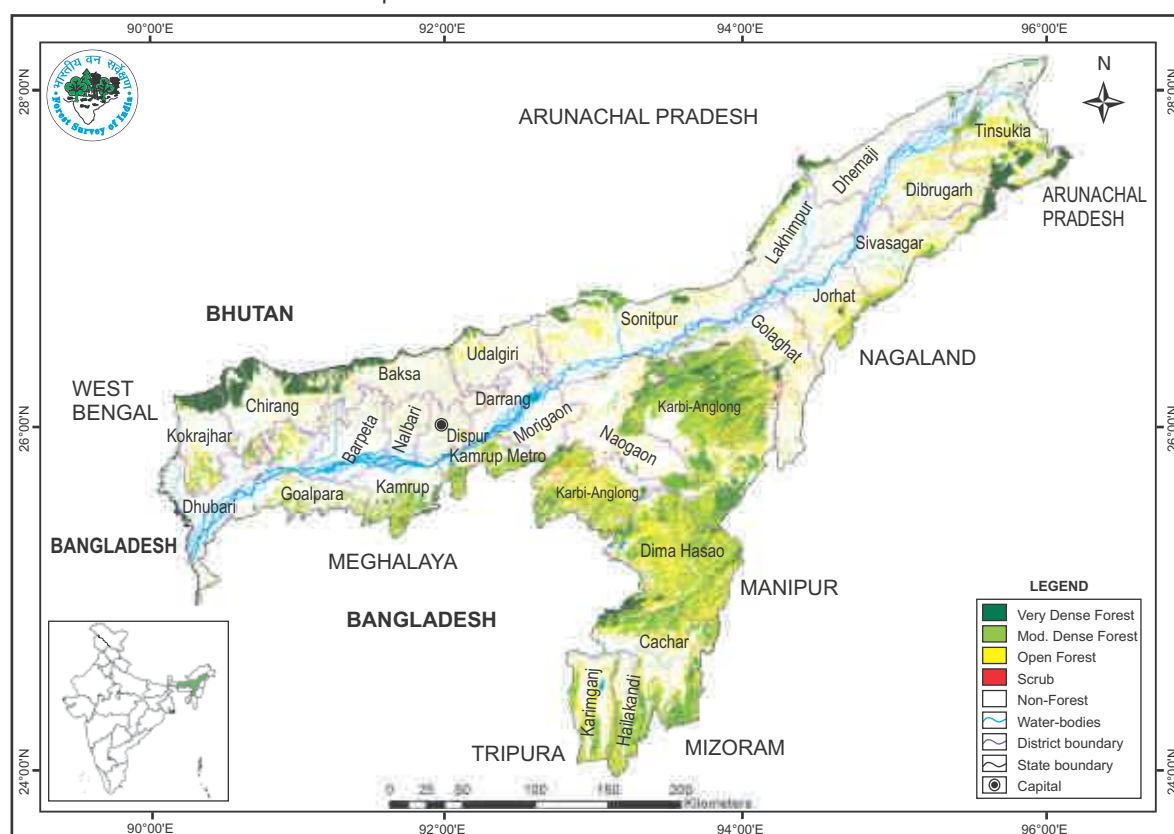


TABLE 11.3.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Assam (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	224	4,619
Ox-bow lake/Cut-off meander	140	1,223
Riverine wetland	36	1,168
Waterlogged	411	3,601
River/Stream	227	54,456
Sub - Total	1,038	65,067
Inland Wetlands -Man-made		
Reservoir/Barrage	2	2,217
Tank/Pond	12	35
Waterlogged	5	11
Sub - Total	19	2,263
Wetlands (<2.25 ha)	527	527
Total	1,584	67,857
Total Recorded Forest (or Green Wash) Area (in ha)		27,54,784
% of Wetland area inside Recorded Forest (or Green Wash) Area		2.46%

(analysis based on the National Wetland Atlas: India, 2011)

11.3.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Assam as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.3.9 Percentage area under different forest types of Assam

Sl.No.	Forest Type	% of Forest cover
1.	1B/C1 Assam Valley Tropical Wet Evergreen Forest (<i>Dipterocarpus</i>)	3.56
2.	1B/C3 Cachar Tropical Evergreen Forest	3.11
3.	1B/C2a Kayea Forest	0.76
4.	1B/C2b Mesua Forest	0.02
5.	2B/C2 Cachar Semi-Evergreen Forest	37.75
6.	2/2S1 Secondary Moist Bamboo Brakes	3.01
7.	2B/C1a Assam Alluvial Plains Semi-Evergreen Forest	1.60
8.	2B/1S1 Sub-Himalayan Light Alluvial Semi-Evergreen Forest	1.25
9.	2B/2S2 Eastern Alluvial Secondary Semi-Evergreen Forest	1.23
10.	2B/2S1 (Pioneer Euphorbiaceous Scrub)	0.28
11.	2B/1S2 Syzygium Parkland	0.07
12.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	17.92
13.	3C/C2d(iv) App. Kamrup Sal	2.71
14.	3C/C1b(I) East Himalayan Upper Bhabar Sal	2.37
15.	3C/2S1 Northern Secondary Moist Mixed Deciduous Forest	1.93
16.	3C/1S1 Low Alluvial Savannah Woodland (<i>Salmalia albizzia</i>)	0.05
17.	3C/C1a(ii) Khasi Hill Sal	0.12

Contd.

Sl.No.	Forest Type	% of Forest cover
18.	3/1S2a Terminalia-Lagerstroemia	0.01
19.	4D/SS1 Eastern Seasonal Swamp Forest	0.01
20.	4C/FS3 Creeper Swamp Forest	0.00
21.	4D/2S1 (Syzygium Parkland)	0.00
22.	4D/2S2 Eastern Wet Alluvial Grassland	0.53
23.	5/1S2 Khair-Sissu Forest	0.08
24.	8B/DS1 (Assam Subtropical Hill Savannah Woodland)	0.04
25.	9/C2 Assam Sub-Tropical Pine Forest	0.41
26.	Plantation/TOF	21.18
	Total	100.00

11.3.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.3.10 and table 11.3.11 in respect of Assam.

TABLE 11.3.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	143
Shrub	149
Herb	153

TABLE 11.3.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Assam

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 1- Tropical Wet Evergreen Forests	2.63	2.99	3.16
2	Group 2- Tropical Semi-Evergreen Forests	3.50	3.17	3.47
3	Group 3- Tropical Moist Deciduous Forests	3.58	2.64	2.85
4	Group 4- Littoral and Swamp Forests	1.37	2.20	2.38
5	Group 5- Tropical Dry Deciduous Forests	*	2.77	2.82
6	Group 8- Subtropical Broadleaved Hill Forests	0.50	2.44	2.25
7	Group 9- Subtropical Pine Forests	1.56	2.54	3.07

* adequate number of sample plots were not available



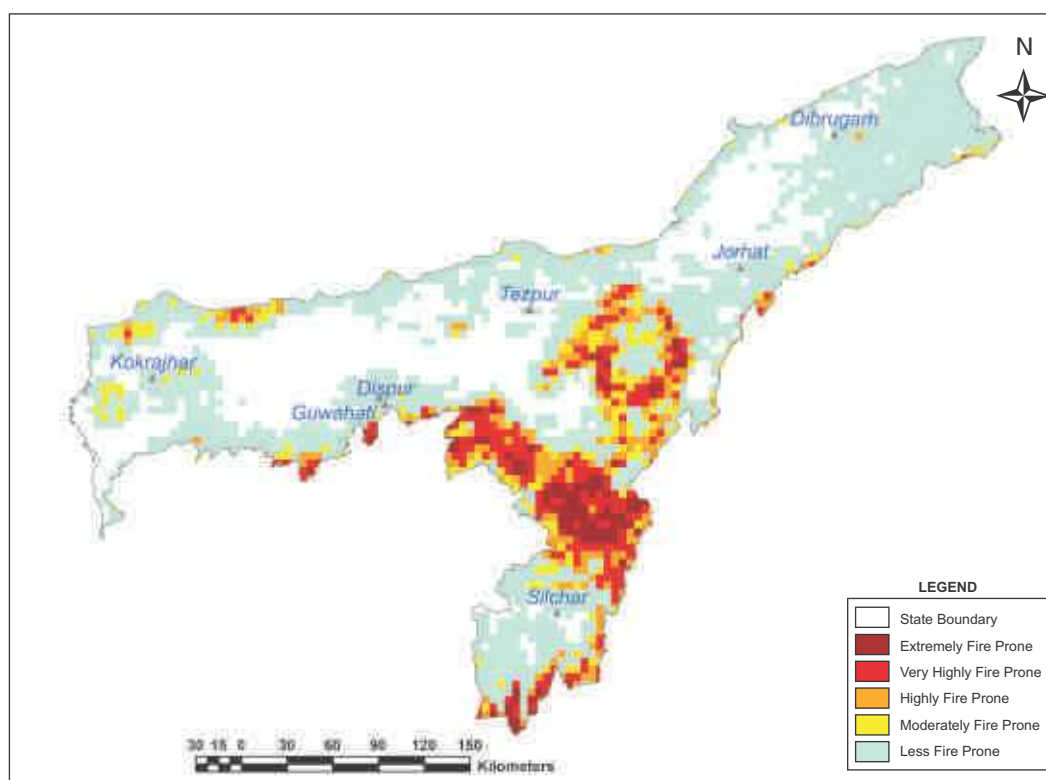
11.3.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.3.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geo graphical Area	% of Total forest cover
1.	Extremely fire prone	6,292.11	21.98
2.	Very highly fire prone	1,743.42	6.10
3.	Highly fire prone	4,731.93	14.48
4.	Moderately fire prone	4,726.24	13.72
5.	Less fire prone	35,712.64	43.72
	Total	53,206.34	100.00

FIGURE 11.3.4 Fire prone forest areas under different fire prone classes



11.3.5 Tree Cover

Forest cover presented in the section 11.3.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Assam has been estimated as given in table 11.3.13

TABLE 11.3.13 Tree Cover in Assam (in sq km)

Tree Cover	Area
	1,408

Tree cover of Assam has decreased by 88 sq km as compared to the previous assessment reported in ISFR2017.

11.3.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.3.14 Extent of TOF in Assam (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
8,183	1,408	9,591

11.3.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Assam is given in the table 11.3.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.3.16

TABLE 11.3.15 Growing Stock in Assam (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	115.40	2.70
Growing Stock in TOF	22.96	1.40

TABLE 11.3.16 Diameter class distribution of top five species inside RFA in Assam (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Schima wallichii</i>	22,155	4,425	0
2.	<i>Bauhinia retusa</i>	11,794	1,668	171
3.	<i>Shorea robusta</i>	8,878	514	171
4.	<i>Tectona grandis</i>	14,607	2,694	0
5.	<i>Albizia species</i>	9,219	3,588	316

11.3.7 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 270.15 million tonnes (990.55 million tonnes of CO₂ equivalent) which is 3.79 % of total forest carbon of the country. Pool wise forest carbon in Assam is given in the following table

TABLE 11.3.17 Forest Carbon in Assam in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
85,844	21,148	11,002	7,223	1,54,832	2,70,149

11.3.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.3.18

TABLE 11.3.18 Growing Stock of Bamboo in Assam

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	10,525	6.58
Total number of culms (in millions)	3,829	9.70
Total equivalent green weight (in 000' tonnes)	24,064	8.67

11.3.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Assam in Rural and Urban areas are given in the table 11.3.19 and table 11.3.20 respectively

TABLE 11.3.19 Top five tree species in TOF (Rural) in Assam

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca catechu</i>	27.87
2.	<i>Albizia species</i>	5.11
3.	<i>Gmelina arborea</i>	4.85
4.	<i>Hevea brasiliensis</i>	4.37
5.	<i>Albizia procera</i>	4.17

TABLE 11.3.20 Top five tree species in TOF (Urban) in Assam

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca catechu</i>	42.06
2.	<i>Cocos nucifera</i>	11.23
3.	<i>Mangifera indica</i>	8.74
4.	<i>Artocarpus integrifolia</i>	4.05
5.	<i>Anthocephalus cadamba</i>	3.60

11.3.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.3.21 and table 11.3.22 respectively.

TABLE 11.3.21 Major NTFP species in the State of Assam

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Diplagium species</i>	Herb	61.97
2.	<i>Thysanolaena maxima</i>	Herb	38.03

TABLE 11.3.22 Major invasive species in the State inside the RFA/Green Wash in Assam (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	886
2.	<i>Mikania micrantha</i>	468
3.	<i>Lantana camara</i>	339
4.	<i>Microcystis aeruginosa</i>	42
5.	<i>Imperata cylindrica</i>	41

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.3.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Assam

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Assam is given in the table 11.3.23

TABLE 11.3.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Assam

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
14,10,975	1,17,12,057	14,437	32,972



11.4

BIHAR

11.4.1 Introduction

Bihar, a State in the eastern part of the country is the 13th largest in terms of geographical area and 3rd largest by population. The State has a geographical area of 94,163 sq km which is 2.86% of the total geographical area of the country. The State lies between 24°16' N to 27°45' N latitude and 83°16' E to 88°30' E longitude. The neighboring States are Uttar Pradesh in the west, Jharkhand in the south and West Bengal in the east. On the northern side, the State has international border with Nepal. There are 38 districts in the State none of which fall in the category of Hill or Tribal district. Ganga is the main river which flows from west to east through the State. The main tributaries of Ganga are Son, Gandak and Phalgu. The annual rainfall ranges between 1,000 to 2,000 mm and the average annual temperature from 20°C to 28°C. The rural and urban population constitutes 88.71% and 11.29% respectively. The Tribal population is 1.28%. As per 2011 census, Bihar has a population of 104.10 million and population density 1,106 per sq km which is much higher than the national average of 382 persons per sq km. The 19th Livestock census 2012 has reported a total livestock population of 32.93 million.

TABLE 11.4.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	9,416	
Reporting area for land utilization	9,360	100.00
Forests	622	6.64
Not available for land cultivation	2,144	22.91
Permanent pastures and other grazing lands	15	0.16
Land under misc. tree crops and groves	248	2.65
Culturable wasteland	45	0.48
Fallow land other than current fallows	119	1.28
Current fallows	889	9.49
Net area sown	5,278	56.39

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.4.1.1 A Brief Overview of Forestry Scenario

Bihar is a forest deficient State and natural forests are found in limited areas. Sal (*Shorea robusta*) forests are found in the West Champaran district in the Terai region in the north and in Kaimur, Rohtas, Aurangabad, Gaya, Jamui, Munger and Banka districts in southern Bihar. The West Champaran district has moist deciduous Sal forest while South Bihar has dry deciduous Sal Forests. Most of the natural forests are notified as Protected Forests. As per the Champion & Seth Classification of Forest Types (1968), the forests of Bihar belong to four Forest Type Groups further divided into 13 different Forest Types.

The improvement of the quality of forests is high in the priority and regeneration activities are carried out regularly. The other thrust area is to increase tree cover in the State and for this purpose, tree plantations and agro forestry are carried out. The State Government has included Forest Department in “Krishi Road Map” and a separate “Hariyali Mission Directorate” has been established to manage these programs. The SFD is also concentrating on massive soil and moisture conservation works in the forest areas which are successful in retaining the soil and moisture and supporting the biodiversity.

Recorded Forest Area (RFA) in the State is 6,877 sq km of which 693 sq km is Reserved Forest, 6,183 sq km is Protected Forest and 1 sq km is Unclassed Forest. In Bihar, during the period 1st January 2015 to 5th February 2019, a total of 1,131.60 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019). As per the information received from the State during the last two years, a total of 56,560 ha of plantations have been raised.

One National Park and 12 Wildlife Sanctuaries constitute the Protected Area network of the State covering 3.44% of its geographical area.

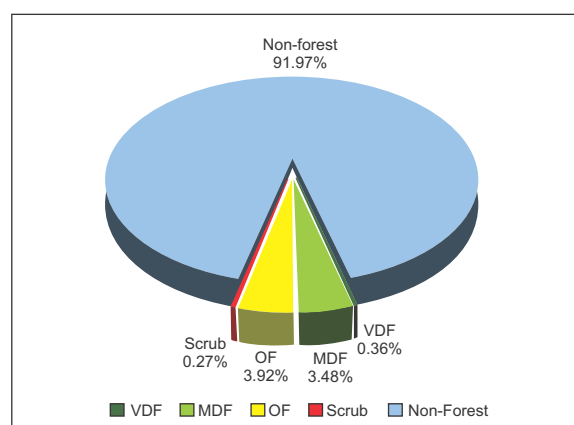
11.4.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Dec 2018, the Forest Cover in the State is 7,305.99 sq km which is 7.76 % of the State's geographical area. In terms of forest canopy density classes, the State has 333.13 sq km under Very Dense Forest (VDF), 3,280.32 sq km under Moderately Dense Forest (MDF) and 3,692.54 sq km under Open Forest (OF). Forest Cover in the State has increased by 6.99 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.4.2 Forest Cover of Bihar
(in sq. km)

Class	Area	% of GA
VDF	333.13	0.36
MDF	3,280.32	3.48
OF	3,692.54	3.92
Total	7,305.99	7.76
Scrub	249.88	0.27

FIGURE 11.4.1 Forest Cover of Bihar



11.4.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 6,877 sq km which is 7.30% of its geographical area. The reserved, protected and unclassified forests are 10.08%, 89.91% and 0.01% of the recorded forest area in the State respectively. However, as the digitized boundary of RFA from the State covers only an area 6,301.97 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.4.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Bihar (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
314	2,451	2,004	4,769	19	829	1,689	2,537
6.59%	51.40%	42.01%		0.75%	32.69%	66.56%	

*in case of Bihar RFA boundaries have been used.

FIGURE 11.4.2 Forest Cover inside and outside RFA in Bihar

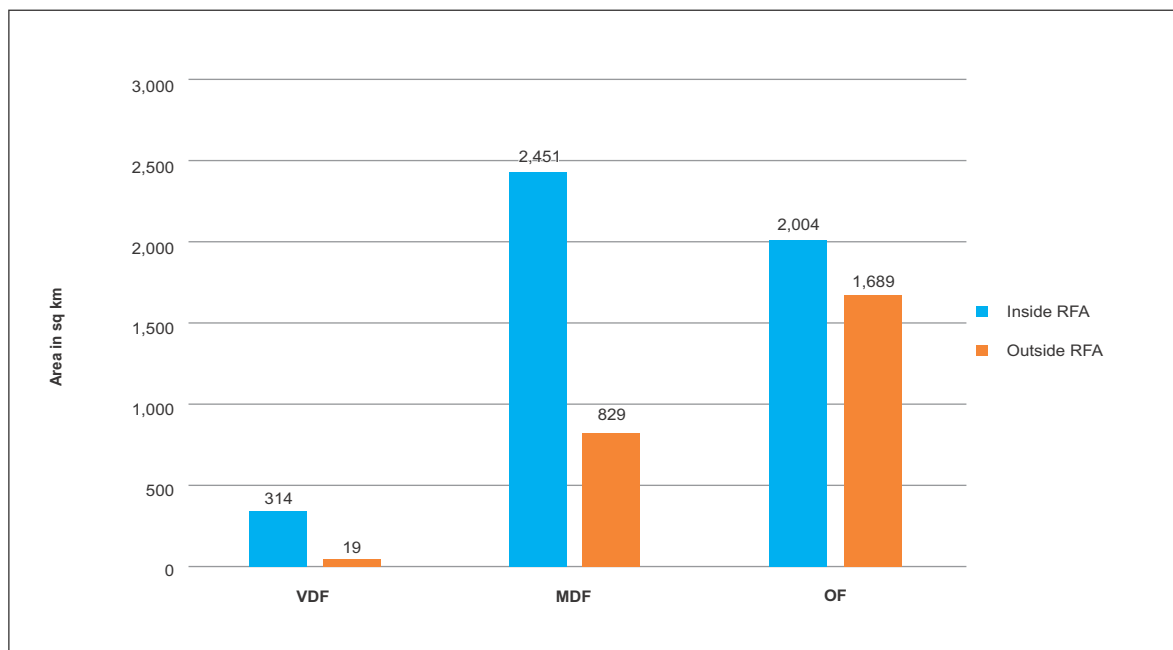


TABLE 11.4.4 District-wise Forest Cover in Bihar

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Araria	2,830	0.00	8.10	142.91	151.01	5.34	-4.99	0.38
Arwal	638	0.00	1.63	2.37	4.00	0.63	-1.00	0.00
Aurangabad	3,305	0.00	62.26	94.50	156.76	4.74	-0.24	16.70
Banka	3,020	0.00	103.34	157.39	260.73	8.63	20.73	34.55
Begusarai	1,918	0.00	28.64	53.31	81.95	4.27	-1.05	0.00
Bhagalpur	2,569	0.00	46.21	23.52	69.73	2.91	1.73	0.00
Bhojpur	2,395	0.00	19.44	12.81	32.25	1.89	-3.75	0.00
Buxar	1,703	0.00	2.94	2.95	5.89	0.26	-0.11	0.00
Darbhanga	2,279	0.00	43.54	94.12	137.66	2.77	1.66	0.00
Gaya	4,976	0.00	134.40	455.91	590.31	29.04	-14.69	62.34
Gopalganj	2,033	0.00	1.98	2.93	4.91	0.16	-0.09	0.00
Jamui	3,098	28.97	351.69	267.29	647.95	69.60	6.95	15.74
Jehanabad	931	0.00	0.00	0.00	0.00	0.00	0.00	5.00
Kaimur(Bhabua)	3,332	0.00	525.14	531.25	1,056.39	41.12	-14.61	19.43
Katihar	3,057	0.00	6.03	55.95	61.98	2.03	0.98	0.00
Khagaria	1,486	0.00	3.18	15.27	18.45	1.24	-2.55	0.00
Kishanganj	1,884	0.00	16.33	87.37	103.70	5.50	1.70	0.00
Lakhisarai	1,228	17.00	144.42	18.99	180.41	14.69	-2.59	5.49
Madhepura	1,788	0.00	0.93	51.95	52.88	2.96	1.88	0.40
Madhubani	3,501	0.00	40.34	163.73	204.07	5.83	7.07	0.00
Munger	1,419	37.97	223.67	21.96	283.60	19.99	-1.40	9.98
Muzaffarpur	3,172	0.00	52.17	109.65	161.82	5.10	19.82	0.00
Nalanda	2,355	0.00	6.86	24.99	31.85	1.35	-0.15	9.17
Nawada	2,494	0.00	200.98	312.52	513.50	20.59	1.50	20.46
Pashchim Champaran	5,228	249.19	550.24	105.23	904.66	17.30	0.66	8.10
Patna	3,202	0.00	18.78	4.76	23.54	0.74	-2.46	0.00
Purbi Champaran	3,968	0.00	65.04	98.82	163.86	4.13	8.86	0.00
Purnia	3,229	0.00	5.00	50.67	55.67	1.72	2.67	0.00
Rohtas	3,881	0.00	352.52	319.71	672.23	17.32	-33.77	42.14
Saharsa	1,687	0.00	4.17	30.45	34.62	2.05	0.62	0.00
Samastipur	2,904	0.00	105.30	48.06	153.36	5.28	-3.64	0.00
Saran	2,641	0.00	26.30	32.83	59.13	2.24	2.13	0.00
Sheikhpura	689	0.00	1.00	0.00	1.00	0.15	0.00	0.00
Sheohar	349	0.00	2.00	18.58	20.58	5.90	1.58	0.00
Sitamarhi	2,294	0.00	37.38	110.40	147.78	6.44	1.78	0.00
Siwan	2,219	0.00	1.99	5.17	7.16	0.32	0.16	0.00
Supaul	2,425	0.00	3.89	134.89	138.78	5.72	8.78	0.00
Vaishali	2,036	0.00	82.49	29.33	111.82	5.49	2.82	0.00
Grand Total	94,163	333.13	3,280.32	3,692.54	7,305.99	7.76	6.99	249.88

TABLE 11.4.5 Forest Cover Change Matrix for Bihar

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	332	0	0	0	0	332
Moderately Dense Forest	1	3,150	17	7	85	3,260
Open Forest	0	50	3,414	44	199	3,707
Scrub	0	0	22	177	29	228
Non Forest	0	80	240	22	86,294	86,636
Total ISFR 2019	333	3,280	3,693	250	86,607	94,163
Net Change	1	20	-14	22	-29	

A net positive change of 6.99 sq km observed in forest cover of the state could be attributed to plantations and conservation practices.

TABLE 11.4.6 Altitude-wise Forest Cover in Bihar

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	93,821	330	3,138	3,564	7,032 (96.25%)	245
500-1000	342	3	142	129	274 (3.75%)	5
Total	94,163	333	3,280	3,693	7,306	250

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.4.7 Forest Cover in different slope classes in Bihar

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	91,177	177	2,131	2,894	5,202 (71.20%)	157
5-10	1,576	72	484	363	919 (12.58%)	34
10-15	594	38	275	171	484 (6.62%)	20
15-20	363	23	175	119	317 (4.34%)	15
20-25	222	14	105	68	187 (2.56%)	11
25-30	122	6	58	39	103 (1.41%)	7
>30	109	3	52	39	94 (1.29%)	6
Total	94,163	333	3,280	3,693	7,306	250

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.4.3 Forest Cover Map of Bihar

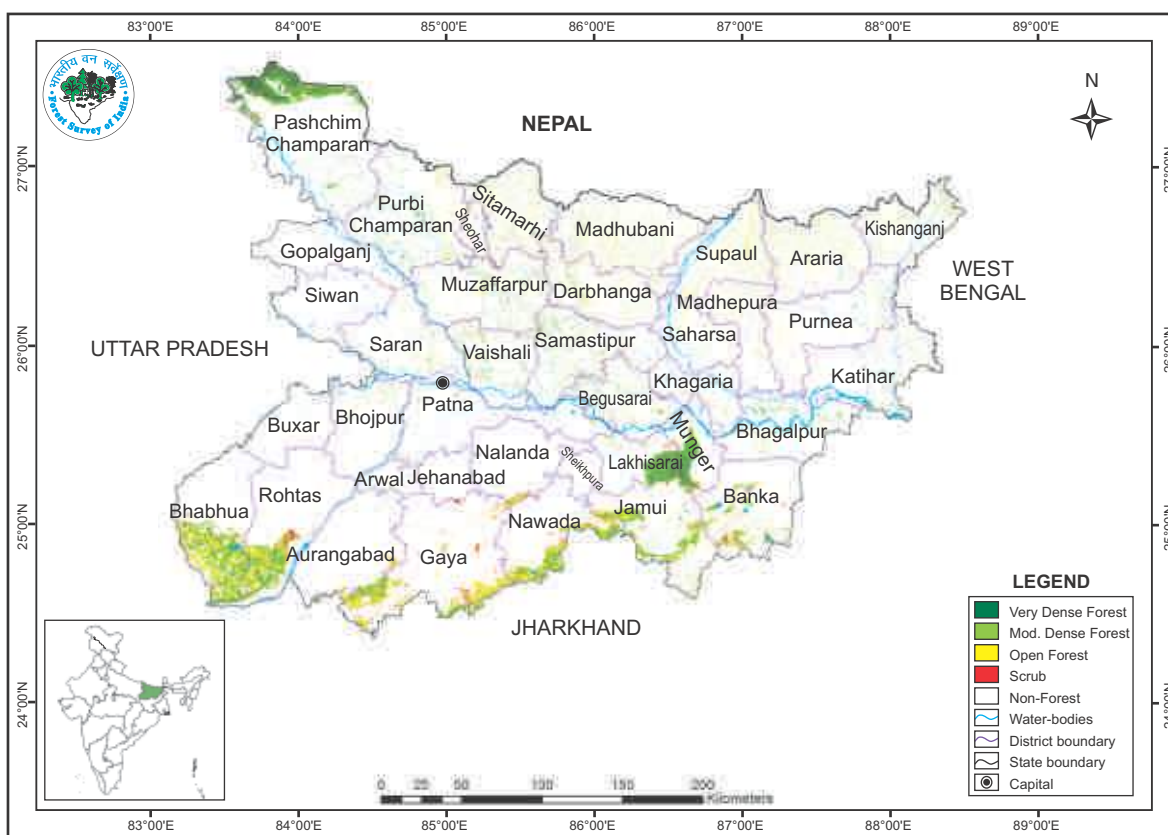


TABLE 11.4.8 Wetlands inside the Recorded Forest Area (or Green wash) in Bihar (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	6	62
Ox-bow lake/Cut-off meander	1	222
Riverine wetland	4	13
Waterlogged	26	139
River/Stream	35	2,137
Sub - Total	72	2,573
Inland Wetlands -Man-made		
Reservoir/Barrage	34	1,224
Tank/Pond	16	32
Sub - Total	50	1,256
Wetlands (<2.25 ha)	163	163
Total	285	3,992
Total Recorded Forest (or Green Wash) Area (in ha)		6,30,197
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.63%

(analysis based on the National Wetland Atlas: India, 2011)

11.4.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Bihar as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.4.9 Percentage area under different forest types of Bihar

Sl.No.	Forest Type	% of Forest cover
1.	2/E1 (Cane Brakes)	0.03
2.	3B/C1b Moist Teak Forest	0.06
3.	3C/C2b(l) Bhabar-Dun Sal Forest	3.66
4.	3C/C3a West Gangatic Moist Mixed Deciduous Forest	2.30
5.	4D/2S2 Eastern Wet Alluvial Grassland	0.22
6.	4D/SS2 <i>Barringtonia</i> Swamp Forest	0.03
7.	5/1S2 <i>Khair-Sissu</i> Forest	0.06
8.	5/DS1 Dry Deciduous Scrub	2.48
9.	5/E2 <i>Boswellia</i> Forest	4.52
10.	5/E9 Dry Bamboo Brake	0.97
11.	5B/C1a Dry Siwalik Sal Forest	5.14
12.	5B/C1c Dry Peninsular Sal Forest	21.13
13.	5B/C2 Northern Dry Mixed Deciduous Forest	30.70
14.	Plantation/TOF	28.70
	Total	100.00

11.4.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.4.10 and table 11.4.11 in respect of Bihar.

TABLE 11.4.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	113
Shrub	42
Herb	52

TABLE 11.4.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Bihar

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 2- Tropical Semi Evergreen Forests	*	2.22	2.85
2.	Group 3- Tropical Moist Deciduous Forests	3.10	2.65	2.02
3.	Group 4- Littoral and Swamp Forests	*	1.58	2.72
4.	Group 5- Tropical Dry Deciduous Forests	3.42	2.25	1.21

* adequate number of sample plots were not available

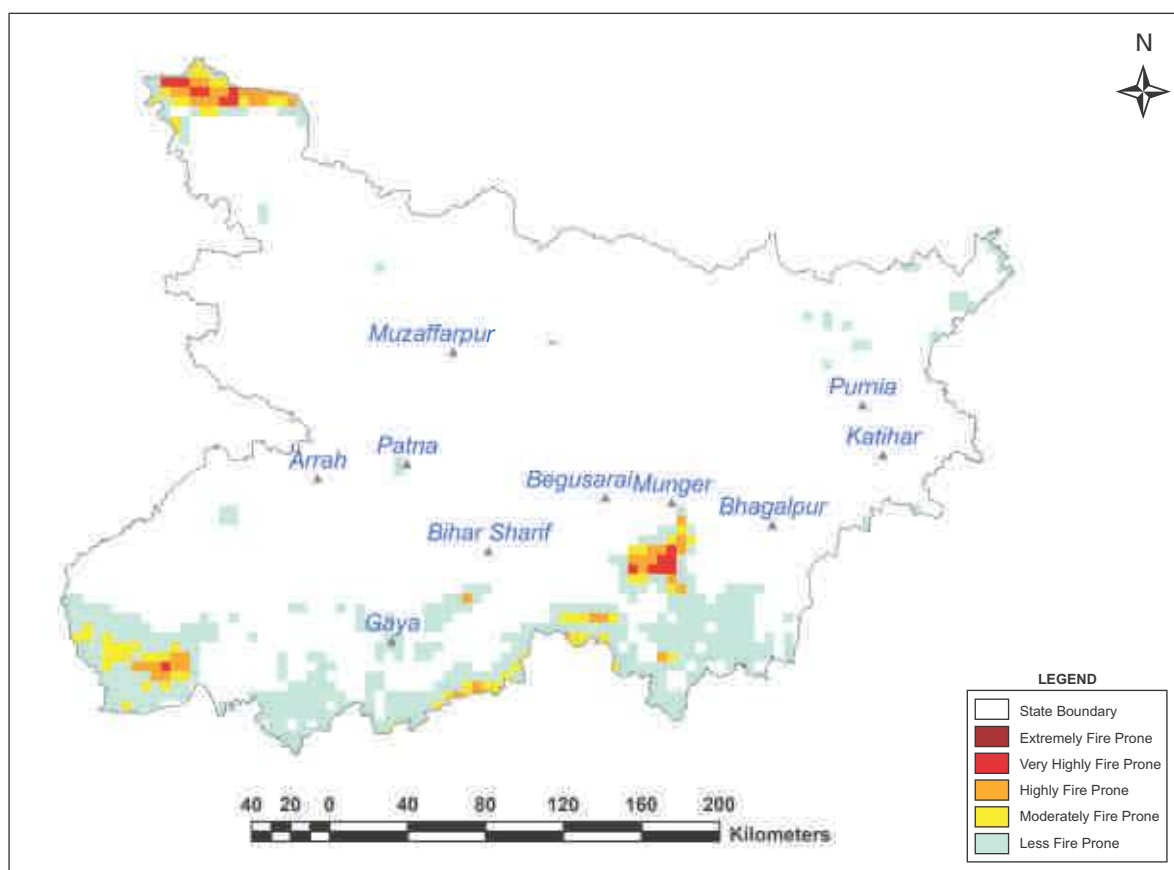
11.4.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.4.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	399.64	7.15
3.	Highly fire prone	1,059.74	17.68
4.	Moderately fire prone	1,557.06	22.74
5.	Less fire prone	10,729.41	52.43
	Total	13,745.85	100.00

FIGURE 11.4.4 Fire prone forest areas under different fire prone classes



11.4.5 Tree Cover

Forest cover presented in the section 11.4.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Bihar has been estimated as given in table 11.4.13.

TABLE 11.4.13 Tree Cover in Bihar (in sq km)

Tree Cover	Area
	2,003

Tree cover of Bihar has decreased by 260 sq km as compared to the previous assessment reported in ISFR2017.

11.4.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.4.14 Extent of TOF in Bihar (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
2,537	2,003	4,540

11.4.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Bihar is given in the table 11.4.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.4.16

TABLE 11.4.15 Growing Stock in Bihar (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	26.73	0.63
Growing Stock in TOF	40.46	2.46

TABLE 11.4.16 Diameter class distribution of top five species inside RFA in Bihar (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	17,528	4,346	694
2.	<i>Madhuca latifolia</i>	6,308	420	67
3.	<i>Buchanania latifolia</i>	6,520	118	0
4.	<i>Lannea coromandelica</i>	8,903	201	0
5.	<i>Anogeissus latifolia</i>	5,462	302	0

11.4.7 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 55.24 million tonnes (202.55 million tonnes of CO₂ equivalent) which is 0.78% of total forest carbon of the country. Pool wise forest carbon in Bihar is given in the following table.

TABLE 11.4.17 Forest Carbon in Bihar in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
15,007	5,428	127	746	33,931	55,239

11.4.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.4.18

TABLE 11.4.18 Growing Stock of Bamboo

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,136	0.71
Total number of culms (in millions)	247	0.63
Total equivalent green weight (in 000' tonnes)	1,822	0.66

11.4.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Bihar in Rural and Urban areas are given in the table 11.4.19 and table 11.4.20 respectively.

TABLE 11.4.19 Top five tree species in TOF (Rural) in Bihar

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	25.81
2.	<i>Dalbergia sissoo</i>	14.22
3.	<i>Borassus flabelliformis</i>	12.66
4.	<i>Litchi senensis</i>	3.50
5.	<i>Bombax ceiba</i>	3.42

TABLE 11.4.20 Top five tree species in TOF (Urban) in Bihar

Sl. No.	Species	Relative Abundance (%)
1.	<i>Litchi senensis</i>	17.63
2.	<i>Mangifera indica</i>	13.38
3.	<i>Bombax ceiba</i>	11.60
4.	<i>Dalbergia sissoo</i>	5.15
5.	<i>Psidium guyava</i>	3.77

11.4.11 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.4.21

TABLE 11.4.21 Major invasive species in the State inside the RFA/Green wash in Bihar (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	490
2.	<i>Chromolaena odorata</i>	87
3.	<i>Argemone mexicana</i>	34
4.	<i>Cassia tora</i>	28
5.	<i>Senna occidentalis</i>	27

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.4.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Bihar

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Bihar is given in the table 11.4.22

TABLE 11.4.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Bihar

Fuel wood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
8,21,428	43,38,362	11,336	13,766

11.5

CHHATTISGARH

11.5.1 Introduction

Chhattisgarh was carved out of Madhya Pradesh in the year 2000. It covers an area of 1,35,192 sq km, which is 4.11% of the geographical area of the country. The State is bordered by the Madhya Pradesh in the northwest, Uttar Pradesh in the north, Jharkhand in the northeast, Maharashtra in the southwest, Telangana in the south and Odisha in the southeast. The State falls under East Deccan physiographic zone and can be divided into three agro-climatic zones, viz. the Chhattisgarh Plains, the Northern Hills of Chhattisgarh and the Bastar Plateau. The State lies between 17°47'N to 24°06' N latitude and 80°15'E to 84°24' E longitude. It has a tropical hot and humid climate. The average annual rainfall varies from about 1,100 mm to about 1,700 mm and the average annual temperature ranges between 11°C to 47°C. The State is drained by number of rivers which include Rihand, Hasdo (a tributary of Mahanadi) and Indravati. There are 18 districts, out of which 11 are tribal districts. The State does not have any hill district. As per the 2011 census, Chhattisgarh has a population of 25.55 million accounting to 2.11% of India's population. The urban, rural and tribal population comprise 23.24%, 76.76% and 30.62% respectively. The average population density of the State is 189 per sq km, which is much lower than the national average of 382 persons per sq km. The 19th Livestock census 2012 has reported a total livestock population of 15.04 million.

TABLE 11.5.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	13,519	
Reporting area for land utilization	13,790	100.00
Forests	6,316	45.80
Not available for land cultivation	1,029	7.47
Permanent pastures and other grazing lands	887	6.43
Land under misc. tree crops and groves	1	0.01
Culturable wasteland	351	2.54
Fallow land other than current fallows	258	1.87
Current fallows	267	1.94
Net area sown	4,681	33.94

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.5.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Chhattisgarh belong to two Type Groups i.e Tropical Moist Deciduous Forests and Tropical Dry Deciduous Forests which are further divided into 12 Forest Types. The State's two main tree species are Sal (*Shorea robusta*) and Teak (*Tectona grandis*). Other major species are Bija (*Pterocarpus marsupium*), Saja (*Terminalia tomentosa*), Dhavdha (*Anogeissus latifolia*), Mahua (*Madhuca indica*), Tendu (*Diospyros melanoxylon*) and bamboo (*Dendrocalamus strictus*) etc. The State is rich in mineral resources like, coal, iron, bauxite, limestone, corundum, tin etc which are mainly found in forest areas. About 50% of the villages in the State are located inside five kilometers radius of forests. The inhabitants are mainly tribal, economically backward, non-tribal and landless people who depend significantly on the forests for livelihood and other needs. Thus, the pressure on forests is high in the State. Joint Forest Management (JFM) began in the State in 1991 and as per the latest available report, there are 7,887 JFMCs covering an area of 33,19,000 hectares & involving 11,17,000 families.

Recorded Forest Area (RFA) in the State is 59,772 sq km of which 25,786 sq km is Reserved Forest, 24,034 sq km is Protected Forest and 9,952 sq km is Unclassed Forest. In Chhattisgarh, during the period 1st January 2015 to 5th February 2019, a total of 3,793.05 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

Three National Parks and 11 Wildlife Sanctuaries constitute the Protected Area network of the State covering 4.93% of its geographical area.

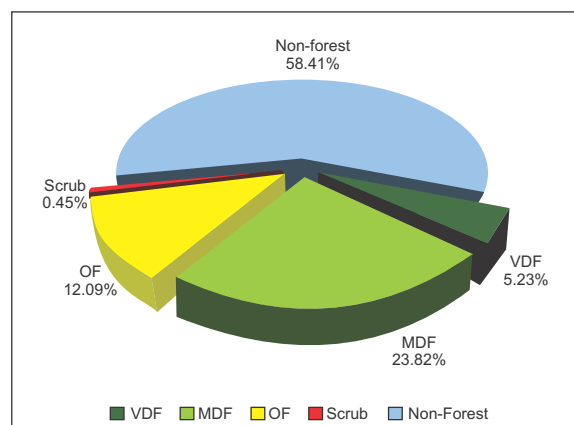
11.5.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to January 2018, the Forest Cover in the State is 55,610.57 sq km which is 41.14 % of the State's geographical area. In terms of forest canopy density classes, the State has 7,067.72 sq km under Very Dense Forest (VDF), 32,197.56 sq km under Moderately Dense Forest (MDF) and 16,345.29 sq km under Open Forest (OF). Forest Cover in the State has increased by 63.57 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.5.2 Forest Cover of Chhattisgarh
(in sq km)

Class	Area	% of GA
VDF	7,067.72	5.23
MDF	32,197.56	23.82
OF	16,345.29	12.09
Total	55,610.57	41.14
Scrub	609.52	0.45

FIGURE 11.5.1 Forest Cover of Chhattisgarh



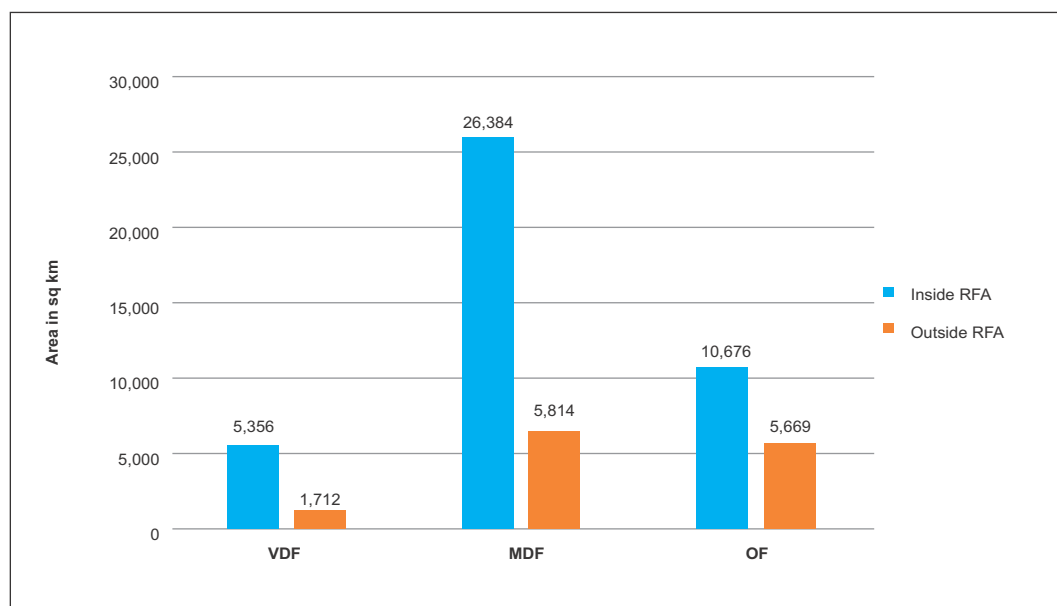
11.5.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 59,772 sq km which is 44.21% of its geographical area. The reserved, protected and unclassified forests are 43.14% and 40.21% and 16.65% of the recorded forest area in the State respectively. However, as the digitized boundary of RFA from the state covers 52,579.93 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.5.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Chhattisgarh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
5,356	26,384	10,676	42,416	1,712	5,814	5,669	13,195
12.63%	62.20%	25.17%		12.97%	44.06%	42.97%	

*in case of Chhattisgarh RFA boundaries have been used.

FIGURE 11.5.2 Forest Cover inside and outside RFA in Chhattisgarh**TABLE 11.5.4** District-wise Forest Cover in Chhattisgarh

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bastar ^T	10,470	954.84	2,117.50	1,160.52	4,232.86	40.43	8.86	34.87
Bijapur ^T	8,530	2,048.29	2,926.49	1,537.37	6,512.15	76.34	5.15	1.98
Bilaspur ^T	8,272	395.00	1,539.19	522.70	2,456.89	29.70	0.89	48.30
Dakshin Bastar	8,298	250.63	2,305.07	1,907.45	4,463.15	53.79	7.15	26.34
Dantewada ^T								
Dhamtari	4,084	49.00	1,385.52	424.60	1,859.12	45.52	2.12	8.91
Durg ^T	8,535	44.00	512.04	220.35	776.39	9.10	5.39	20.48
Janjgir-Champa	3,853	2.00	22.13	125.76	149.89	3.89	0.89	13.98
Jashpur ^T	5,838	225.36	1,316.71	573.70	2,115.77	36.24	-15.23	21.00
Kabeerddham	4,235	79.09	1,083.84	385.79	1,548.72	36.57	2.72	12.75
Korba	6,598	203.00	2,313.62	877.08	3,393.70	51.44	3.70	92.03
Koriya	6,604	78.53	2,579.90	1,438.18	4,096.61	62.03	3.61	66.69
Mahasamund	4,790	4.00	515.22	425.75	944.97	19.73	1.97	27.38
Narayanpur ^T	4,653	1,127.55	1,690.63	978.12	3,796.30	81.59	-5.70	19.22
Raigarh ^T	7,086	237.96	1,591.03	791.34	2,620.33	36.98	9.33	25.18

Contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Raipur	12,383	141.83	2,413.04	1,075.05	3,629.92	29.31	10.92	54.43
Rajnandgaon ^T	8,070	31.00	1,749.51	754.67	2,535.18	31.41	8.18	50.13
Surguja ^T	15,732	706.72	3,930.64	2,445.25	7,082.61	45.02	10.61	77.86
Uttar Bastar Kanker ^T	7,161	488.92	2,205.48	701.61	3,396.01	47.42	3.01	7.99
Grand Total	1,35,192	7,067.72	32,197.56	16,345.29	55,610.57	41.14	63.57	609.52

TABLE 11.5.5 Forest Cover Change Matrix for Chhattisgarh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	7,058	0	0	0	6	7,064
Moderately Dense Forest	5	32,165	4	1	40	32,215
Open Forest	0	4	16,201	4	59	16,268
Scrub	0	0	5	541	6	552
Non Forest	5	29	135	64	78,860	79,093
Total ISFR 2019	7,068	32,198	16,345	610	78,971	1,35,192
Net Change	4	-17	77	58	-122	

Positive changes observed in forest cover is due to conservation and plantation activities.

TABLE 11.5.6 Altitude-wise Forest Cover in Chhattisgarh

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	88,516	3,430	15,969	9,630	29,029 (52.20%)	420
500-1000	45,491	3,583	15,883	6,479	25,945 (46.65%)	177
1000-2000	1,185	55	346	236	637 (1.15%)	13
Total	1,35,192	7,068	32,198	16,345	55,611	610

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.5.7 Forest Cover in different slope classes in Chhattisgarh

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,06,433	4,051	17,658	10,877	32,586 (58.60%)	349
5-10	16,248	1,503	7,037	2,765	1,305 (20.33%)	130
10-15	6,477	829	3,789	1,279	5,897 (10.60%)	72
15-20	3,345	413	2,053	738	3,204 (5.76%)	36
20-25	1,638	177	1,005	412	1,594 (2.87%)	15
25-30	696	67	425	188	680 (1.22%)	6
>30	355	28	231	86	345 (0.62%)	2
Total	1,35,192	7,068	32,198	16,345	55,611	610

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.5.3 Forest Cover Map of Chattisgarh

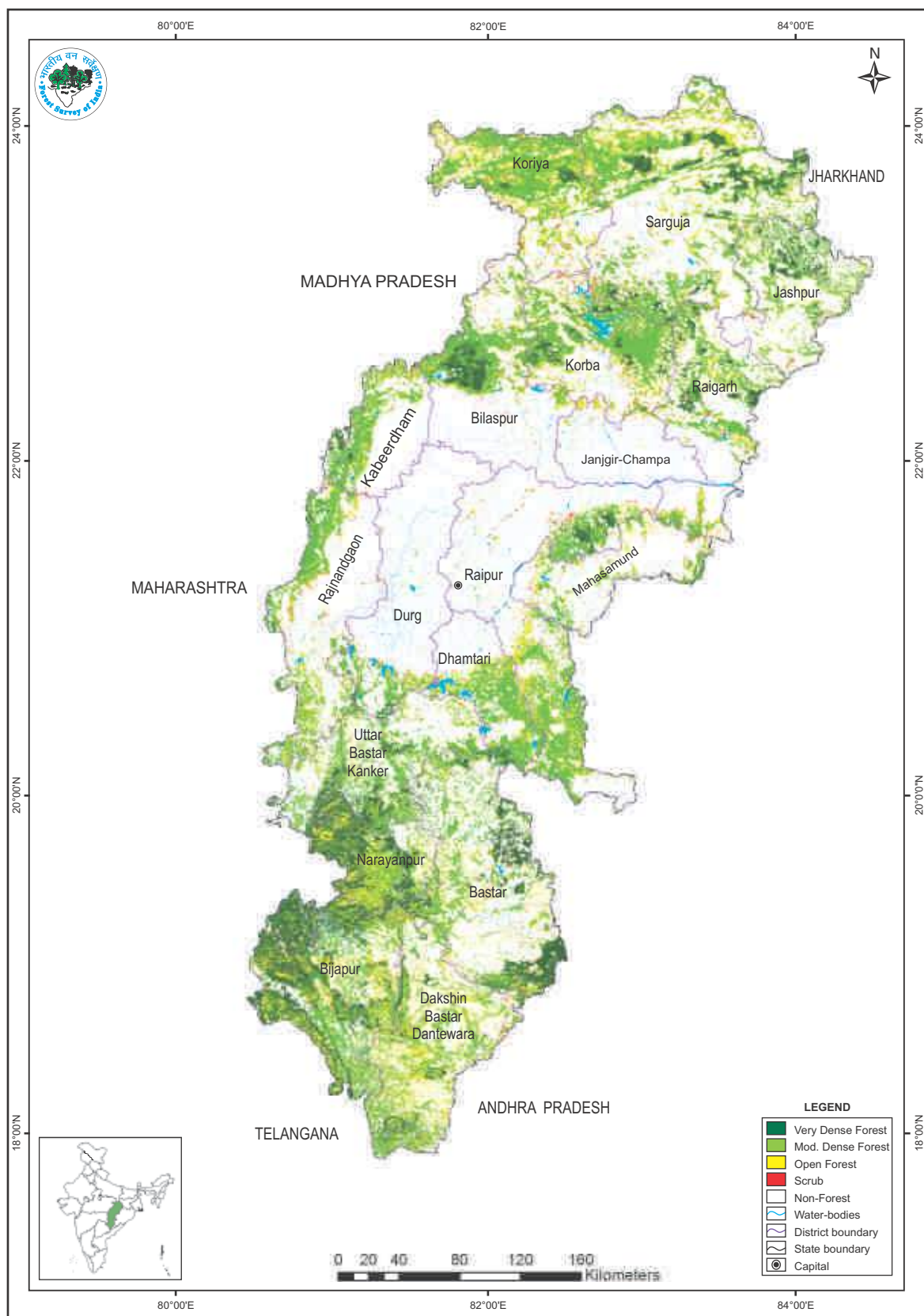


TABLE 11.5.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Chhattisgarh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
River/Stream	101	39,987
Sub - Total	101	39,987
Inland Wetlands - Man-made		
Reservoir/Barrage	259	18,294
Tank/Pond	919	3,693
Waterlogged	4	9
Sub - Total	1,182	21,996
Wetlands (<2.25 ha)	2,415	2,415
Total	3,698	64,398
Total Recorded Forest (or Green Wash) Area (in ha)		52,57,993
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.22%

(analysis based on the National Wetland Atlas: India, 2011)

11.5.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Chhattisgarh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.5.9 Percentage area under different forest types of Chhattisgarh

Sl. No.	Forest Type	% of Forest cover
1.	3B/C1c Slightly Moist Teak Forest	6.47
2.	3B/C2 Southern Moist Mixed Deciduous Forest	15.68
3.	3C/C2e (i) Moist Peninsular High Level Sal Forest	1.48
4.	3C/C2e (ii) Moist Peninsular Low Level Sal Forest	16.64
5.	3/E1 <i>Terminalia Tomentosa</i> Forest	0.02
6.	3/2S1 (Dry Bamboo Brakes)	0.00
7.	5A/C1b Dry Teak Forest	0.43
8.	5A/C3 Southern Dry Mixed Deciduous Forest	27.37
9.	5B/C1c Dry Peninsular Sal Forest	15.27
10.	5B/C2 Northern Dry Mixed Deciduous Forest	13.16
11.	5B/DS1 Dry Deciduous Scrub	0.98
12.	5/E9 Dry Bamboo Brakes	1.49
13.	Plantation/ TOF	1.01
	Total	100.00

11.5.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.5.10 and table 11.5.11 in respect of Chhattisgarh.

TABLE 11.5.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	129
Shrub	48
Herb	50

TABLE 11.5.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Chhattisgarh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	3.17	2.62	2.59
2.	Group 5- Tropical Dry Deciduous Forests	3.07	2.89	2.61

11.5.4 Fire Prone Forest Areas

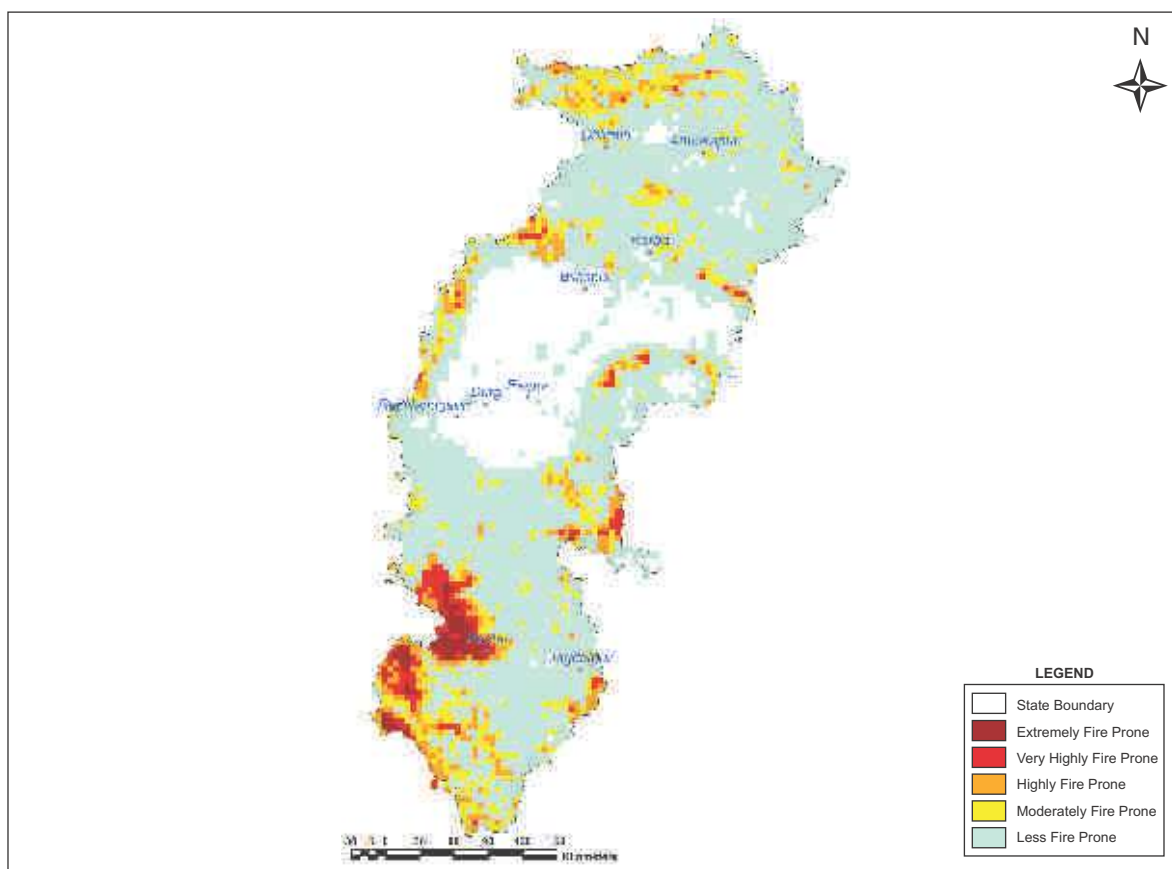
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.5.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	2,261.08	3.90
2	Very highly fire prone	3,515.25	6.04
3	Highly fire prone	8,484.75	13.55
4	Moderately fire prone	16,265.31	22.34
5	Less fire prone	77,989.12	54.17
	Total	1,08,515.51	100.00



FIGURE 11.5.4 Fire prone forest areas under different fire prone classes



11.5.5 Tree Cover

Forest cover presented in the section 11.5.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Chhattisgarh has been estimated as given in table 11.5.13.

TABLE 11.5.13 Tree Cover in Chhattisgarh (in sq km)

Tree Cover	Area
	4,248

Tree cover of Chhattisgarh has increased by 415 sq km as compared to the previous assessment reported in ISFR 2017.

11.5.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.5.14 Extent of TOF in Chhattisgarh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
13,195	4,248	17,443

11.5.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Chhattisgarh is given in the table 11.5.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.5.16

TABLE 11.5.15 Growing Stock in Forest (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	358.958	8.40
Growing Stock in TOF	99.92	6.08

TABLE 11.5.16 Diameter class distribution of top five species inside RFA in Chhattisgarh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	2,75,047	70,322	4,003
2.	<i>Terminalia tomentosa</i>	72,724	17,672	681
3.	<i>Cleistanthus collinus</i>	1,06,733	2,377	282
4.	<i>Lagerstroemia perviflora</i>	66,911	4,332	134
5.	<i>Buchanania latifolia</i>	66,077	1,111	0

11.5.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 480.25 million tonnes (1,760.92 million tonnes of CO₂ equivalent) which is 6.74% of total forest carbon of the country. Pool wise forest carbon in Chhattisgarh is given in the following table

TABLE 11.5.17 Forest Carbon in Chhattisgarh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,45,912	46,908	1,858	9,969	2,75,603	4,80,250

11.5.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.5.18

TABLE 11.5.18 Growing Stock of Bamboo in Chhattisgarh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	11,255	7.03
Total number of culms (in millions)	2,114	5.36
Total equivalent green weight (in 000' tonnes)	11,743	4.23

11.5.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Chhattisgarh in Rural and Urban areas are given in the table 11.5.19 and table 11.5.20 respectively

TABLE 11.5.19 Top five tree species in TOF (Rural) in Chhattisgarh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Shorea robusta</i>	9.24
2.	<i>Butea frondosa</i>	8.98
3.	<i>Acacia arabica</i>	8.62
4.	<i>Mangifera indica</i>	8.51
5.	<i>Madhuca latifolia</i>	7.86

TABLE 11.5.20 Top five tree species in TOF (Urban) in Chhattisgarh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	16.03
2.	<i>Moringa species</i>	8.78
3.	<i>Azadirachta indica</i>	6.10
4.	<i>Tectona grandis</i>	6.05
5.	<i>Psidium guyava</i>	5.82

11.5.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.5.21 and table 11.5.22 respectively.

TABLE 11.5.21 Major NTFP species in the state of Chhattisgarh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Shorea robusta</i>	Tree	41.47
2.	<i>Nervilia aragoana</i>	Herb	15.43
3.	<i>Buchanania lanzan</i>	Tree	7.95
4.	<i>Diospyros melanoxylon</i>	Tree	7.79
5.	<i>Anogeissus latifolia</i>	Tree	7.64

TABLE 11.5.22 Major invasive species in the State inside the RFA/Green Wash in Chhattisgarh (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	1,332
2.	<i>Ageratum conyzoides</i>	906
3.	<i>Cassia tora</i>	609
4.	<i>Triumfetta rhomboidea</i>	366
5.	<i>Chromolaena odorata</i>	334

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.5.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Chhattisgarh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Chhattisgarh is given in the table 11.5.23

TABLE 11.5.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Chhattisgarh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
36,08,449	8,27,71,189	3,92,489	8,52,164

11.6

DELHI

11.6.1 Introduction

Delhi, the National Capital Territory (NCT) of India, has a geographical area of 1,483 sq km, which is 0.05 % of the geographical area of the country. The State lies between 28°22'N to 28°54'N latitude and 76°48'E to 77°23'E longitude and is bordered by Haryana on the three sides and Uttar Pradesh on the East. The landscape of Delhi can geographically be divided into three major regions viz the low-lying Yamuna flood plains, the Aravalli Ridge and the great Gangetic plains that cover most part of the city. The altitude of the Delhi ranges from 180 m to 316 m above the mean sea level. Climate of the state is hot in summer and cold in winter. The rainfall varies from 400 mm to 600 mm. The annual temperature ranges between 3°C to 45°C. The State has 9 districts out of which none is hill or tribal. As per the 2011 census Delhi has a population of 16.79 million accounting to 1.38% of India's population. The urban & rural population constitutes 97.50% and 2.50% respectively. The population density of the NCT is 11,320 per sq km. The 19th Livestock census 2012 has reported a total livestock population of 0.36 million in the State.

TABLE 11.6.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	148	
Reporting area for land utilization	147.49	100.00
Forests	1.48	1.00
Not available for land cultivation	93.20	63.18
Permanent pastures and other grazing lands	0.06	0.04
Land under misc. tree crops and groves	1.18	0.80
Culturable wasteland	9.89	6.71
Fallow land other than current fallows	8.06	5.47
Current fallows	11.73	7.96
Net area sown	21.89	14.84

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.6.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Delhi belong to the Type Group 5, Tropical Dry Deciduous Forest and Type Group 6 Tropical Thorn Forests. Around 67.35% of the total forest cover comes under plantation/ TOF and 32.65% constitute the natural forest, which covers 57.67 sq km of Delhi's forests.

Forest department under the Government of Delhi supervises and monitors various activities such as distribution of seedlings to public, government departments & institutions, plantations on gram sabha lands, along the roads, ridge area, river banks, railway lines etc. To promote the tree plantation activity as a mass campaign and to encourage participation of Residential Welfare Associations, Civil Society, Government organizations, educational institutions etc, the Government of NCT of Delhi, carries out the 'Greening Delhi Campaign' every year.

The Recorded Forest Area (RFA) in the State is 102 sq km of which 78 sq km is Reserved Forest and 24 sq km is Protected Forest. In Delhi, no forest land has been diverted for non-forestry purposes under the Forest Conservation Act, 1980 in the last four years (MoEF & CC, 2019).

The Protected Area network in the State has one Wildlife Sanctuary viz Asola Bhatti Wildlife Sanctuary which covers 1.96% of geographical area of the State.

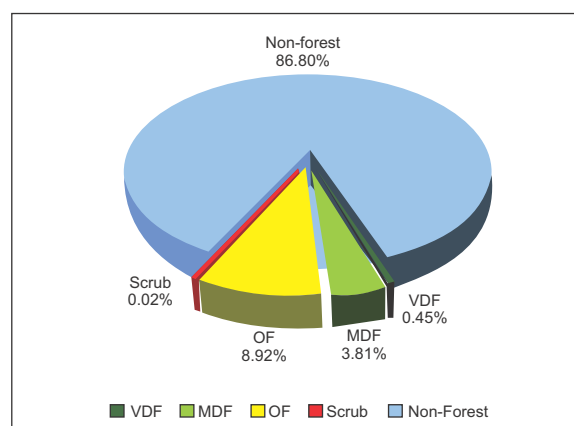
11.6.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017, the Forest Cover in the State is 195.44 sq km which is 13.18 % of the State's geographical area. In terms of forest canopy density classes, the State has 6.72 sq km under Very Dense Forest (VDF), 56.42 sq km under Moderately Dense Forest (MDF) and 132.30 sq km under Open Forest (OF). Forest Cover in the State has increased by 3.03 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.6.2 Forest Cover of Delhi
(in sq. km)

Class	Area	% of GA
VDF	6.72	0.45
MDF	56.42	3.81
OF	132.30	8.92
Total	195.44	13.18
Scrub	0.30	0.02

FIGURE 11.6.1 Forest Cover of Delhi



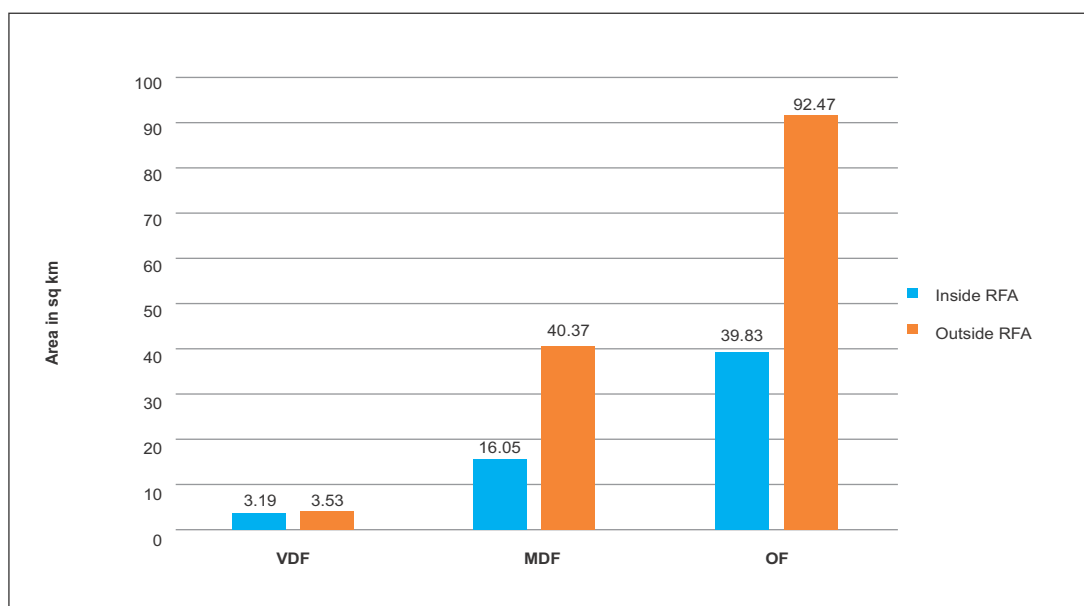
11.6.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 102 sq km which is 6.88 % of its geographical area. The reserved and protected forests are 76.48 % and 23.52 % of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 102.04 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.6.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Delhi (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
3.19	16.05	39.83	59.07	3.53	40.37	92.47	136.37
5.40%	27.17%	67.43%		2.59%	29.60%	67.81%	

*in case of Delhi RFA boundaries have been used.

FIGURE 11.6.2 Forest Cover inside and outside RFA in Delhi**TABLE 11.6.4** District-wise Forest Cover in Delhi (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Central Delhi	21	0.00	2.08	2.86	4.94	23.52	0.00	0.00
East Delhi	63	0.00	1.05	2.70	3.75	5.95	0.05	0.00
New Delhi	35	1.69	5.47	9.31	16.47	47.06	0.06	0.00
North Delhi	61	0.00	2.82	1.76	4.58	7.51	0.00	0.00
North-East Delhi	62	0.00	0.99	3.00	3.99	6.44	0.01	0.00
North-West Delhi	443	0.09	8.77	9.18	18.04	4.07	0.49	0.02
South Delhi	247	2.59	17.75	64.29	84.63	34.26	1.28	0.23
South-West Delhi	421	2.35	14.91	34.93	52.19	12.40	1.09	0.05
West Delhi	130	0.00	2.58	4.27	6.85	5.27	0.05	0.00
Grand Total	1,483	6.72	56.42	132.30	195.44	13.18	3.03	0.30

TABLE 11.6.5 Forest Cover Change Matrix for Delhi

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	6.72	0.00	0.00	0.00	0.00	6.72
Moderately Dense Forest	0.00	56.23	0.00	0.00	0.01	56.24
Open Forest	0.00	0.00	129.03	0.00	0.42	129.45
Scrub	0.00	0.00	0.26	0.30	0.11	0.67
Non Forest	0.00	0.19	3.01	0.00	1,286.72	1,289.92
Total ISFR 2019	6.72	56.42	132.30	0.30	1,287.26	1,483.00
Net Change	0.00	0.18	2.85	-0.37	-2.66	

Main reasons for the increase in forest cover are plantation and conservation activities.

TABLE 11.6.6 Altitude-wise Forest Cover in Delhi

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	1,483	6.72	56.42	132.30	195.44 (100%)	0.30
Total	1,483	6.72	56.42	132.30	195.44	0.30

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.6.7 Forest Cover in different slope classes in Delhi

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,407	6.72	52.40	122.00	181.12 (92.67%)	0.30
5-10	70	0.00	4.02	9.30	13.32 (6.82%)	0.00
10-15	5	0.00	0.00	1.00	1.00 (0.51%)	0.00
15-20	1	0.00	0.00	0.00	0.00 (0.00%)	0.00
Total	1,483	6.72	56.42	132.30	195.44	0.30

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.6.3 Forest Cover Map of Delhi

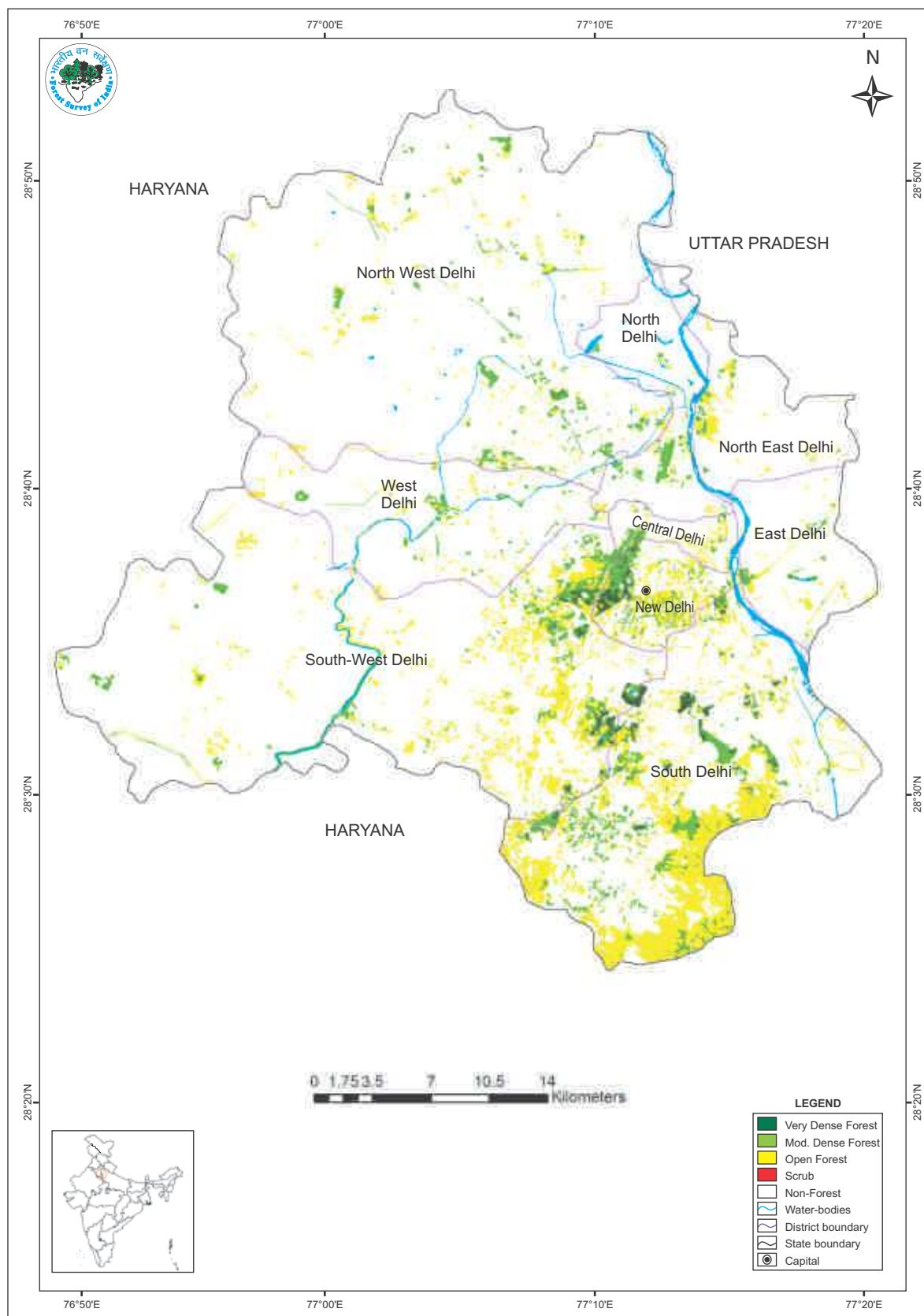


TABLE 11.6.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Delhi

(in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	2
Riverine wetland	0	0
Waterlogged	0	0
River/Stream	0	0
Sub - Total	1	2
Inland Wetlands -Man-made		
Reservoir/Barrage	0	0
Tank/Pond	0	0
Waterlogged	0	0
Sub - Total	0	0
Wetlands (<2.25 ha)	16	16
Total	17	18
Total Recorded Forest (or Green Wash) Area (in ha)		10,204
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.18%

(analysis based on the National Wetland Atlas: India, 2011)

11.6.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Delhi as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.6.9 Percentage area under different forest types of Delhi

Sl. No.	Forest Type	% of Forest cover
1.	5B/C2 Northern Dry Mixed Deciduous Forest	21.73
2.	6B/C2 Ravine Thorn Forest	45.37
3.	Plantation/TOF	32.90
	Total	100.00

11.6.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.6.10 and table 11.6.11 in respect of Delhi.

TABLE 11.6.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	16
Shrub	11
Herb	36

TABLE 11.6.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Delhi

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 5- Tropical Dry Deciduous Forests	1.56	*	*
2.	Group 6- Tropical Thorn Forests	0.99	2.07	3.38

*adequate number of sample plots were not available

11.6.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.6.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	0.00	0.00
3.	Highly fire prone	0.00	0.00
4.	Moderately fire prone	0.00	0.00
5.	Less fire prone	1,296.85	100.00
	Total	1,296.85	100.00

11.6.5 Tree Cover

Forest cover presented in the section 11.6.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Delhi has been estimated as given in table 11.6.13.

TABLE 11.6.13 Tree Cover in Delhi (in sq km)

Tree Cover	Area
	129

Tree cover of Delhi has increased by 16 sq km as compared to the previous assessment reported in ISFR2017.

11.6.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.6.14 Extent of TOF in Delhi (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
136	129	265

11.6.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Delhi is given in the table 11.6.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.6.16

TABLE 11.6.15 Growing Stock in Forest (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	0.54	0.01
Growing Stock in TOF	1.69	0.10

TABLE 11.6.16 Diameter class distribution of top five species inside RFA in Delhi (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Prosopis juliflora</i>	588	12	0
2.	<i>Ficus virene</i>	18	25	0
3.	<i>Acacia lenticularis</i>	86	12	0
4.	<i>Leucaena leucocephala</i>	86	0	0
5.	<i>Cassia fistula</i>	49	0	0

11.6.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 1.24 million tonnes (4.55 million tonnes of CO₂ equivalent) which is 0.017% of total forest carbon of the country. Pool wise forest carbon in Delhi is given in the following table

TABLE 11.6.17 Forest Carbon in different pools in Delhi (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
277	98	2	21	838	1,236

11.6.9 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Delhi in Rural and Urban areas are given in the table 11.6.18 and table 11.6.19 respectively

TABLE 11.6.18 Top five tree species in TOF (Rural) in Delhi

Sl. No.	Species	Relative Abundance (%)
1.	<i>Prosopis juliflora</i>	35.35
2.	<i>Eucalyptus species</i>	17.42
3.	<i>Grevillea robusta</i>	12.64
4.	<i>Azadirachta indica</i>	8.35
5.	<i>Leucaena leucocephala</i>	4.03

TABLE 11.6.19 Top five tree species in TOF (Urban) in Delhi

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	10.51
2.	<i>Morus species</i>	7.19
3.	<i>Polyalthia longifolia</i>	7.02
4.	<i>Ficus religiosa</i>	6.48
5.	<i>Prosopis juliflora</i>	5.85

11.6.10 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.6.20.

TABLE 11.6.20 Major invasive species in the State of Delhi (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Prosopis juliflora</i>	8.13
2.	<i>Lantana camara</i>	0.72
3.	<i>Achyranthes aspera</i>	0.32
4.	<i>Ageratina adenophora</i>	0.32
5.	<i>Cassia tora</i>	0.32

Major invasive species are given in terms of their estimated extent.

11.7

GOA

11.7.1 Introduction

Goa, became a Union Territory of India in 1961 and attained statehood in 1987. It is located along the Arabian Sea and has an area of 3,702 sq km which is 0.11% of the geographical area of the country and is bordered by Maharashtra in the North & East and Karnataka in the South. The State lies between 14°53' N to 15°40' N latitude and 73°40' E to 74°21' E longitudes. The State has two distinct physiographic regions, namely Western Ghats and coastal plains. Goa has a tropical monsoon climate. The average annual rainfall is 3,800 mm and the average annual temperature ranges between 16°C to 37°C. The State is drained by a number of rivers, the important rivers being Mandovi and Zuari. The State has two districts, none of which are classified as hill or tribal districts. As per the 2011 census, Goa has a population of 1.46 million accounting to 0.91% of India's population. The urban and rural population is 62.17% and 37.83% respectively. The Tribal population is 10.23%. The average population density of the State is 394 persons per sq km which is slightly higher than the national average. The 19th Livestock census 2012 has reported a total livestock population of 0.14 million.

TABLE 11.7.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	370	
Reporting area for land utilization	361	100.00
Forests	125	34.75
Not available for land cultivation	37	10.28
Permanent pastures and other grazing lands	1	0.36
Land under misc. tree crops and groves	1	0.16
Culturable wasteland	53	14.55
Fallow land other than current fallows	0	0.00
Current fallows	15	4.11
Net area sown	129	35.79

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.7.1.1 A Brief Overview of Forestry Scenario

The forests of Goa are rich in diversity due to the variations in altitude, aspect, soil characters, slope etc. As per Champion and Seth Classification of Forest Types (1968), the forests of Goa have five Forest Type Groups which are further divided into five Forest Types. Major portion of the vegetation in Goa belongs to plateau vegetation along undulating terrain and hills. Goa has 16 mangrove species including *Rhizophora* spp, *Bruguiera* spp, *Ceriops tagal*, *Kandelia* spp, *Avicennia* spp, *Sonneratia* spp, *Acrostichum* spp, *Aegiceras* spp, *Excoecaria* spp, *Lumnitzera* spp.

Goa Forest Department implements various schemes like Rehabilitation of Degraded Forests, Western Ghats Development Programme, Development of Gardens, Parks and Fountains, Social and Urban Forestry etc.

Recorded Forest Area (RFA) in the State is 1,225 sq km of which 253 sq km is Reserved Forest and 972 sq km is Unclassed Forests. In Goa, during the period 1st January 2015 to 5th February 2019, a total of 42.75 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019). As per the information received from the State 140 ha of plantations have been raised in the State in the last two years.

One National Park and six Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.33% of its geographical area.

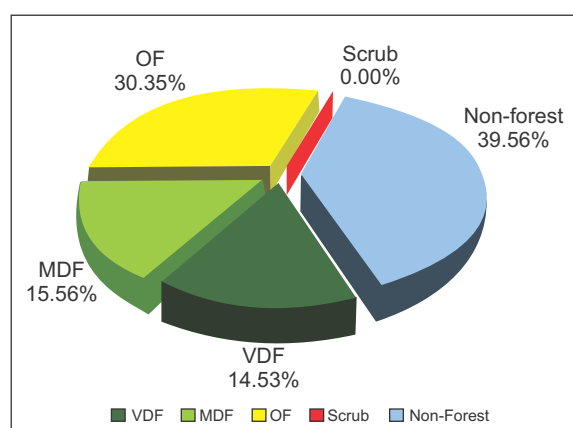
11.7.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data period of Dec 2017, the Forest Cover in the State is 2,237.49 sq km which is 60.44% of the State's geographical area. In terms of forest canopy density classes, the State has 538.00 sq km under Very Dense Forest (VDF), 576.09 sq km under Moderately Dense Forest (MDF) and 1,123.40 sq km under Open Forest (OF). Forest Cover in the State has increased by 8.49 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.7.2 Forest Cover of Goa
(in sq km)

Class	Area	% of GA
VDF	538.00	14.53
MDF	576.09	15.56
OF	1,123.40	30.35
Total	2,237.49	60.44
Scrub	0.00	0.00

FIGURE 11.7.1 Forest Cover of Goa



11.7.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

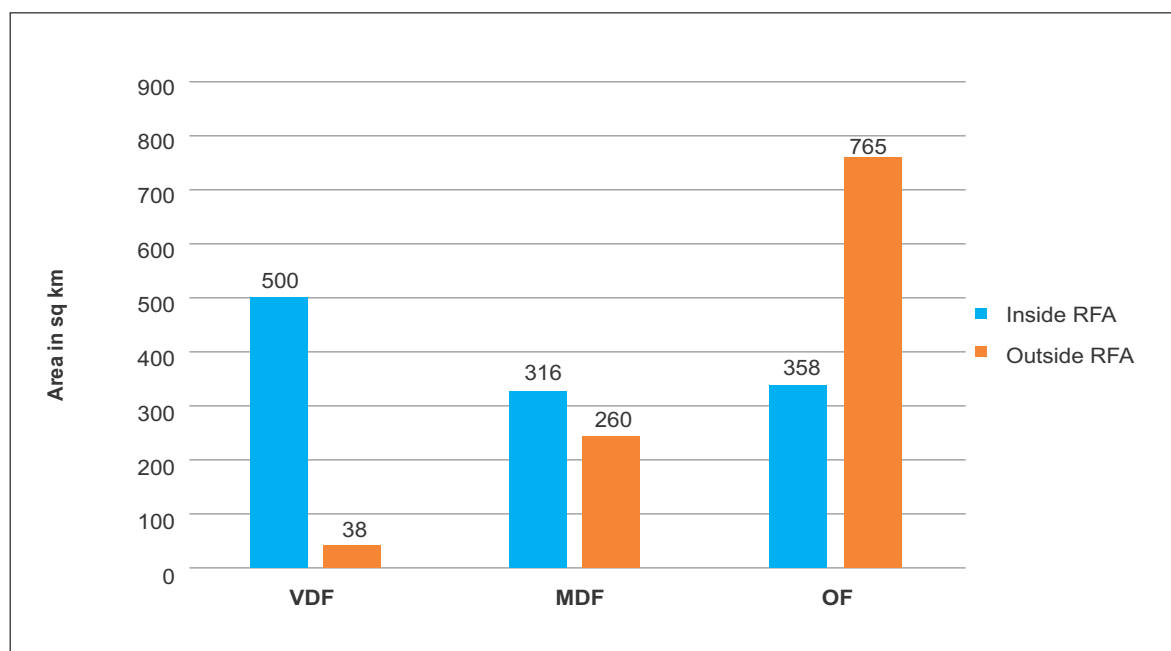
The State has reported extent of recorded forest area (RFA) 1,225 sq km which is 33.09% of its geographical area. The reserved and unclassified forests are 20.65% and 79.35% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 1,309.00 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.7.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Goa

(in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
500	316	358	1,174	38	260	765	1,063
42.59%	26.92%	30.49%		3.57%	24.46%	71.97%	

*in case of Goa RFA, boundaries have been used.

FIGURE 11.7.2 Forest Cover inside and outside RFA in Goa**TABLE 11.7.4** District-wise Forest Cover in Goa

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
North Goa	1,736	127.00	231.15	574.76	932.91	53.74	5.91	0.00
South Goa	1,966	411.00	344.94	548.64	1,304.58	66.36	2.58	0.00
Grand Total	3,702	538.00	576.09	1,123.40	2,237.49	60.44	8.49	0.00

TABLE 11.7.5 Forest Cover Change Matrix for Goa

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	538	0	0	0	0	538
Moderately Dense Forest	0	576	0	0	0	576
Open Forest	0	0	1,115	0	0	1,115
Scrub	0	0	0	0	0	0
Non Forest	0	0	8	0	1,465	1,473
Total ISFR 2019	538	576	1,123	0	1,465	3,702
Net Change	0	0	8	0	-8	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.7.6 Altitude-wise Forest Cover in Goa

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,549	442	556	1,095	2,093 (93.56 %)	0
500-1000	153	96	20	28	144 (6.44 %)	0
Total	3,702	538	576	1,123	2,237	0

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.7.7 Forest Cover in different slope classes in Goa

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,918	100	212	502	814 (36.39 %)	0
5-10	795	122	148	283	553 (24.72 %)	0
10-15	463	118	104	162	384 (17.17 %)	0
15-20	273	92	64	90	246 (11.00 %)	0
20-25	136	55	29	44	128 (5.72 %)	0
25-30	64	28	12	22	62 (2.77 %)	0
>30	53	23	7	20	50 (2.23 %)	0
Total	3,702	538	576	1,123	2,237	0

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.7.3 Forest Cover Map of Goa

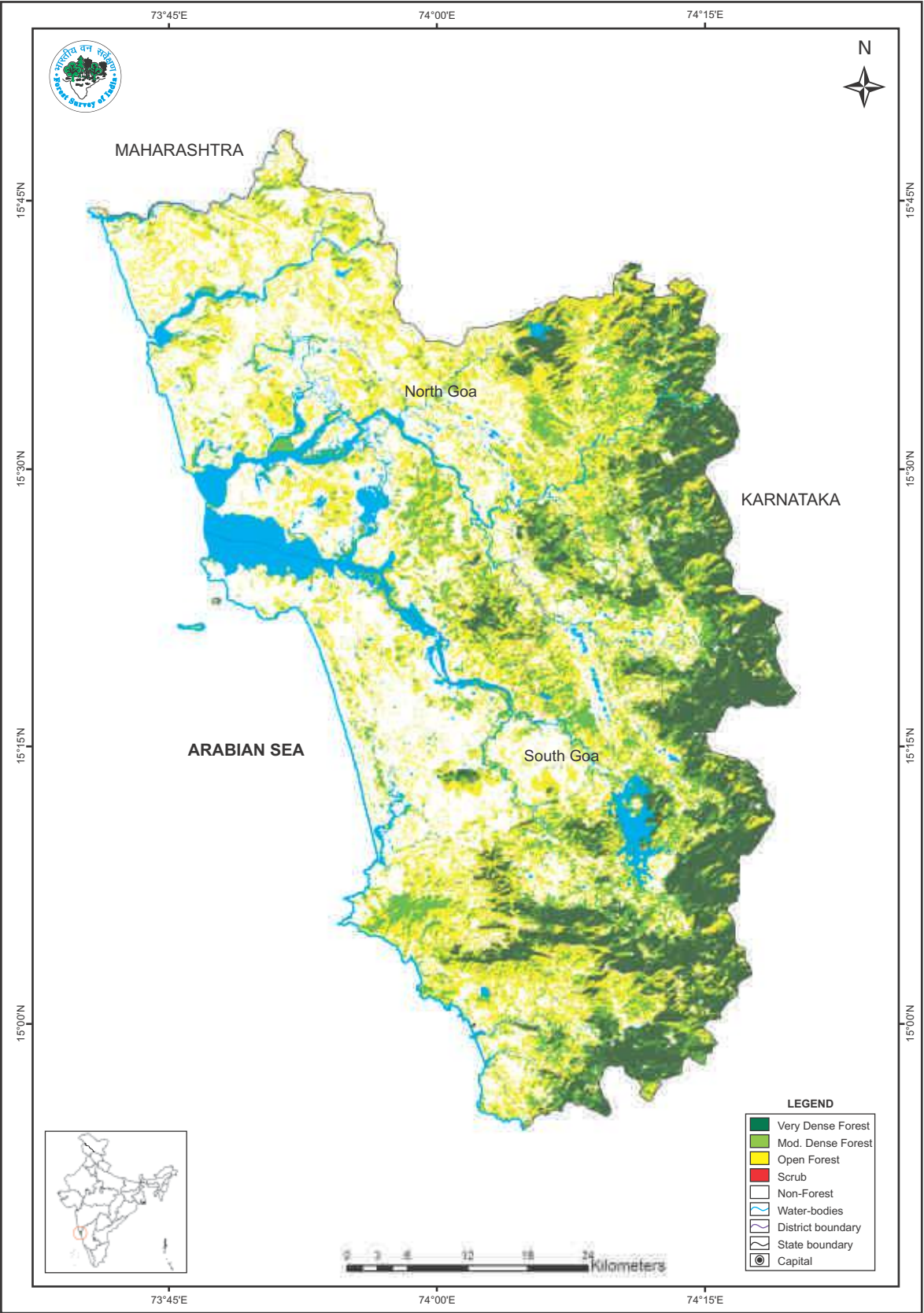


TABLE 11.7.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Goa

(in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	3	33
Ox-bow lake/Cut-off meander	1	6
River/Stream	11	488
Sub - Total	15	527
Inland Wetlands - Man-made		
Reservoir/Barrage	2	134
Tank/Pond	22	92
Sub - Total	24	226
Coastal Wetlands - Natural		
Sand/Beach	3	2
Mangrove	2	243
Sub -Total	5	245
Wetlands (<2.25 ha)	27	27
Total	71	1,025
Total Recorded Forest (or Green Wash) Area (in ha)		1,30,900
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.78%

*(analysis based on the National Wetland Atlas: India, 2011)***11.7.3 Forest Types & Biodiversity**

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Goa as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.7.9 Percentage area under different Forest Types of Goa

Sl.No.	Forest Type	% of Forest cover
1.	1A/C4 West Coast Tropical Evergreen Forest	22.40
2.	2A/C2 West Coast Semi-Evergreen Forest	21.35
3.	3B/C2 Southern Moist Mixed Deciduous Forest	42.55
4.	4B/TS2 Mangrove Forest	1.08
5.	5/E7 Laterite Thorn Forest	0.02
6.	Plantation/ TOF	12.60
	Total	100.00

11.7.3.1 Assessment of Biodiversity in Goa

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.7.10 and table 11.7.11 in respect of Goa.

TABLE 11.7.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	118
Shrub	50
Herb	38

TABLE 11.7.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Goa

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	2.86	2.54	2.61
2.	Group 2- Tropical Semi-Evergreen Forests	3.14	2.16	2.28
3.	Group 3- Tropical Moist Deciduous Forests	3.13	2.65	1.83
4.	Group 4- Littoral and Swamp Forests	*	0.23	0.67
5.	Group 5- Tropical Dry Deciduous Forests	*	1.23	0.41

*adequate number of sample plots were not available

11.7.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.7.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	-	0.00
2.	Very highly fire prone	-	0.00
3.	Highly fire prone	-	0.00
4.	Moderately fire prone	1.10	0.05
5.	Less fire prone	3,589.82	99.95
	Total	3,590.92	100.00

11.7.5 Tree Cover

Forest cover presented in the section 11.7.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Goa has been estimated as given in table 11.7.13.

TABLE 11.7.13 Tree Cover in Goa (in sq km)

Tree Cover	Area
	272

Tree cover of Goa has decreased by 51 sq km as compared to the previous assessment reported in ISFR 2017.



11.7.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.7.14 Extent of TOF in Goa (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
1,063	272	1,335

11.7.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Goa is given in the table 11.7.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.7.16

TABLE 11.7.15 Growing Stock in Goa (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	11.16	0.26
Growing Stock in TOF	4.03	0.25

TABLE 11.7.16 Diameter class distribution of top five species inside RFA in Goa (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Terminalia paniculata</i>	5,698	1,771	161
2.	<i>Terminalia tomentosa</i>	2,235	544	0
3.	<i>Xylia xylocarpa</i>	2,617	483	0
4.	<i>Careya arborea</i>	1,570	181	0
5.	<i>Anacardium occidentale</i>	3,463	282	0

11.7.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size 25.34 million tonnes (92.91 million tonnes of CO₂ equivalent) which is 0.36% of total forest carbon of the country. Pool wise forest carbon in Goa is given in the following table

TABLE 11.7.17 Forest Carbon in Goa in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
9,010	2,617	172	665	12,874	25,338

11.7.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.7.18

TABLE 11.7.18 Growing Stock of Bamboo in Goa

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	418	0.26
Total number of culms (in millions)	30	0.08
Total equivalent green weight (in 000' tonnes)	202	0.07

11.7.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Goa in rural and urban areas are given in the table 11.7.19 and table 11.7.20 respectively.

TABLE 11.7.19 Top five tree species in TOF (Rural) in Goa

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca triandra</i>	28.58
2.	<i>Cocos nucifera</i>	22.42
3.	<i>Anacardium occidentale</i>	6.33
4.	<i>Acacia auriculiformis</i>	6.17
5.	<i>Areca catechu</i>	3.71

TABLE 11.7.20 Top five tree species in TOF (Urban) in Goa

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	38.17
2.	<i>Mangifera indica</i>	10.18
3.	<i>Acacia auriculiformis</i>	4.14
4.	<i>Anacardium occidentale</i>	3.76
5.	<i>Artocarpus heterophyllus</i>	3.73

11.7.11 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.7.21.

TABLE 11.7.21 Major invasive species in the State inside the RFA/Green Wash in Goa (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	60
2.	<i>Cassia tora</i>	13
3.	<i>Ageratina adenophora</i>	3
4.	<i>Triumfetta rhomboidea</i>	1
5.	<i>Acacia farnesiana</i>	1

Major invasive species are given in terms of their estimated extent.

11.7.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Goa

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Goa is given in the table 11.7.22.

TABLE 11.7.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Goa

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
30,285	34,852	312	2,699

11.8

GUJARAT

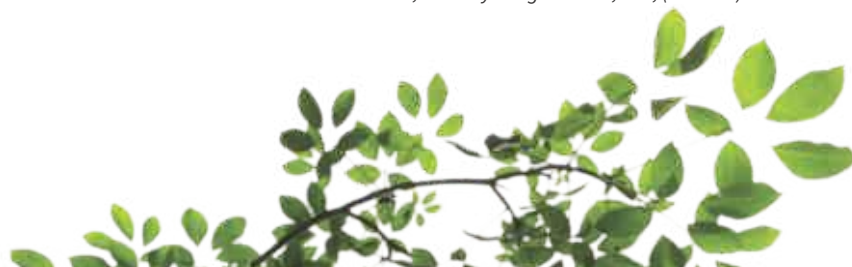
11.8.1 Introduction

Gujarat is the western most State of the country having the longest coastline among the Indian States. The geographical area of the State is 1,96,244 sq km, which is 5.97% of the geographical area of the country. The State lies between 20°07'N to 24°43'N latitude and 68°10'E to 74°29'E longitude and has international border with Pakistan in the North. It shares border with Rajasthan in the north and the northeast, Madhya Pradesh in the east and Maharashtra and Dadra & Nagar Haveli in the south. Physiographically the State can be divided into three distinct regions viz the peninsula, traditionally known as Saurashtra which is a hilly tract with low hills, Kachchh on the north-west which is barren and contains the famous Rann of Kachchh and the mainland, extending from the Rann of Kuchchh and the Aravalli hills to the river Damanganga and consists of plains with alluvial soil. Climate of the State is moderate with mean temperature ranging from 25°C to 28°C and the average annual rainfall from 800 mm to 1,000 mm. The State has 26 districts out of which 8 districts are tribal. As per the 2011 census Gujarat has a population of 60.44 million accounting to 4.99% of India's population. The rural and urban population constitutes 42.60% and 57.40% respectively. Tribal population is 14.75% of the State's population. The population density of the State is 308 per sq km which is lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 27.12 million in the State.

TABLE 11.8.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	19,602	
Reporting area for land utilization	19,069	100.00
Forests	1,834	9.62
Not available for land cultivation	3,723	19.52
Permanent pastures and other grazing lands	851	4.46
Land under misc. tree crops and groves	4	0.02
Culturable wasteland	1,960	10.28
Fallow land other than current fallows	16	0.08
Current fallows	379	1.99
Net area sown	10,302	54.03

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.8.1.1 A Brief Overview of Forestry Scenario

The unique features of the State of Gujarat are the climatic and geomorphologic conditions such as the largest coastline in the country, the saline deserts of Rann, grasslands, wetlands etc. These factors have bestowed the State with rich floral and faunal diversity. The Asiatic lion and Wild Ass have their last reserve in the forests of Gir and the Little Rann of Kachchh respectively in Gujarat. As per Champion & Seth Classification of Forest Types (1968), the forests in Gujarat belongs to four Type Groups which are further divided into 25 Forest Types.

Recorded Forest Area (RFA) in the state is 21,647 sq km of which 14,373 sq km is Reserved Forest, 2,886 sq km of Protected Forest and 4,388 sq km of Unclassed Forests. In Gujarat, during the period 1st January 2015 to 5th February 2019, a total of 2,009.30 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the state during the last two years a total of 75,672 ha of plantations were raised in the State.

Four National Parks, 23 Wildlife Sanctuaries and one Conservation Reserve constitute the Protected Area network of the State covering 8.83% of its geographical area.

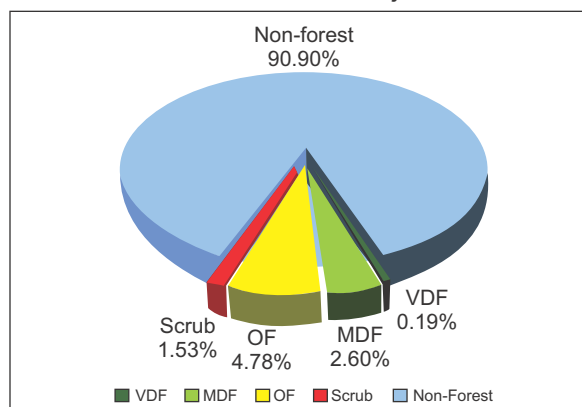
11.8.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Dec 2017, the Forest Cover in the State is 14,857.33 sq km which is 7.57% of the State's geographical area. In terms of forest canopy density classes, the State has 377.90 sq km under Very Dense Forest (VDF), 5,092 sq km under Moderately Dense Forest (MDF) and 9,387.43 sq km under Open Forest (OF). Forest Cover in the State has increased by 100.33 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.8.2 Forest Cover of Gujarat
(in sq km)

Class	Area	% of GA
VDF	377.90	0.19
MDF	5,092.00	2.60
OF	9,387.43	4.78
Total	14,857.33	7.57
Scrub	2,994.11	1.53

FIGURE 11.8.1 Forest Cover of Gujarat



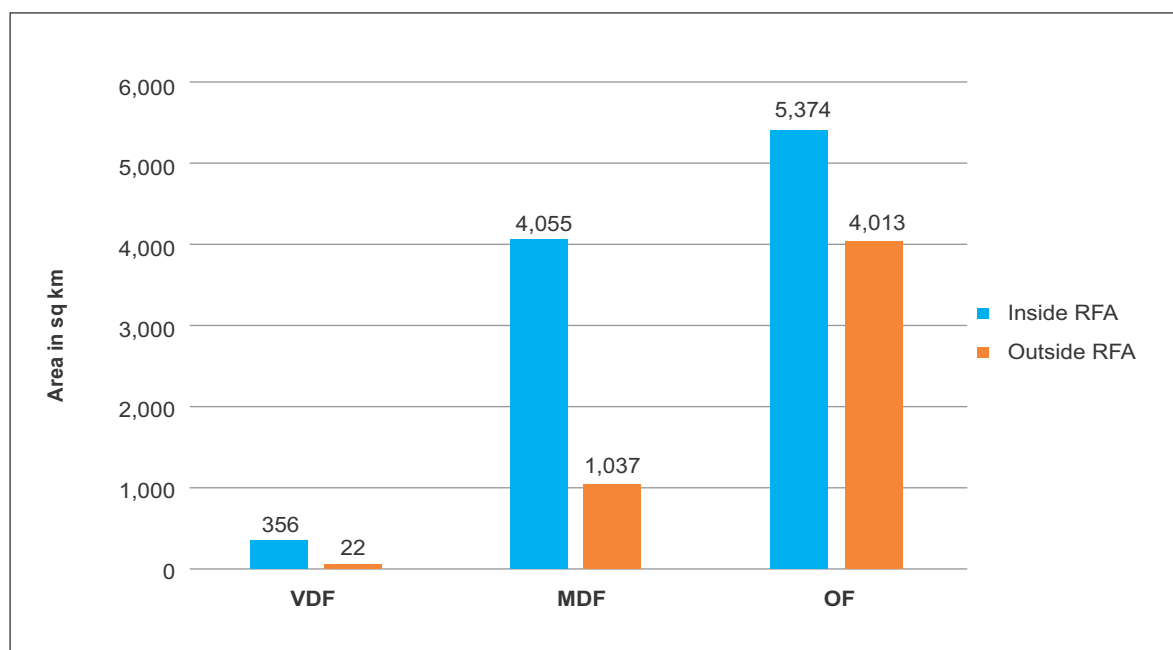
11.8.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 21,647 sq km which is 11.03% of its geographical area. The reserved, protected and unclassified forests are 66.39%, 13.33% and 20.28% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 30,354.44 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.8.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Gujarat (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
356	4,055	5,374	9,785	22	1,037	4,013	5,072
3.64%	41.44%	54.92%		0.43%	20.44%	79.13%	

*in case of Gujarat RFA boundaries have been used.

FIGURE 11.8.2 Forest Cover inside and outside RFA in Gujarat**TABLE 11.8.4** District-wise Forest Cover in Gujarat

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Ahmedabad	8,107	0.00	12.75	118.46	131.21	1.62	2.21	40.53
Amreli	7,397	0.00	63.01	197.39	260.40	3.52	9.40	90.69
Anand	3,204	0.00	9.32	41.16	50.48	1.58	-12.52	16.51
Banas Kantha ^T	10,743	0.00	367.74	454.76	822.50	7.66	-25.50	153.64
Bharuch ^T	6,509	0.00	58.12	219.40	277.52	4.26	-36.48	14.48
Bhavnagar	10,034	0.00	47.85	245.36	293.21	2.92	16.21	84.70
Dohod	3,642	1.00	115.64	413.18	529.82	14.55	-8.18	30.17
Gandhinagar	2,140	0.00	10.14	81.91	92.05	4.30	0.05	51.77
Jamnagar	14,184	0.00	53.75	417.36	471.11	3.32	36.11	157.86
Junagadh	8,831	15.00	938.08	740.23	1,693.31	19.17	59.31	95.43
Kachchh	45,674	0.00	284.89	2,060.40	2,345.29	5.13	33.29	1,520.19
Kheda	3,953	0.00	17.64	76.80	94.44	2.39	0.44	36.01
Mahesana	4,401	0.00	9.91	148.71	158.62	3.60	-0.38	45.59
Narmada	2,817	20.00	460.24	467.76	948.00	33.65	-15.00	25.50
Navsari	2,246	18.00	122.61	221.82	362.43	16.14	60.43	10.14
Panch Mahals ^T	5,231	0.00	203.13	506.93	710.06	13.57	-26.94	48.75
Patan	5,792	0.00	1.00	101.51	102.51	1.77	0.51	115.60
Porbandar	2,316	0.00	16.15	110.53	126.68	5.47	2.68	40.17
Rajkot	11,198	0.00	2.64	151.68	154.32	1.38	13.32	95.12
Sabarkantha ^T	7,394	29.00	302.30	483.97	815.27	11.03	8.27	111.77
Surat ^T	4,549	5.00	288.85	206.21	500.06	10.99	-14.94	81.94

Contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Surendranagar	10,423	0.00	6.00	167.99	173.99	1.67	-1.01	48.30
Tapi ^T	3,139	79.90	475.66	236.85	792.41	25.24	-17.59	7.00
The Dangs ^T	1,766	210.00	740.36	412.26	1,362.62	77.16	-5.38	3.00
Vadodara ^T	7,546	0.00	140.83	462.38	603.21	7.99	-25.79	42.53
Valsad ^T	3,008	0.00	343.39	642.42	985.81	32.77	47.81	26.72
Grand Total	1,96,244	377.90	5,092.00	9,387.43	14,857.33	7.57	100.33	2,994.11

TABLE 11.8.5 Forest Cover Change Matrix for Gujarat

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	378	0	0	0	0	378
Moderately Dense Forest	0	5,078	40	4	78	5,200
Open Forest	0	9	8,287	206	677	9,179
Scrub	0	0	222	1,759	213	2,194
Non Forest	0	5	838	1,025	1,77,425	1,79,293
Total ISFR 2019	378	5,092	9,387	2,994	1,78,393	1,96,244
Net Change	0	-108	208	800	-900	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.8.6 Altitude-wise Forest Cover in Gujarat

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	1,95,407	329	4,748	9,172	14,249 (95.91%)	2,990
500-1000	830	49	343	214	606 (4.08%)	3
1000-2000	7	0	1	1	2 (0.01%)	1
Total	1,96,244	378	5,092	9,387	14,857	2,994

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.8.7 Forest Cover in different slope classes in Gujarat

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,85,312	121	2,306	6,359	8,786 (59.14%)	2,566
5-10	6,265	73	1,067	1,384	2,524 (16.99%)	267
10-15	2,322	67	740	791	1,598 (10.76%)	92
15-20	1,257	56	491	461	1,008 (6.78%)	42
20-25	659	37	285	243	565 (3.80%)	18
25-30	291	17	135	105	257 (1.73%)	6
>30	138	7	68	44	119 (0.80%)	3
Total	1,96,244	378	5,092	9,387	14,857	2,994

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.8.3 Forest Cover Map of Gujarat

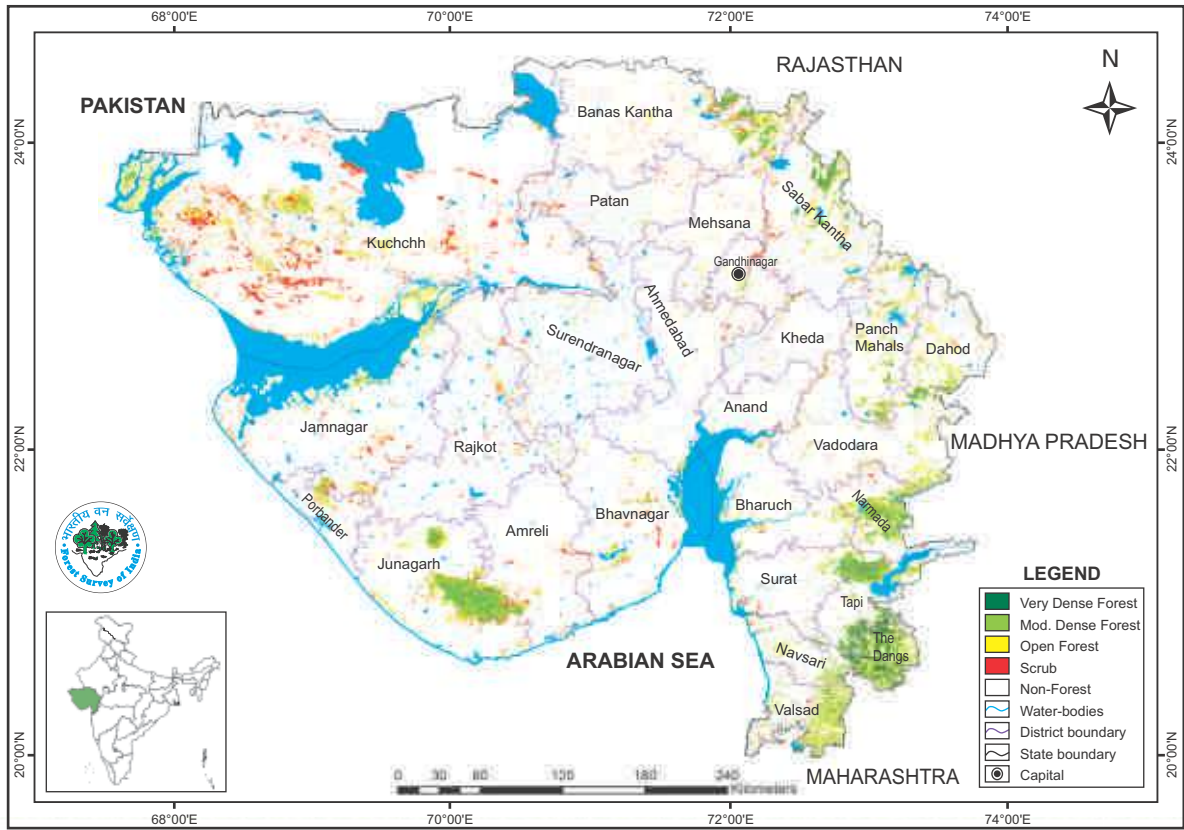


TABLE 11.8.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Gujarat (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	18	12,613
Waterlogged	66	3,476
River/Stream	476	21,869
Sub - Total	560	37,958
Inland Wetlands -Man-made		
Reservoir/Barrage	342	32,928
Tank/Pond	1,329	8,456
Waterlogged	3	2,801
Salt Pan	3	269
Sub - Total	1,677	44,454
Coastal Wetlands – Natural		
Lagoon	14	7,010
Creek	53	14,991
Sand/Beach	36	2,054
Intertidal mud flat	249	104,9483
Salt Marsh	106	21,166
Mangrove	150	19,634
Coral Reef	73	13,314
Sub -Total	681	11,27,652
Wetlands (<2.25 ha)	611	611
Total	3,529	12,10,675
Total Recorded Forest (or Green Wash) Area (in ha)		30,35,444
% of Wetland area inside Recorded Forest (or Green Wash) Area		39.88%

(Analysis based on the National Wetland Atlas: India, 2011)

11.8.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Gujarat as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.8.9 Percentage area under different forest types of Gujarat

Sl.No.	Forest Type	% of Forest cover
1.	3B/C1b Moist Teak Forest	4.50
2.	3B/C1c Slightly Moist Teak Forest	3.83
3.	3B/C2 Southern Moist Mixed Deciduous Forest	6.79
4.	4B/TS1 Mangrove Scrub	3.86
5.	4B/TS2 Mangrove Forest	3.37
6.	5A/C1a Very Dry Teak Forest	4.60
7.	5A/C1b Dry Teak Forest	11.77
8.	5A/C3 Southern Dry Mixed Deciduous Forest	12.75
9.	5B/DS1 Dry Deciduous Scrub	5.00
10.	5B/DS4 (Dry Grassland)	1.93

Contd.

Sl.No.	Forest Type	% of Forest cover
11.	5/E1 Anogeissus Pendula Forest	0.35
12.	5/E2 Boswellia Forest	0.01
13.	5/E3 Babul Forest	0.81
14.	5/E5 Butea Forest	0.52
15.	5/E8c Salvadoria - Tamarix Scrub	0.99
16.	5/E9 Dry Bamboo Brake	0.66
17.	5/1S1 Dry Tropical Riverain Forest	0.01
18.	5/2S1 Secondary Dry Deciduous Forest	0.28
19.	5B/C2 Northern Dry Mixed Deciduous Forest	5.28
20.	6A/C1 Southern Thorn Forest	0.38
21.	6B/C1 Desert Thorn Forest	9.22
22.	6/DS2 Tropical Euphorbia Scrub	4.82
23.	6/E2 Acacia Senegal Forest	5.20
24.	6/E3 Rann Saline Thorn Forest	4.76
25.	6/E4 Salvadoria Scrub	0.10
26.	Plantation/TOF	8.21
	Total	100.00

11.8.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.8.10 and table 11.8.11 in respect of Gujarat.

TABLE 11.8.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	102
Shrub	37
Herb	73

TABLE 11.8.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Gujarat.

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 3- Tropical Moist Deciduous Forests	2.80	2.40	2.02
2	Group 4- Littoral and Swamp Forests	*	0.86	1.80
3	Group 5- Tropical Dry Deciduous Forests	3.09	2.14	3.30
4	Group 6- Tropical Thorn Forests	1.93	1.44	2.58

*adequate number of sample plots were not available



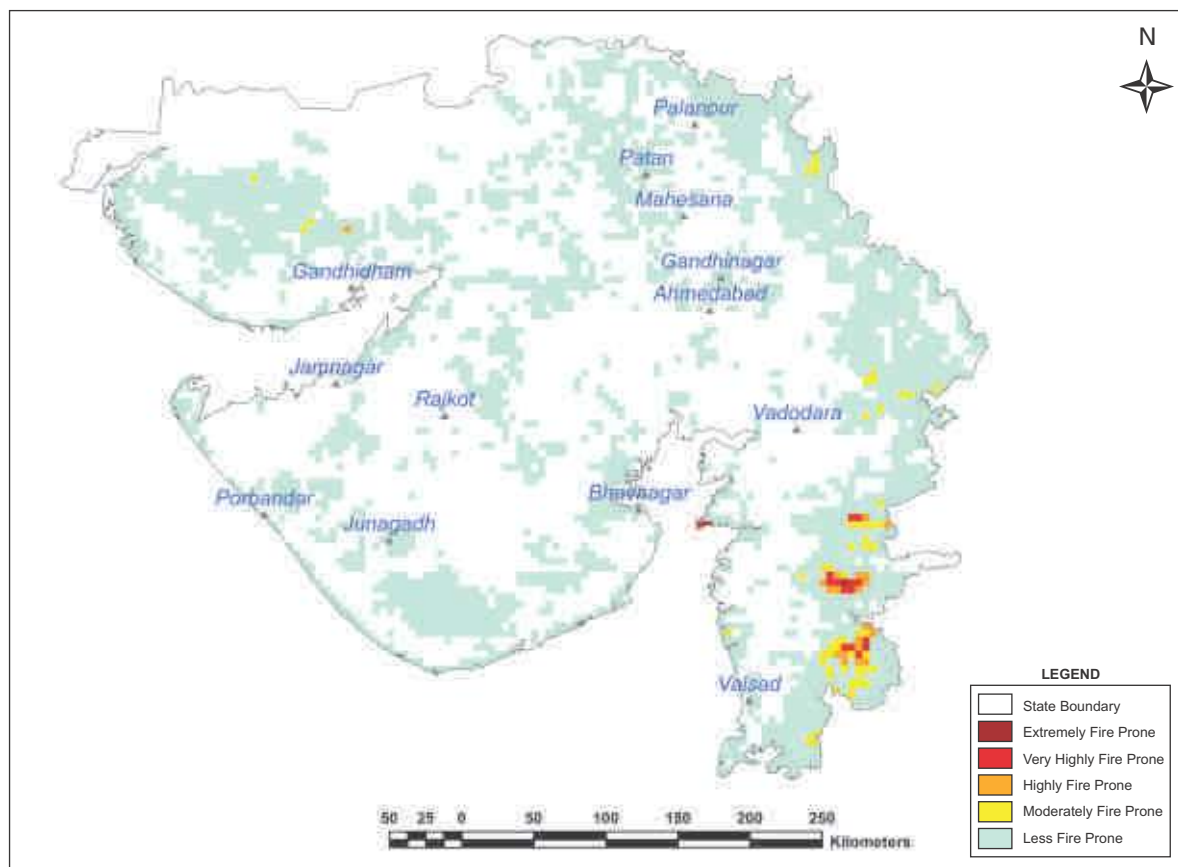
11.8.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.8.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	68.41	0.25
2.	Very highly fire prone	390.01	2.69
3.	Highly fire prone	521.59	3.45
4.	Moderately fire prone	1,443.32	8.43
5.	Less fire prone	68,028.78	85.18
	Total	70,452.11	100.00

FIGURE 11.8.4 Fire prone forest areas under different fire prone classes



11.8.5 Tree Cover

Forest cover presented in the section 11.8.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Gujarat has been estimated as given in table 11.8.13.

TABLE 11.8.13 Tree Cover in Gujarat (in sq km)

Tree Cover	Area
	6,912

Tree cover of Gujarat has decreased by 1,112 sq km as compared to the previous assessment reported in ISFR 2017.

11.8.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based methodology. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.8.14 Extent of TOF in Gujarat (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
5,072	6,912	11,984

11.8.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Gujarat is given in the table 11.8.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.8.16

TABLE 11.8.15 Growing Stock in Gujarat (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	48.31	1.13
Growing Stock in TOF	82.60	5.03

TABLE 11.8.16 Diameter class distribution of top five species inside RFA in Gujarat (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Tectona grandis</i>	55,834	3,429	345
2.	<i>Terminalia tomentosa</i>	12,671	1,599	0
3.	<i>Butea frondosa</i>	17,629	694	0
4.	<i>Prosopis juliflora</i>	14,925	0	0
5.	<i>Wrightia tinctoria</i>	25,809	1000	0

11.8.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size 107.25 million tonnes (393.25 million tonnes of CO₂ equivalent) which is 1.51% of total forest carbon of the country. Pool wise forest carbon in Gujarat is given in the following table

TABLE 11.8.17 Forest Carbon in Gujarat in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
27,737	9,636	315	1,556	68,003	1,07,247

11.8.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.8.18

TABLE 11.8.18 Growing Stock of Bamboo in Gujarat

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	3,393	2.12
Total number of culms (in millions)	677	1.72
Total equivalent green weight (in 000' tonnes)	8,877	3.20

11.8.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Gujarat in Rural and Urban areas are given in the table 11.8.19 and table 11.8.20 respectively

TABLE 11.8.19 Top five tree species in TOF (Rural) in Gujarat

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	25.17
2.	<i>Mangifera indica</i>	12.06
3.	<i>Acacia arabica</i>	6.11
4.	<i>Prosopis juliflora</i>	5.79
5.	<i>Tectona grandis</i>	4.62

TABLE 11.8.20 Top five tree species in TOF (Urban) in Gujarat

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	26.91
2.	<i>Pittosporum ferrugineum</i>	8.16
3.	<i>Polyalthia species</i>	5.13
4.	<i>Mangifera indica</i>	4.12
5.	<i>Cocos nucifera</i>	3.73

11.8.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.8.21 and table 11.8.22 respectively.

TABLE 11.8.21 Major NTFP species in the State inside the RFA/Green wash in Gujarat (in sq km)

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Rizophora mucronata</i>	Shrub	39.08
2.	<i>Desomodium gangeticum</i>	Shrub	31.03
3.	<i>Phyllanthus amarus</i>	Herb	20.69
4.	<i>Ruta graveolens</i>	Herb	4.60
5.	<i>Chlorophytum borivilliamnum</i>	Herb	2.30

TABLE 11.8.22 Major invasive species in the State inside the RFA/Green wash in Gujarat (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Prosopis juliflora</i>	290
2.	<i>Cassia tora</i>	266
3.	<i>Ageratum conyzoides</i>	149
4.	<i>Lantana camara</i>	139
5.	<i>Senna occidentalis</i>	74

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.8.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Gujarat

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Gujarat is given in the table 11.8.23

TABLE 11.8.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Gujarat

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
49,83,289	11,90,53,905	2,91,749	11,92,475



11.9

HARYANA

11.9.1 Introduction

Haryana is situated in the northern part of India and has a geographical area of 44,212 sq km which constitutes 1.34% of the geographical area of the country. The State lies between latitude 27°39'N to 30°55'N and longitude 74°27'E to 77°36'E. Physiographically Haryana falls in the Indo Gangetic plain although some of the areas fall in Shiwalik hills as well. Climate of the State varies from moist sub-tropical in north bordering Himachal Pradesh to arid in southern part bordering Rajasthan. The State is bordered by Himachal Pradesh and Punjab in the North, Uttarakhand, Uttar Pradesh and Delhi on the East and Rajasthan on the West & South. The average annual rainfall varies from about 200 mm to 1,400 mm and the average annual temperature ranges between 1°C to 45°C. The Yamuna and the Ghaggar are the important rivers of the state. The state has 21 districts, none are classified as tribal or hill districts. As per the 2011 census, Haryana has a population of 25.35 million accounting to 2.1% of India's population. The rural and urban population constitutes 34.87% and 65.13% respectively. The population density of the State is 573 per sq km which is higher than the national average. The 19th Livestock census 2012 has reported a total livestock population of 8.82 million.

TABLE 11.9.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	4,421	
Reporting area for land utilization	4,371	100.00
Forests	37	0.86
Not available for land cultivation	653	14.94
Permanent pastures and other grazing lands	25	0.57
Land under misc. tree crops and groves	9	0.20
Culturable wasteland	17	0.39
Fallow land other than current fallows	22	0.51
Current fallows	86	1.97
Net area sown	3,522	80.56

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.9.1.1 A Brief Overview of Forestry Scenario

Haryana is primarily an agricultural State of India and 80% of the total geographical area is under agriculture. As per the Champion & Seth Classification of Forest Types (1968), the forests in Haryana belong to three Forest Type Groups i.e. Tropical Dry Deciduous Forest, Tropical Thorn Forest and Subtropical Pine Forests which are divided into 10 Forest Types. Over 500 bird species have been recorded in the State which is almost 40% of total bird species in the country. Although, the maximum portion of the geographical area consists of agricultural fields, over a time, the State has achieved a unique status in the field of agroforestry which has enabled the forest deficient State to support a large number of wood-based industries based on farm-grown timber. Poplar and Eucalyptus trees are the major agroforestry species which have become the main resource for improvement of livelihood of farmers in northern and central parts of the State.

Special emphasis is being given to Soil and Moisture Conservation works in the hills to conserve water and deliver it to adjacent farmlands for increasing their productivity and enhancing incomes. Herbal Parks have been developed in every district to bring people closer to the natural ecosystem.

Recorded Forest Area (RFA) in the State is 1,559 sq km of which 249 sq km is Reserved Forests, 1,158 sq km is Protected Forests and 152 sq km is Unclassed Forests. In Haryana, during the period 1st January 2015 to 5th February 2019, a total of 1,529 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Two National Parks, eight Wildlife Sanctuaries and two Conservation Reserves constitute the Protected Area network of the State covering 0.75% of its geographical area.

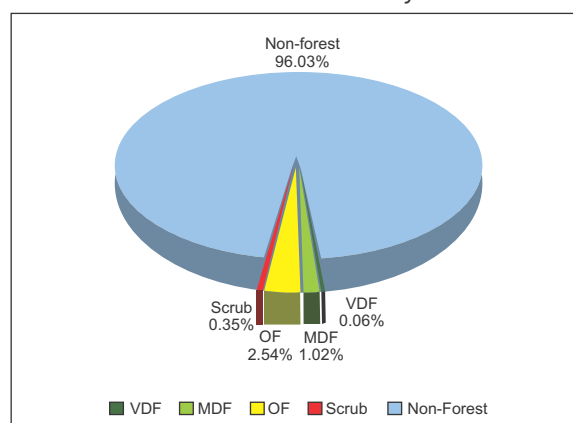
11.9.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct to Dec 2017, the Forest Cover in the State is 1,602.44 sq km which is 3.62% of the State's geographical area. In terms of forest canopy density classes, the State has 28.00 sq km under Very Dense Forest (VDF), 450.90 sq km under Moderately Dense Forest (MDF) and 1,123.54 sq km under Open Forest (OF). Forest Cover in the State has increased by 14.44 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.9.2 Forest Cover of Haryana
(in sq km)

Class	Area	% of GA
VDF	28.00	0.06
MDF	450.90	1.02
OF	1,123.54	2.54
Total	1,602.44	3.62
Scrub	154.29	0.35

FIGURE 11.9.1 Forest Cover of Haryana



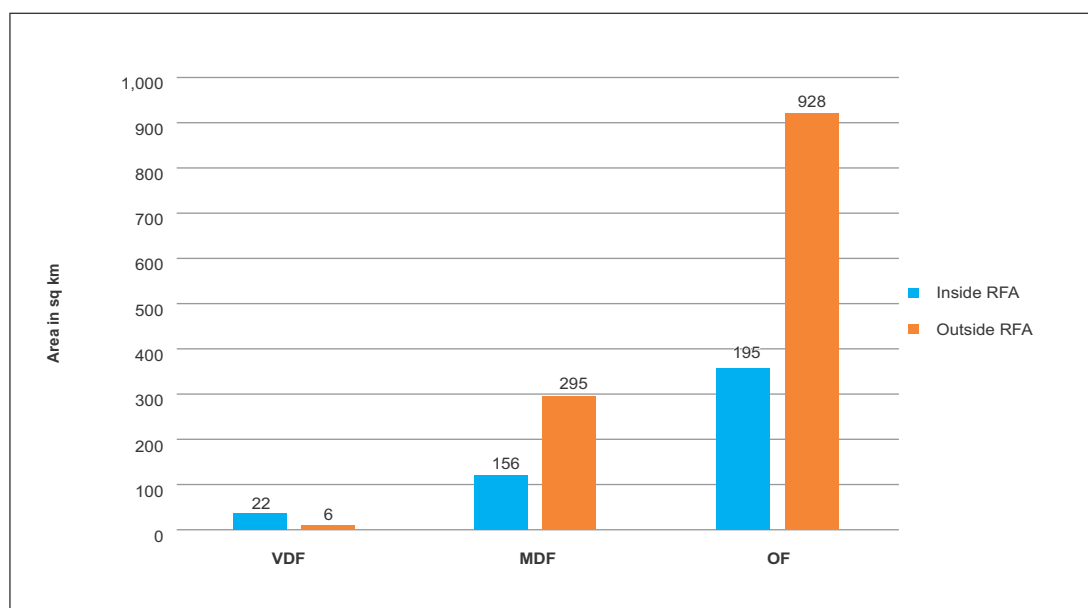
11.9.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 1,559 sq km which is 3.53% of its geographical area. The reserved, protected and unclassified forests are 15.97%, 74.28% and 9.75% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 565.81 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.9.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Haryana (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
22	156	195	373	6	295	928	1,229
5.85%	41.89%	52.26%		0.50%	23.96%	75.54%	

*in case of Haryana RFA boundaries have been used.

FIGURE 11.9.2 Forest Cover inside and outside RFA in Haryana**TABLE 11.9.4** District-wise Forest Cover in Haryana (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Ambala	1,574	0.00	18.00	33.35	51.35	3.26	-0.65	1.00
Bhiwani	4,778	0.00	8.00	105.81	113.81	2.38	1.81	11.00
Faridabad	741	0.00	26.05	53.89	79.94	10.79	-0.06	17.76
Fatehabad	2,538	0.00	3.00	15.00	18.00	0.71	0.00	0.00
Gurgaon	1,258	0.00	33.69	82.49	116.18	9.24	-0.82	17.00
Hisar	3,983	0.00	11.86	45.78	57.64	1.45	0.64	4.32
Jhajjar	1,834	0.00	0.00	25.93	25.93	1.41	1.93	4.00
Jind	2,702	0.00	4.98	16.02	21.00	0.78	0.00	0.00
Kaithal	2,317	0.00	23.92	33.15	57.07	2.46	0.07	0.00
Karnal	2,520	0.00	4.00	28.24	32.24	1.28	0.24	0.76
Kurukshetra	1,530	0.00	17.60	22.15	39.75	2.60	0.75	2.50
Mahendragarh	1,899	0.00	22.00	81.29	103.29	5.44	4.29	35.00
Mewat	1,507	0.00	14.00	97.18	111.18	7.38	1.18	25.38
Palwal	1,359	0.00	1.97	12.00	13.97	1.03	-0.03	0.00
Panchkula	898	6.00	150.90	233.80	390.70	43.51	-0.30	23.84

Contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Panipat	1,268	0.00	2.95	12.93	15.88	1.25	-0.12	1.00
Rewari	1,594	0.00	10.00	52.45	62.45	3.92	3.45	8.44
Rohtak	1,745	0.00	2.97	18.16	21.13	1.21	2.13	0.39
Sirsa	4,277	0.00	3.01	53.59	56.60	1.32	-0.40	0.00
Sonipat	2,122	0.00	3.00	17.97	20.97	0.99	0.97	0.97
Yamunanagar	1,768	22.00	89.00	82.36	193.36	10.94	-0.64	0.93
Grand Total	44,212	28.00	450.90	1,123.54	1,602.44	3.62	14.44	154.29

TABLE 11.9.5 Forest Cover Change Matrix for Haryana

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	28	0	0	0	0	28
Moderately Dense Forest	0	451	0	0	1	452
Open Forest	0	0	1,103	0	5	1,108
Scrub	0	0	5	148	1	154
Non Forest	0	0	15	6	42,449	42,470
Total ISFR 2019	28	451	1,123	154	42,456	44,212
Net Change	0	-1	15	0	-14	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.9.6 Altitude-wise Forest Cover in Haryana

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	43,838	16	336	969	1,321 (82.46%)	142
500-1000	330	12	94	133	239 (14.92%)	11
1000-2000	44	0	21	21	42 (2.62%)	1
Total	44,212	28	451	1,123	1,602	154

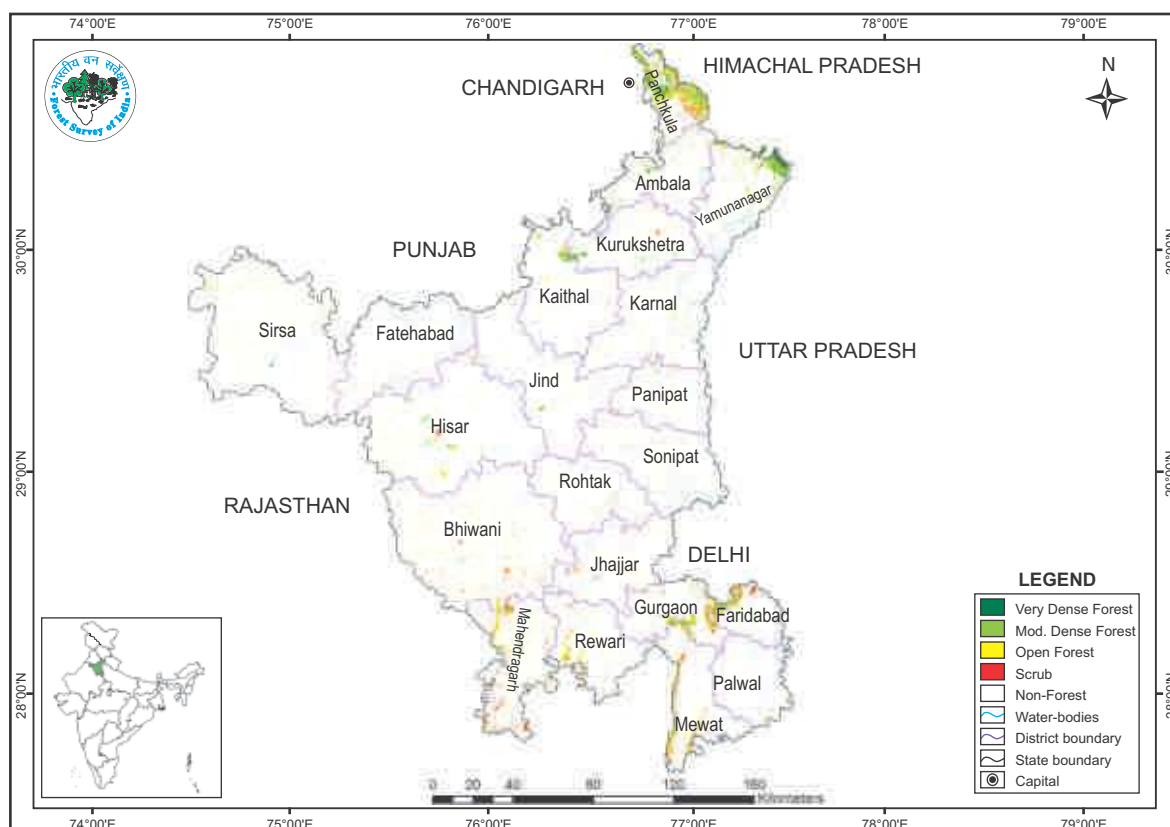
(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.9.7 Forest Cover in different slope classes in Haryana

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	42,615	14	246	782	1,042 (65.04%)	91
5-10	1,104	7	75	128	210 (13.11%)	24
10-15	228	4	55	84	143 (8.93%)	15
15-20	126	2	36	58	96 (5.99%)	11
20-25	74	1	21	37	59 (3.68%)	7
25-30	41	0	12	21	33 (2.06%)	4
>30	24	0	6	13	19 (1.19%)	2
Total	44,212	28	451	1,123	1,602	154

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE. 11.9.3 Forest Cover Map of Haryana**TABLE 11.9.8** Wetlands inside the Recorded Forest Area (or Green Wash) in Haryana

(in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	5	671
Waterlogged	2	7
River/Stream	9	1,022
Sub - Total	16	1,700
Inland Wetlands -Man-made		
Tank/Pond	16	61
Waterlogged	11	89
Sub - Total	27	150
Wetlands (<2.25 ha)	35	35
Total	78	1,885
Total Recorded Forest (or Green Wash) Area (in ha)		56,581
% of Wetland area inside Recorded Forest (or Green Wash) Area		3.33%

(analysis based on the National Wetland Atlas: India, 2011)

11.9.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Haryana as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.9.9 Percentage Area under different forest types of Haryana

Sl.No.	Forest Type	% of Forest cover
1.	5B/C1a Dry Siwalik Sal Forest	2.66
2.	5B/C2 Northern Dry Mixed Deciduous Forest	30.20
3.	5/DS1 Dry Deciduous Scrub	1.62
4.	5/E9 Dry Bamboo Brakes	0.41
5.	5/E1/DS1 <i>Anogeissus Pendula</i> Scrub	0.89
6.	5/E1 <i>Anogeissus Pendula</i> Forest	5.00
7.	6B/C2 Ravine Thorn Forest	14.32
8.	6B/C1 Desert Thorn Forest	6.08
9.	6/1S1 Desert Dune Scrub	6.40
10.	9/C1a Siwalik Chir Pine Forest	0.72
11.	Plantation/ TOF	31.70
	Total	100.00

11.9.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.9.10 and table 11.9.11 in respect of Haryana.

TABLE 11.9.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	45
Shrub	43
Herb	50

TABLE 11.9.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Haryana

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 5- Tropical Dry Deciduous Forests	2.69	1.88	1.70
2	Group 6- Tropical Thorn Forests	1.94	1.96	2.24
3	Group 9- Subtropical Pine Forests	*	2.62	2.23

*adequate number of sample plots were not available

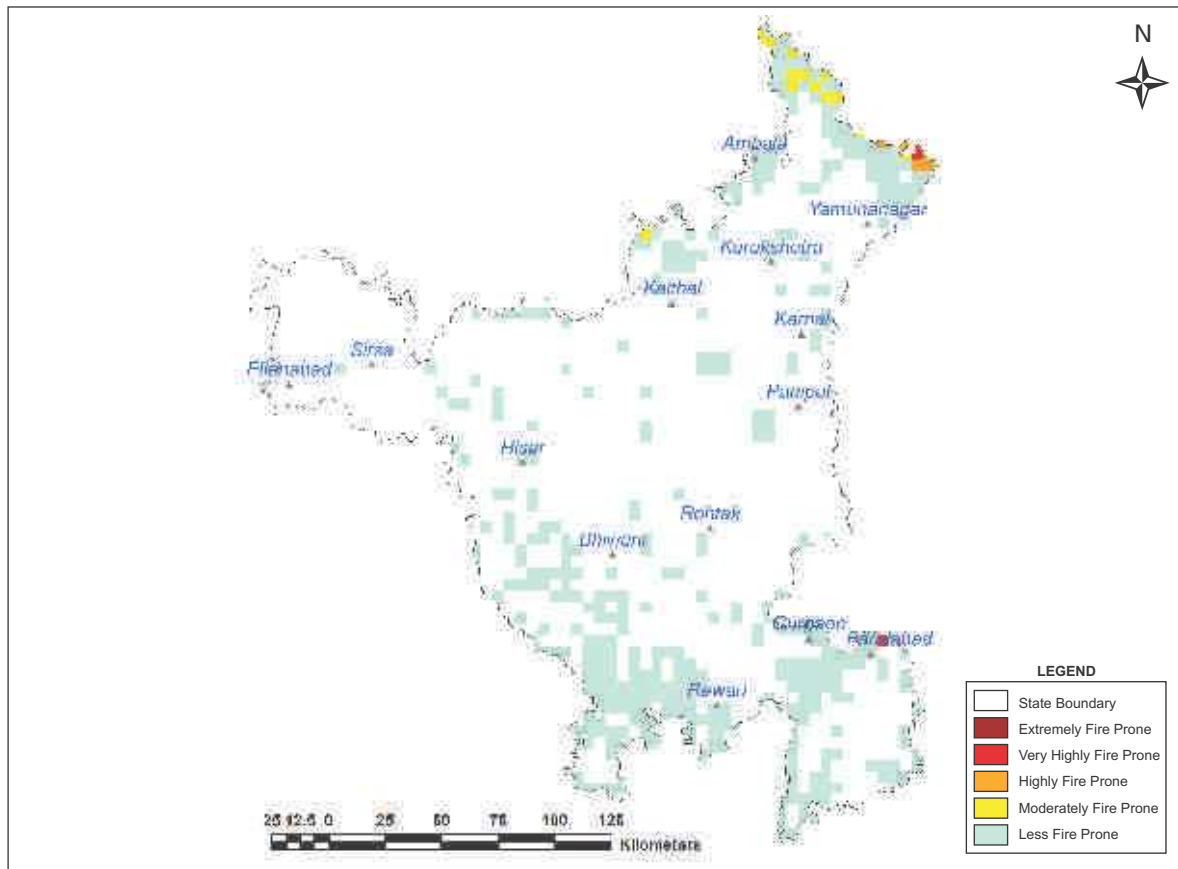
11.9.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.9.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	0.00	0.00
2	Very highly fire prone	44.28	2.33
3	Highly fire prone	72.69	5.87
4	Moderately fire prone	283.08	18.08
5	Less fire prone	9,317.45	73.72
	Total	9,717.50	100.00

FIGURE 11.9.4 Fire prone forest areas under different fire prone classes



11.9.5 Tree Cover

Forest cover presented in the section 11.9.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Haryana has been estimated as given in table 11.9.13.

TABLE 11.9.13 Tree Cover in Haryana (in sq km)

Tree Cover	Area
	1,565

Tree cover of Haryana has increased by 150 sq km as compared to the previous assessment reported in ISFR 2017.

11.9.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.9.14 Extent of TOF in Haryana (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
1,229	1,565	2,794

11.9.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Haryana is given in the table 11.9.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.9.16

TABLE 11.9.15 Growing Stock in Haryana (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	4.22	0.10
Growing Stock in TOF	17.56	1.07

TABLE 11.9.16 Diameter class distribution of top five species inside RFA in Haryana (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Eucalyptus species</i>	2,347	301	0
2.	<i>Dalbergia sissoo</i>	1,707	350	0
3.	<i>Prosopis juliflora</i>	3,038	158	0
4.	<i>Acacia catechu</i>	3,114	0	0
5.	<i>Acacia tortolis</i>	2,244	65	0

11.9.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 10.47 million tonnes (38.39 million tonnes of CO₂ equivalent) which is 0.15% of total forest carbon of the country. Pool wise forest carbon in Haryana is given in the following table.

TABLE 11.9.17 Forest Carbon in Haryana in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
2,455	929	18	137	6,927	10,466

11.9.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.9.18

TABLE 11.9.18 Growing Stock of Bamboo in Haryana

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	72	0.04
Total number of culms (in millions)	-	-
Total equivalent green weight (in 000' tonnes)	-	-

11.9.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Haryana in Rural and Urban areas are given in the table 11.9.19 and table 11.9.20 respectively

TABLE 11.9.19 Top five tree species in TOF (Rural) in Haryana

Sl. No.	Species	Relative Abundance (%)
1.	<i>Eucalyptus species</i>	22.02
2.	<i>Dalbergia sissoo</i>	12.06
3.	<i>Prosopis cineraria</i>	9.26
4.	<i>Azadirachta indica</i>	8.19
5.	<i>Populus species</i>	6.56

TABLE 11.9.20 Top five tree species in TOF (Urban) in Haryana

Sl. No.	Species	Relative Abundance (%)
1.	<i>Eucalyptus species</i>	15.37
2.	<i>Azadirachta indica</i>	11.06
3.	<i>Prosopis juliflora</i>	8.99
4.	<i>Morus species</i>	6.08
5.	<i>Melia azadirachta</i>	6.05

11.9.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.9.21 and table 11.9.22 respectively

TABLE 11.9.21 Major NTFP Species in the state of Haryana

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Calamus longisetus</i>	Shrub	100.00

TABLE 11.9.22 Major invasive species in the state inside the RFA/Green Wash in Haryana (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	78
2.	<i>Prosopis juliflora</i>	54
3.	<i>Saccharum spontanem</i>	54
4.	<i>Ageratum houstonianum</i>	26
5.	<i>Leucanea leucocephala</i>	14

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.9.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Haryana

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Haryana is given in the table 11.9.23

TABLE 11.9.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Haryana

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
5,00,015.80	68,40,019.08	39	16,471

11.10

HIMACHAL PRADESH

11.10.1 Introduction

The State of Himachal Pradesh has a geographical area of 55,673 sq km, which constitutes 1.69% of the geographical area of the country. The State lies between 30°22'N to 33°12'N latitude and 75°45' E to 79°04' E longitude and is bordered by Jammu & Kashmir in the North, Punjab in the West, Haryana in the South and Uttarakhand in the Southwest. The State has international border with China in the East. Predominantly a mountainous State in the western Himalayas, the State has three distinct regions viz the Shiwaliks with altitude upto 1,500 m, middle Himalayan region between 1,500 m to 3,000 m and the Himadris higher than 3,000 m. About one third of the area in the State is permanently under snow, glaciers and cold desert. The tree growth is minimal in this region due to harsh conditions. The average annual rainfall is about 1,800 mm. The temperature varies from sub-zero to 35°C. The Satluj, Beas, Ravi, Chenab and Yamuna are the important rivers of the State. The State has 12 districts all of which are hill districts. There are three tribal districts. As per the 2011 census, Himachal Pradesh has a population of 6.86 million accounting for 0.57% of India's population. The rural and urban population constitutes 89.97% and 10.03% respectively. Tribal population is 5.71% of the State's population. The population density of the State is 123 per sq km which is much lower than the national average. The 19th livestock census 2012 has reported a total livestock population of 4.84 million.

TABLE 11.10.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	5,567	
Reporting area for land utilization	4,576	100.00
Forests	1,126	24.61
Not available for land cultivation	1,127	24.64
Permanent pastures and other grazing lands	1,511	33.01
Land under misc. tree crops and groves	64	1.39
Culturable wasteland	122	2.66
Fallow land other than current fallows	22	0.49
Current fallows	54	1.18
Net area sown	550	12.02

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.10.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Himachal Pradesh belong to eight Type Groups which are further divided into 39 Forest Types. The forests in the State can be broadly classified into coniferous forests and broad-leaved forests. Distribution of species follows altitudinal zonation. The vegetation varies from dry scrub forests at lower altitudes to alpine pastures at higher altitudes. In between these two extremes, distinct vegetational zones of Mixed Deciduous Forests, Bamboo, Chir Pine, Oak, Deodar, Kail, Fir and Spruce are found. More than 95 species are endemic to Himachal Pradesh and characteristic of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years. The State Government aims at bringing 50% of the geographical area under forest cover. Being a forest fire sensitive State, a detailed standard operating procedure called 'HP Forest Fire Manual – Prevention and Control' has been published by the State in 2018.

Recorded Forest Area (RFA) in the State is 37,033 sq km of which 1,898 sq km is Reserved Forests, 33,130 sq km is Protected Forests, and 2,005 sq km Unclassed Forests. In Himachal Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 959.63 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

The Protected Area network in the State has five National Parks, 28 Wildlife Sanctuaries and three Conservation Reserves, which cover 15.10% of geographical area of the State.

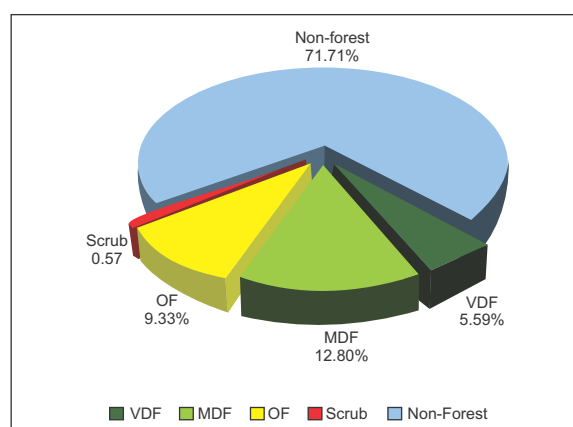
11.10.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct to Dec 2017, the Forest Cover in the State is 15,433.52 sq km which is 27.72% of the State's geographical area. In terms of forest canopy density classes, the State has 3,112.71 sq km under Very Dense Forest (VDF), 7,125.93 sq km under Moderately Dense Forest (MDF) and 5,194.88 sq km under Open Forest (OF). Forest Cover in the State has increased by 333.52 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.10.2 Forest Cover of Himachal Pradesh
(in sq km)

Class	Area	% of GA
VDF	3,112.71	5.59
MDF	7,125.93	12.80
OF	5,194.88	9.33
Total	15,433.52	27.72
Scrub	315.28	0.57

FIGURE 11.10.1 Forest Cover of Himachal Pradesh



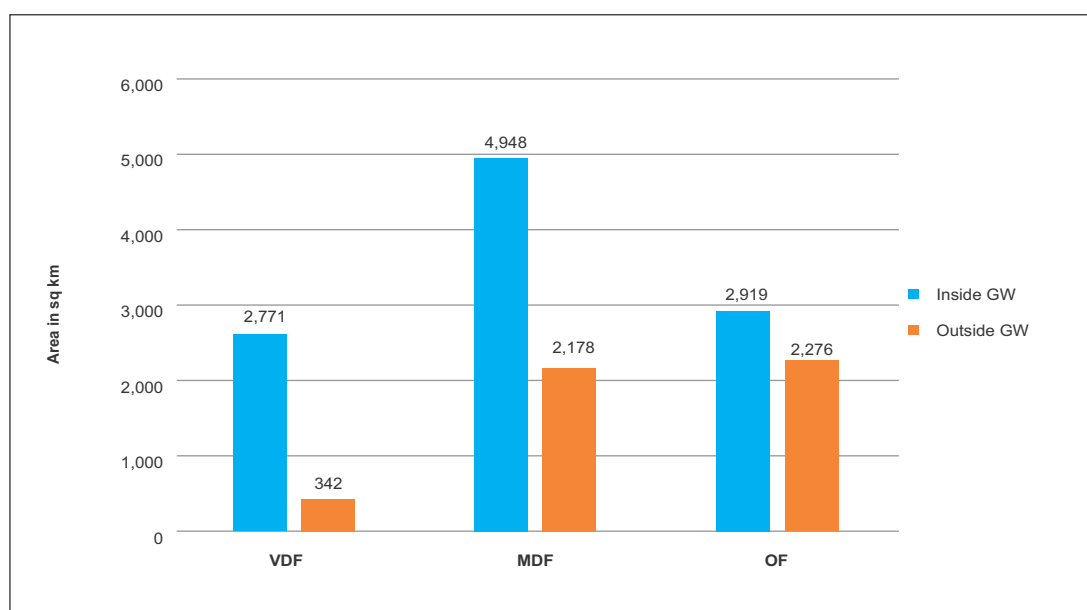
11.10.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 37,033 sq km which is 66.52% of its geographical area. The reserved, protected and unclassified forests are 5.13%, 89.46% and 5.41% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 14,024.98 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.10.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Himachal Pradesh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
2,771	4,948	2,919	10,638	342	2,178	2,276	4,796
26.05%	46.51%	27.44%		7.13%	45.42%	47.45%	

*in case of Himachal Pradesh Green Wash boundaries have been used.

FIGURE 11.10.2 Forest Cover inside and outside Green Wash in Himachal Pradesh

TABLE 11.10.4 District-wise Forest Cover in Himachal Pradesh (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bilaspur ^H	1,167	21.70	190.72	168.28	380.70	32.62	5.70	1.70
Chamba TH	6,522	767.89	1,012.51	674.76	2,455.16	37.64	12.16	20.97
Hamirpur ^H	1,118	38.91	102.84	213.15	354.90	31.74	41.90	12.31
Kangra ^H	5,739	298.76	1,288.65	766.78	2,354.19	41.02	157.19	15.66
Kinnaur TH	6,401	79.81	329.28	236.90	645.99	10.09	22.99	60.37
Kullu ^H	5,503	586.08	879.25	510.96	1,976.29	35.91	-10.71	23.88
Lahul & Spiti TH	13,841	15.00	30.87	114.48	160.35	1.16	-32.65	15.37
Mandi ^H	3,950	368.51	756.98	647.53	1,773.02	44.89	12.02	19.96
Shimla ^H	5,131	745.74	1,090.30	583.37	2,419.41	47.14	20.41	30.37
Sirmaur ^H	2,825	130.22	689.96	570.69	1,390.87	49.23	3.87	56.98
Solan ^H	1,936	41.44	444.54	404.31	890.29	45.99	24.29	49.38
Una ^H	1,540	18.65	310.03	303.67	632.35	41.06	76.35	8.33
Grand Total	55,673	3,112.71	7,125.93	5,194.88	15,433.52	27.72	333.52	315.28

TABLE 11.10.5 Forest Cover Change Matrix for Himachal Pradesh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	3,088	20	2	0	0	3,110
Moderately Dense Forest	18	6,613	54	0	20	6,705
Open Forest	7	493	4,714	0	71	5,285
Scrub	0	0	0	264	44	308
Non Forest	0	0	425	51	39,789	40,265
Total ISFR 2019	3,113	7,126	5,195	315	39,924	55,673
Net Change	3	421	-90	7	-341	

Main reasons for the increase 333.52 sq km in forest cover in the State are plantation and conservation activities.

TABLE 11.10.6 Altitude-wise Forest Cover in Himachal Pradesh

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	2,925	13	458	360	831 (5.39%)	14
500-1000	7,625	220	1,912	1,589	3,721 (24.10%)	62
1000-2000	9,628	694	1,679	1,552	3,925 (25.43%)	124
2000-3000	8,101	1,814	2,225	1,057	5,096 (33.02%)	28
3000-4000	6,848	372	848	625	1,845 (11.96%)	70
>4000	20,546	0	4	12	16 (0.10%)	17
Total	55,673	3,113	7,126	5,195	15,434	315

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.10.7 Forest Cover in different slope classes in Himachal Pradesh

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	6,362	69	438	551	1,058 (6.86%)	27
5-10	5,614	149	801	713	1,663 (10.78%)	27
10-15	6,424	282	975	730	1,987 (12.88%)	36
15-20	7,274	417	1,079	728	2,224 (14.41%)	44
20-25	7,570	497	1,082	690	2,269 (14.69%)	47
25-30	7,224	520	1,000	612	2,132 (13.81%)	46
>30	15,205	1,179	1,751	1,171	4,101 (26.57%)	88
Total	55,673	3,113	7,126	5,195	15,434	315

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.10.3 Forest Cover Map of Himachal Pradesh

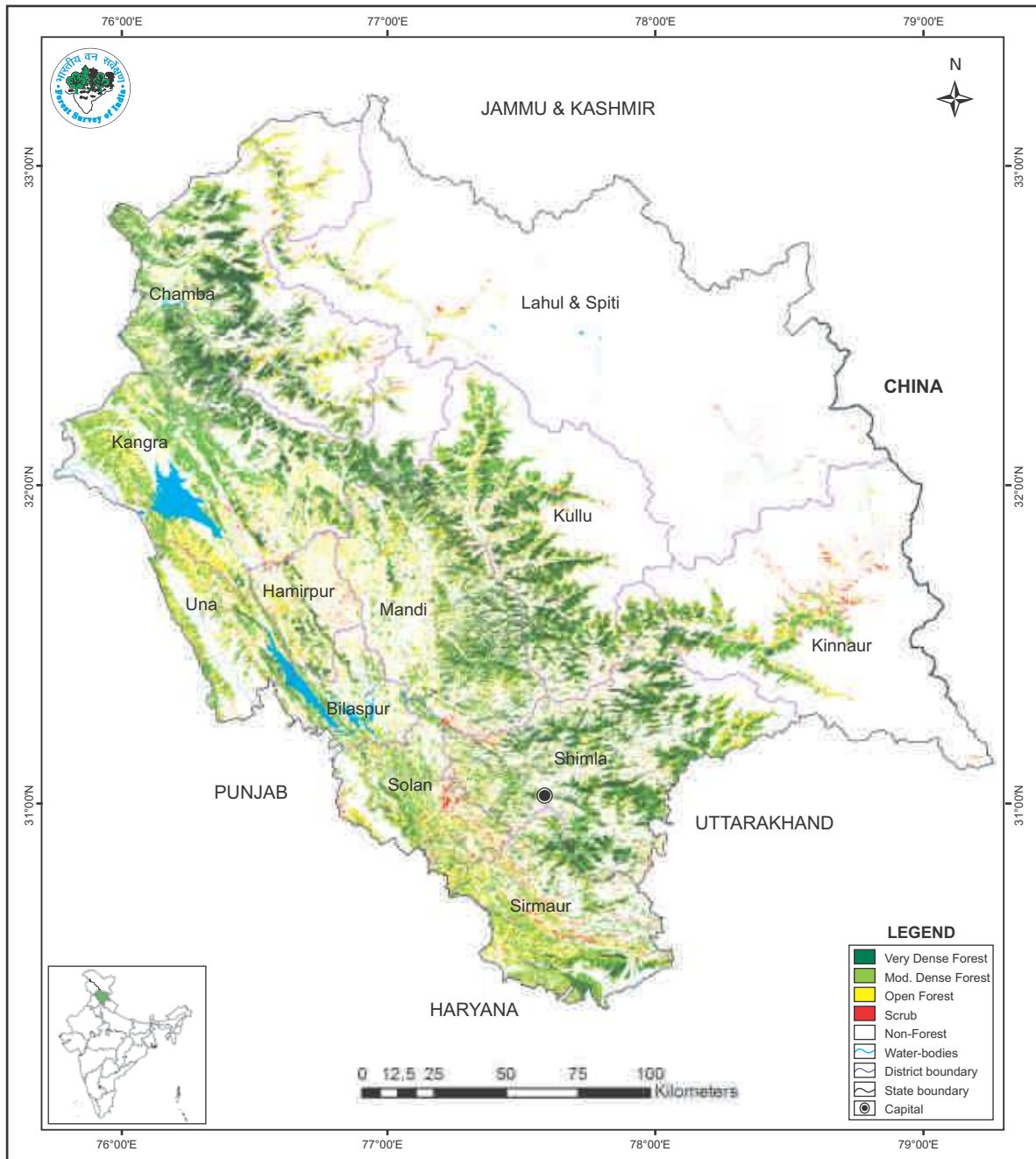


TABLE 11.10.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Himachal Pradesh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	4	17
Waterlogged	2	3
River/Stream	44	6,207
Sub - Total	50	6,227
Inland Wetlands - Man-made		
Reservoir/Barrage	9	1936
Tank/Pond	4	6
Waterlogged	1	3
Sub - Total	14	1,945
Wetlands (<2.25 ha)	49	49
Total	113	8,221

Total Recorded Forest (or Green Wash) Area (in ha)	14,02,498
% of Wetland area inside Recorded Forest (or Green Wash) Area	0.59%

(analysis based on the National Wetland Atlas: India, 2011)

11.10.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Himachal Pradesh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.10.9 Percentage area under different forest types of Himachal Pradesh

Sl. No.	Forest Type	% of Forest cover
1.	3C/C2b(I) Bhabar-Dun Sal Forest	1.13
2.	5/1S2 Khair-sissu Forest	0.01
3.	5/DS1 Dry Deciduous Scrub	0.80
4.	5/DS3 (<i>Euphorbia</i> Scrub)	0.03
5.	5/E9 Dry Bamboo Brake	0.49
6.	5B/C1a Dry Siwalik Sal Forest	0.51
7.	5B/C2 Northern Dry Mixed Deciduous Forest	12.70
8.	9/C1a Lower or Siwalik Chir Pine Forest	10.40
9.	9/C1b Upper or Himalayan Chir Pine Forest	3.76
10.	9/C1/DS1 Himalayan Subtropical Scrub	0.47
11.	12/1S1 Alder Forest	0.02
12.	12/2S1 Low Level Blue Pine Forest	2.79
13.	12/C1/DS1 Oak Scrub	1.31
14.	12/C1/DS2 Himalayan Temperate Secondary Scrub	0.67
15.	12/C1a Ban Oak Forest (<i>Q.incana</i>)	4.43
16.	12/C1b Moru Oak Forest (<i>Q.dilatata</i>)	0.07
17.	12/C1c Moist Deodar Forest (<i>Cedrus</i>)	11.40
18.	12/C1d Western Mixed Coniferous Forest (Spruce, Blue Pine, Silver Fir)	14.03
19.	12/C1e Moist Temperate Deciduous Forest	0.81
20.	12/C2a Kharsu Oak Forest (<i>Q.semecarpifolia</i>)	0.20

Contd.

Sl.No.	Forest Type	% of Forest cover
21.	12/C2b West Himalayan Upper Oak/Fir Forest	0.07
22.	12/DS1 Montane Bamboo Brakes	0.06
23.	12/DS3 Himalayan Temperate Pastures	4.36
24.	12/E1 Cypress Forest	0.02
25.	13/1S2 Populus / Salix Forest	0.02
26.	13/C1 Dry Broadleaved and Coniferous Forest (<i>Q.ilex- P. gerardiana</i>)	0.04
27.	13/C2a Neoza Pine Forest (<i>P.gerardiana</i>)	0.63
28.	13/C2b Dry Deodar Forest (<i>Cedrus</i>)	1.19
29.	13/C3 West Himalayan Dry Temperate Deciduous Forest	0.00
30.	13/C4 West Himalayan High Level Dry Blue Pine Forest (<i>P. wallichiana</i>)	0.65
31.	13/C5 West Himalayan Dry Juniper Forest (<i>J. macropoda</i>)	0.79
32.	14/C1a West Himalayan Sub-Alpine High Level Fir Forest	0.92
33.	14/C1b West Himalayan Birch/Fir Forest	3.37
34.	15/C1 Birch/ <i>Rhododendron</i> Scrub Forest	0.29
35.	15/C2 Deciduous Alpine Scrub	0.05
36.	15/C3 Alpine Pasture	13.96
37.	15/E1 Dwarf <i>Rhododendron</i> Scrub	0.02
38.	16/C1 Dry Alpine Scrub	0.97
39.	16/E1 Dwarf Juniper Scrub	1.57
40.	Plantation/ TOF	4.99
	Total	100.00

11.10.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.10.10 and table 11.10.11 in respect of Himachal Pradesh.

TABLE 11.10.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	116
Shrub	99
Herb	109

TABLE 11.10.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Himachal Pradesh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	1.95	2.15	1.71
2.	Group 5- Tropical Dry Deciduous Forests	2.87	2.13	1.95
3.	Group 9- Subtropical Pine Forests	2.63	2.17	1.89
4.	Group 12- Himalayan Moist Temperate Forests	2.95	3.25	3.48
5.	Group 13- Himalayan Dry Temperate Forests	2.03	2.56	2.51
6.	Group 14- Sub Alpine Forests	1.64	1.83	1.87
7.	Group 15- Moist Alpine Scrub	0.17	*	*
8.	Group 16- Dry Alpine Scrub	0.87	2.34	2.30

*adequate number of sample plots were not available

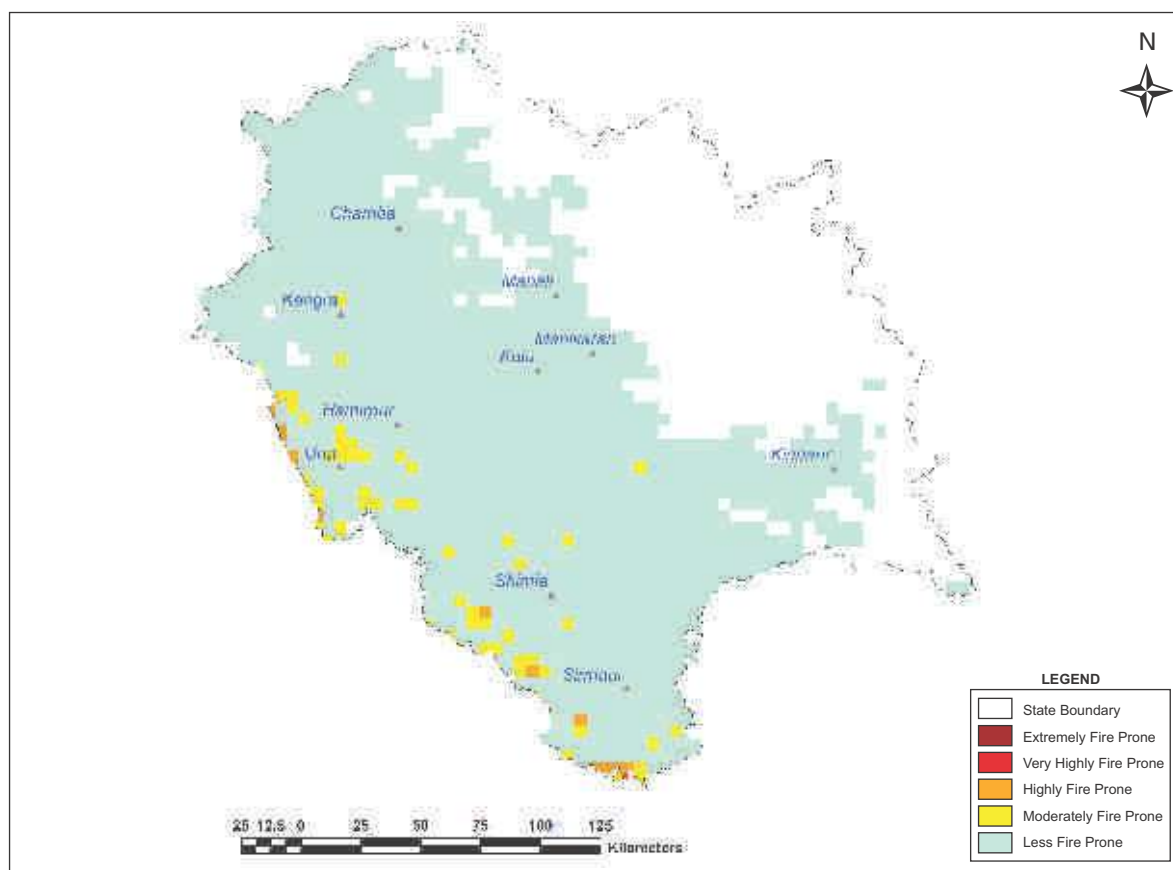
11.10.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.10.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	4.76	0.03
3.	Highly fire prone	220.4	1.18
4.	Moderately fire prone	1,204.52	4.59
5.	Less fire prone	35,829.66	94.20
	Total	37,259.42	100.00

FIGURE 11.10.4 Fire prone forest areas under different fire prone classes



11.10.5 Tree Cover

Forest cover presented in the section 11.10.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Himachal Pradesh has been estimated as given in table 11.10.13.

TABLE 11.10.13 Tree Cover in Himachal Pradesh (in sq km)

Tree Cover	Area
	829

Tree cover of Himachal Pradesh has increased by 7 sq km as compared to the previous assessment reported in ISFR2017.

11.10.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.10.14 Extent of TOF in Himachal Pradesh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
4,796	829	5,625

11.10.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Himachal Pradesh is given in the table 11.10.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.10.16

TABLE 11.10.15 Growing Stock in Himachal Pradesh (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	347.07	8.12
Growing Stock in TOF	25.19	1.53

TABLE 11.10.16 Diameter class distribution of top five species inside RFA in Himachal Pradesh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Cedrus deodara</i>	48,821	16,723	3,546
2.	<i>Pinus wallichiana</i>	30,849	11,563	3,808
3.	<i>Quercus leucotrichaphora</i>	74,936	12,287	622
4.	<i>Pinus roxburghii</i>	50,408	18,922	1,969
5.	<i>Mallotus philippinensis</i>	24,768	72	0

11.10.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 252.36 million tonnes (925.32 million tonnes of CO₂ equivalent) which is 3.54% of total forest carbon of the country. Pool wise forest carbon in Himachal Pradesh is given in the following table

TABLE 11.10.17 Forest Carbon in Himachal Pradesh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,10,045	30,745	2,559	2,711	1,06,300	2,52,360

11.10.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.10.18

TABLE 11.10.18 Growing Stock of Bamboo in Himachal Pradesh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	650	0.41
Total number of culms (in millions)	485	1.23
Total equivalent green weight (in 000' tonnes)	1,975	0.71

11.10.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Himachal Pradesh in Rural and Urban areas are given in the table 11.10.19 and table 11.10.20 respectively

TABLE 11.10.19 Occurrence of top five tree species in TOF (Rural) in Himachal Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus roxburghii</i>	21.83
2.	<i>Acacia catechu</i>	9.05
3.	<i>Grewia oppositifolia</i>	8.79
4.	<i>Cedrus deodara</i>	5.36
5.	<i>Quercus leucotrichophora</i>	3.64

TABLE 11.10.20 Occurrence of top five tree species in TOF (Urban) in Himachal Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus roxburghii</i>	11.53
2.	<i>Morus species</i>	9.07
3.	<i>Grewia oppositifolia</i>	8.16
4.	<i>Mangifera indica</i>	6.64
5.	<i>Cedrela toona</i>	5.15

11.10.11 Invasive Species

Invasive species as assessed from forest inventory data are presented in the table 11.10.21.

TABLE 11.10.21 Major invasive species in the State inside the RFA/Green Wash in Himachal Pradesh (in sq km)

Sl. No.	Species	Estimated Extent
1	<i>Lantana camara</i>	654
2	<i>Ageratina adenophora</i>	39
3	<i>Ageratum conyzoides</i>	36
4	<i>Melochia corchorifolia</i>	30
5	<i>Dioscorea deltoidea</i>	29

Invasive species are given in terms of their estimated extent.

11.10.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Himachal Pradesh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Himachal Pradesh is given in the table 11.10.22

TABLE 11.10.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Himachal Pradesh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
5,92,761	32,55,579	593	11,264

11.11

Jammu & Kashmir (combined)

11.11.1 Introduction

The Government of India vide notification dated 31.10.2019 has carved out two union territories of Jammu & Kashmir and Ladakh from the erstwhile State of Jammu & Kashmir. Situated in the northernmost part of the country, Jammu & Kashmir (UT) and Ladakh (UT), cover an area of 2,22,236 sq km, which is 6.76% of the geographical area of the country. The UT of Jammu & Kashmir is bordered by Pakistan in the west, UT of Ladakh is situated on the northern and eastern side and the States of Himachal Pradesh and Punjab lie South to the UT of Jammu & Kashmir. The UT of Ladakh has international border with Pakistan, Afghanistan and China. It shares borders with the UT of Jammu & Kashmir in the West and Himachal Pradesh in the South. The average annual rainfall varies from about 600 mm to about 800 mm and the average annual temperature from sub-zero to 40°C. The two UT's are drained by a number of rivers viz Jhelum, Chenab, Indus, Ravi, Tawi etc. All the 22 districts of UT of Jammu & Kashmir and two districts of UT of Ladakh are hill districts and both UT's do not have any tribal district. As per census 2011, the combined population of two UT's is 12.54 million accounting to 1.04% of India's population. The rural and urban population constitute 72.62% and 27.38% respectively. Tribal population is 11.91% of the UT's population. The average population density of the two UTs is 125 persons per sq km, which is lower than the national average. The 19th livestock census 2012 has reported a total livestock population of 9.2 million.

Table 11.11.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	22,224	
Reporting area for land utilization	4,058	100.00
Forests	2,299	56.65
Not available for land cultivation	571	14.08
Permanent pastures and other grazing lands	113	2.77
Land under misc. tree crops and groves	57	1.39
Culturable wasteland	139	3.44
Fallow land other than current fallows	15	0.37
Current fallows	106	2.61
Net area sown	758	18.69

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.11.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forest in UT of Jammu & Kashmir and UT of Ladakh belong to eight Type Groups which are further divided into 42 Forest Types, the highest in the country. The Jammu & Kashmir Forest Act, 1987 is the only state-specific Forest/Wildlife act or rule that exists in the UTs. The two UTs have a Forest Protection Force to assist the Department in enforcing the forest laws on the ground and protection of forests and wildlife. The Forest Department of the two UTs have implemented various schemes focusing on rehabilitation of degraded forests, consolidation and demarcation, Eco Task Force, urban forestry, pasture and fodder development, stabilization of strip area on National Highways, development of Conifer Forests, CM's Participatory Afforestation Scheme, Integrated Forest Protection, participatory grazing land development programme etc.

Recorded Forest Area (RFA) in the two UTs is 20,230 sq km of which 17,643 sq km is Reserved Forests, 2,551 sq km is Protected Forest, and 36 sq km is Unclassed Forests. In the UT of Jammu & Kashmir and UT of Ladakh, during the period 1st January 2015 to 5th February 2019, no forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

The two UTs have so far notified 15,912 sq km under the Protection Area Network (PAN) which is 15.59% of the total geographical area of the combined UT, comprising five National Parks, 14 Wildlife Sanctuaries and 35 Conservation Reserves. The Protected Area (PA) network of the two UTs is the highest in the country in terms of area, which is nearly 10% of the country's PA network.

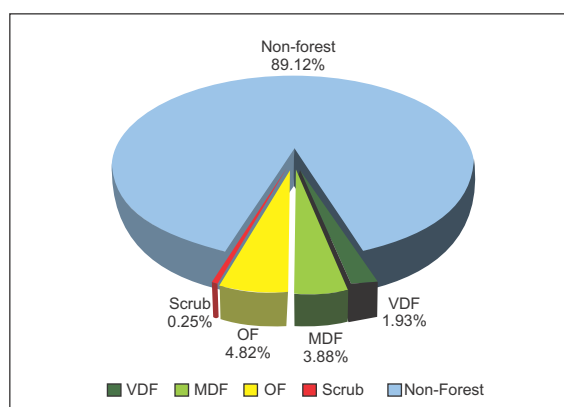
11.11.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Sept 2017 to Nov 2017, the Forest Cover in the two UTs is 23,611.89 sq km which is 10.63% of the geographical area. In terms of forest canopy density classes, the UTs have 4,280.48 sq km under Very Dense Forest (VDF), 8,612.36 sq km under Moderately Dense Forest (MDF) and 10,719.05 sq km under Open Forest (OF). Forest Cover in the UTs has increased by 370.89 sq km as compared to the previous assessment reported in ISFR2017.

TABLE 11.11.2 Combined Forest Cover of UTs of Jammu & Kashmir and Ladakh

(in sq km)		
Class	Area	% of GA
VDF	4,280.48	1.93
MDF	8,612.36	3.88
OF	10,719.05	4.82
Total	23,611.89	10.63
Scrub	547.54	0.25

FIGURE 11.11.1 Combined Forest Cover of UTs of Jammu & Kashmir and Ladakh



11.11.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

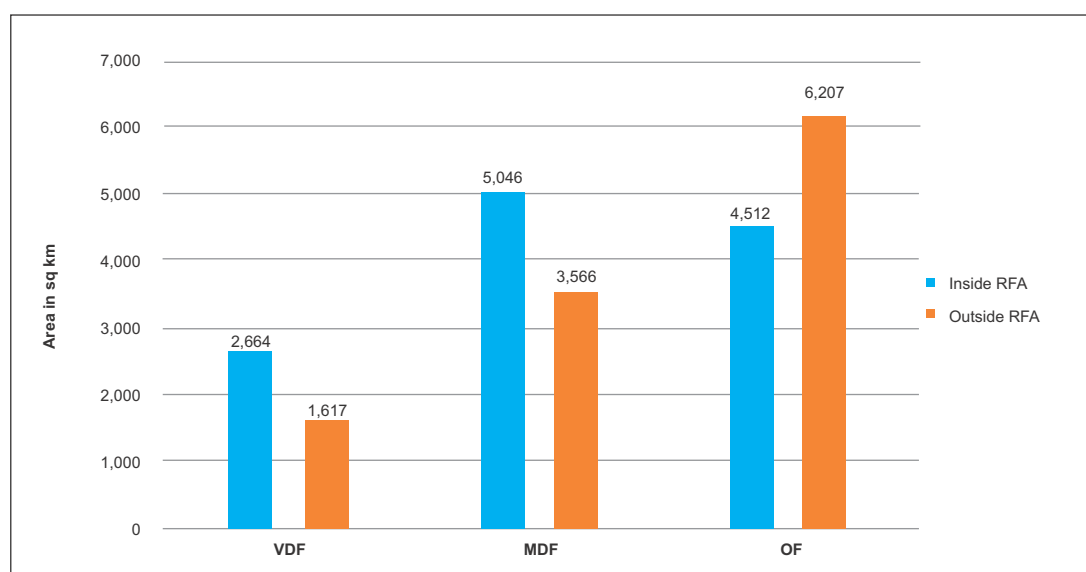
The two UTs have reported extent of recorded forest area (RFA) 20,230 sq km which is 9.10% of its geographical area. The reserved, protected and unclassified forests are 87.21%, 12.61% and 0.18% respectively of the recorded forest area in the UTs. However, as the digitized boundary of recorded forest area from the UTs cover 27,727.80 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.11.3 Combined Forest Cover inside and outside Recorded Forest Area or (Green Wash) in UTs of Jammu & Kashmir and Ladakh

(in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
2,664	5,046	4,512	12,222	1,617	3,566	6,207	11,390
21.80%	41.29%	36.91%		18.13%	36.47%	45.40%	

*in case of Jammu & Kashmir and Ladakh RFA boundaries have been used.

FIGURE 11.11.2 Forest Cover inside and outside RFA in UTs of Jammu & Kashmir and Ladakh

TABLE 11.11.4a District-wise Forest Cover in Jammu & Kashmir, UT

(in sq km)

District	Shape File Area #	2019 Assessment				% of Shape File Area	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Anantnag ^H	2,727	126.55	455.28	492.36	1,074.19	39.39	49.19	0.77
Badgam ^H	1,250	100.85	76.04	164.95	341.84	27.35	49.84	16.00
Bandipura ^H	2,676	270.85	177.16	194.83	642.84	24.02	34.84	3.53
Baramula ^H	2,062	287.57	211.90	370.79	870.26	42.20	63.26	7.05
Doda ^H	2,411	327.98	703.50	454.45	1,485.93	61.63	-30.07	0.40
Ganderbal ^H	1,620	129.36	179.13	186.01	494.50	30.52	58.50	6.58
Jammu ^H	2,407	0.00	241.41	526.22	767.63	31.89	22.63	35.54
Kathua ^H	2,512	108.16	607.96	615.32	1,331.44	53.00	-3.56	6.59
Kishtwar ^H	8,179	235.96	716.41	832.68	1,785.05	21.82	-20.95	5.82
Kulgam ^H	1,265	84.92	99.00	206.32	390.24	30.85	32.24	4.98
Kupwara ^H	2,744	783.42	408.34	273.19	1,464.95	53.39	-17.05	1.22
Mirpur ^H	3,759	0.00	484.66	753.13	1,237.79	32.93	12.79	41.56
Muzaffarabad ^H	4,663	873.97	441.86	293.20	1,609.03	34.51	-12.97	47.48
Pulwama ^H	896	15.70	117.72	240.72	374.14	41.76	70.14	5.60
Punch ^H	4,244	332.28	1,121.33	654.10	2,107.71	49.66	2.71	10.06

Contd.

District	Shape File Area #	2019 Assessment				% of Shape File Area	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Rajauri ^h	2,635	42.04	424.48	838.78	1,305.30	49.54	0.30	7.43
Ramban ^h	1,288	70.55	287.17	308.52	666.24	51.73	-14.76	0.53
Reasi ^h	1,932	234.54	393.58	470.29	1,098.41	56.85	-4.59	12.37
Samba ^h	921	0.00	124.26	207.53	331.79	36.02	18.79	12.59
Shupiyan ^h	505	62.50	37.22	224.33	324.05	64.17	46.05	1.00
Srinagar ^h	282	0.24	20.03	24.97	45.24	16.04	18.24	0.00
Udhampur ^h	2,280	115.42	624.03	634.57	1,374.02	60.26	-27.98	22.45
Grand Total	53,258	4,202.86	7,952.47	8,967.26	21,122.59	39.66	347.59	249.55

Area of shape file provided by Survey of India (December, 2019). Notified geographical area from SOI awaited.

FIGURE 11.11.3a Forest Cover Map of Jammu & Kashmir, UT

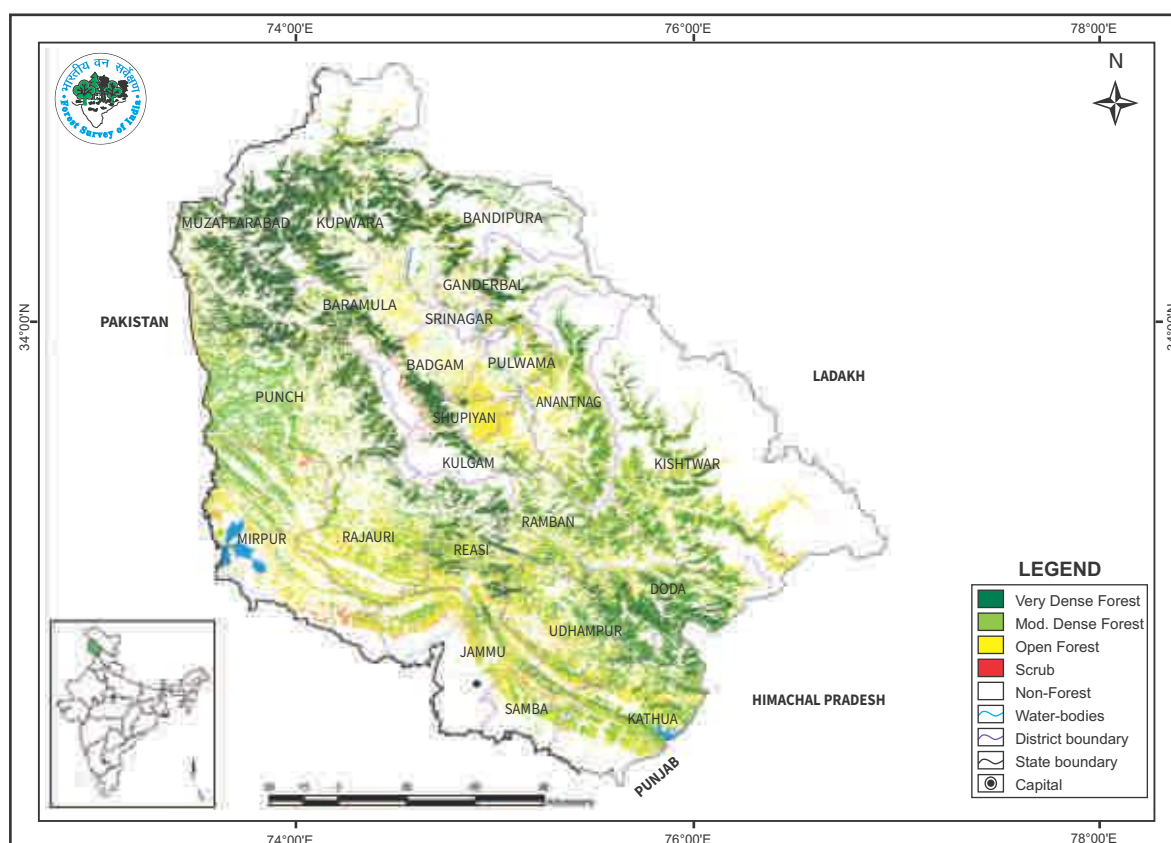


TABLE 11.11.4b District- wise Forest Cover in Ladakh, UT

(in sq km)

District	Shape File Area #	2019 Assessment				% of Shape File Area	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Kargil ^h	14,202	0.00	2.16	57.52	59.68	0.42	8.68	26.32
Leh ^h	1,55,219	77.62	657.73	1,694.27	2,429.62	1.57	14.62	271.67
Grand Total	1,69,421	77.62	659.89	1,751.79	2,489.30	1.47	23.30	297.99

Area of shape file provided by Survey of India (December, 2019). Notified geographical area from SOI awaited.

FIGURE 11.11.3b Forest Cover Map of Ladakh, UT

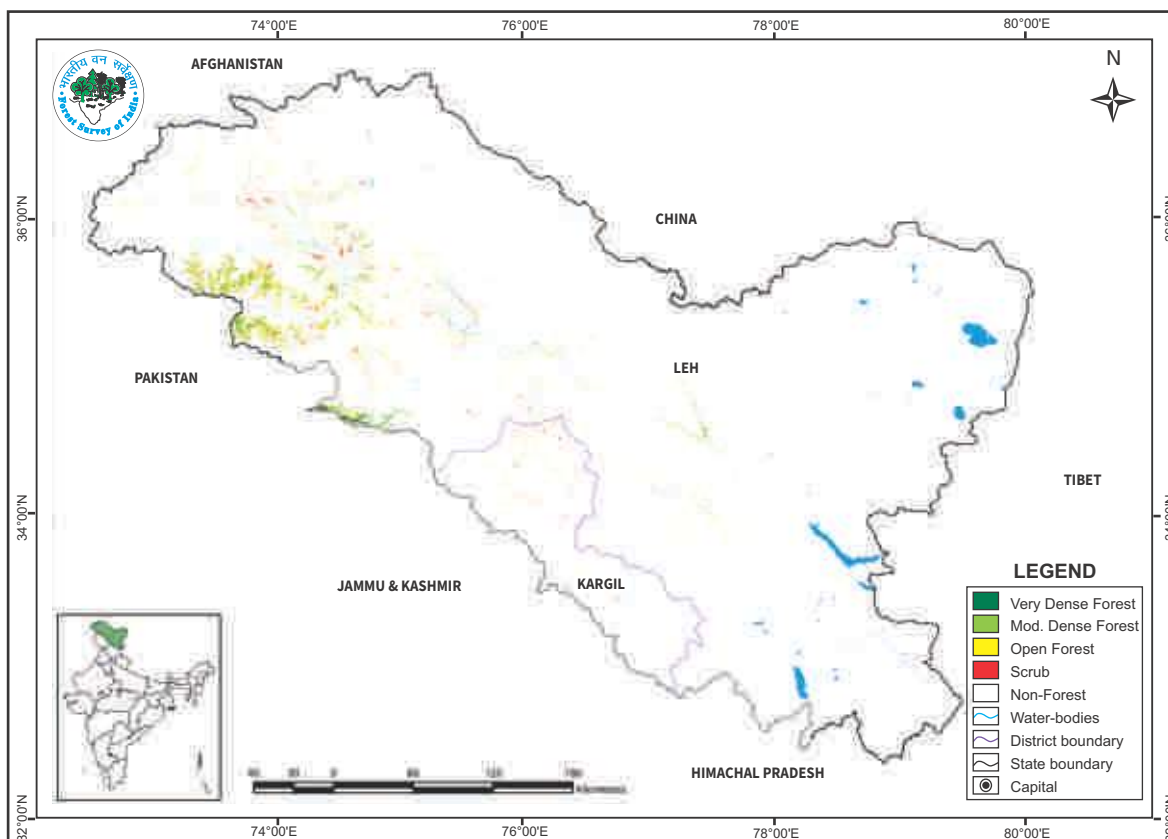


Table 11.11.5 Forest Cover Change Matrix for UTs of Jammu & Kashmir and Ladakh (combined) (in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	3,905	101	14	0	55	4,075
Moderately Dense Forest	232	8,109	77	13	148	8,579
Open Forest	81	210	9,823	15	458	10,587
Scrub	2	10	47	454	60	573
Non Forest	61	182	758	66	1,97,355	1,98,422
Total ISFR 2019	4,281	8,612	10,719	548	1,98,076	2,22,236
Net Change	206	33	132	-25	-346	

Main reasons for the increase in forest cover in the UTs are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.11.6 Altitude-wise Forest Cover in UTs of Jammu & Kashmir and Ladakh (combined) (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	5,084	1	220	756	977 (4.14%)	66
500-1000	6,585	44	1,380	2,243	3,667 (15.53%)	58
1000-2000	16,089	690	2,458	3,209	6,357 (26.92%)	27
2000-3000	19,306	2,902	3,299	2,741	8,942 (37.87%)	80
3000-4000	33,728	644	1,252	1,735	3,631 (15.38%)	257
>4000	1,41,444	0	3	35	38 (0.16%)	60
Total	2,22,236	4,281	8,612	10,719	23,612	548

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.11.7 Forest Cover in different slope classes in UTs of Jammu & Kashmir and Ladakh (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	37,945	94	518	1,796	2,408 (10.20%)	77
5-10	24,194	242	781	1,367	2,390 (10.12%)	66
10-15	25,178	419	1,139	1,445	3,003 (12.72%)	69
15-20	27,638	605	1,361	1,451	3,417 (14.47%)	72
20-25	28,297	710	1,393	1,362	3,465 (14.68%)	72
25-30	26,843	725	1,283	1,218	3,226 (13.66%)	67
>30	52,141	1,486	2,137	2,080	5,703 (24.15%)	125
Total	2,22,236	4,281	8,612	10,719	23,612	548

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.11.8 Wetlands inside the Recorded Forest Area (or Green Wash) in UTs of Jammu & Kashmir and Ladakh (combined) (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	8	11,266
High altitude Wetland	168	2,095
Riverine wetland	36	1,693
River/Stream	57	20,030
Sub - Total	269	35,084
Inland Wetlands - Man-made		
Reservoir/Barrage	3	967
Tank/Pond	1	3
Sub - Total	4	970
Wetlands (<2.25 ha)	208	208
Total	481	36,262
Total Recorded Forest (or Green Wash) Area (in ha)		27,72,780
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.31%

(analysis based on the National Wetland Atlas: India, 2011)

11.11.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of UTs of Jammu & Kashmir and Ladakh (combined) as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.11.9 Percentage area under different forest types of UTs of Jammu & Kashmir and Ladakh (combined)

Sl.No.	Forest Type	% of Forest cover
1	5B/C2 Northern Dry Mixed Deciduous Forest	6.17
2	5B/DS1 Dry Deciduous Scrub	1.89
3	5/DS3 (<i>Euphorbia</i> Scrub)	0.01
4	5/E9 Dry Bamboo Brake	0.12
5	5/1S2 <i>Khair-Sissu</i> Forest	0.02
6	9/C1a Lower or Siwalik Chir Pine Forest	10.86
7	9/C1b Upper or Himalayan Chir Pine Forest	4.27
8	9/DS1 Himalayan Subtropical Scrub	1.27
9	10/C1a <i>Olea Cuspidata</i> Scrub Forest	0.65

Contd.

Sl.No.	Forest Type	% of Forest cover
10	10/C1/DS1 <i>Dodonaea</i> Scrub	0.03
11	10/C1b <i>Acacia Modesta</i> Scrub Forest	0.04
12	12/C1a <i>Ban</i> Oak Forest (<i>Q. incana</i>)	2.75
13	12/C1b <i>Moru</i> Oak Forest (<i>Q. dilatata</i>)	0.16
14	12/C1/DS1 Oak Scrub	0.48
15	12/C1c Moist Deodar Forest (<i>Cedrus</i>)	8.93
16	12/C1d Western Mixed Coniferous Forest (Spruce, Blue Pine, Silver fir)	12.82
17	12/C1e Moist Temperate Deciduous Forest	0.12
18	12/C1f (Low-Level Blue Pine Forest (<i>P. wallichiana</i>))	6.47
19	12/C1/DS2 Himalayan Temperate Secondary Scrub	0.64
20	12/C2a <i>Kharsu</i> Oak Forest (<i>Q. semecarpifolia</i>)	0.00
21	12/C2b West Himalayan Upper Oak/Fir Forest	0.01
22	12/DS3 Himalayan Temperate Pastures	1.80
23	12/1S1 Alder Forest	0.02
24	12/1S2 Riverain Blue Pine Forest	0.21
25	12/2S1 Low-Level Blue Pine Forest	0.19
26	13(i)/C1 Dry Broadleaved and Coniferous Forest (<i>Q. ilex-P. gerardiana</i>)	2.55
27	13(i)/C2b Dry Deodar Forest (<i>Cedrus</i>)	3.12
28	13/C2/DS1 <i>Pohu</i> Scrub	0.24
29	13/C2/DS2 Dry Temperate Scrub	0.52
30	13(i)/C3 (West Himalayan Dry Temperate Deciduous Forest)	0.91
31	13(i)/C4 West Himalayan High-Level Dry Blue Pine Forest	4.83
32	13/1S2 <i>Populus / Salix</i> Forest	0.48
33	14/C1a West Himalayan Sub-Alpine Fir Forest	4.36
34	14/C1b West Himalayan Sub-Alpine Birch/Fir Forest	5.57
35	14/DS1 Sub-Alpine Pastures	0.30
36	14/2S1 (Sub-Alpine Blue Pine Forest (<i>P. wallichiana</i>))	1.05
37	15/C1 Birch/ <i>Rhododendron</i> Scrub Forest	0.56
38	15/C2 Deciduous Alpine Scrub	0.49
39	15/E1 Dwarf <i>Rhododendron</i> Scrub	0.04
40	15/C3 (Alpine Pastures)	2.37
41	16/C1 Dry Alpine Scrub	5.02
42	16/E1 Dwarf Juniper Scrub	2.82
43	Plantation/ TOF	4.84
	Total	100.00

11.11.3.1 Assessment of Biodiversity in UTs of Jammu & Kashmir and Ladakh (combined)

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.11.10 and table 11.11.11 in respect of UTs of Jammu & Kashmir and Ladakh (combined).

TABLE 11.11.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	73
Shrub	133
Herb	272

TABLE 11.11.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of UTs of Jammu & Kashmir and Ladakh (combined)

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 5- Tropical Dry Deciduous Forests	2.28	3.00	2.04
2.	Group 9- Subtropical Pine Forests	2.43	3.37	1.97
3.	Group 10- Subtropical Dry Evergreen Forests	0.69	2.64	2.46
4.	Group 12- Himalayan Moist Temperate Forests	1.98	3.26	4.10
5.	Group 13- Himalayan Dry Temperate Forests	1.53	2.49	3.68
6.	Group 14- Sub Alpine Forests	1.58	2.96	3.52
7.	Group 15- Moist Alpine Scrub	1.25	1.30	2.77
8.	Group 16- Dry Alpine Scrub	1.05	*	*

* adequate number of sample plots were not available

11.11.4 Fire Prone Forest Areas

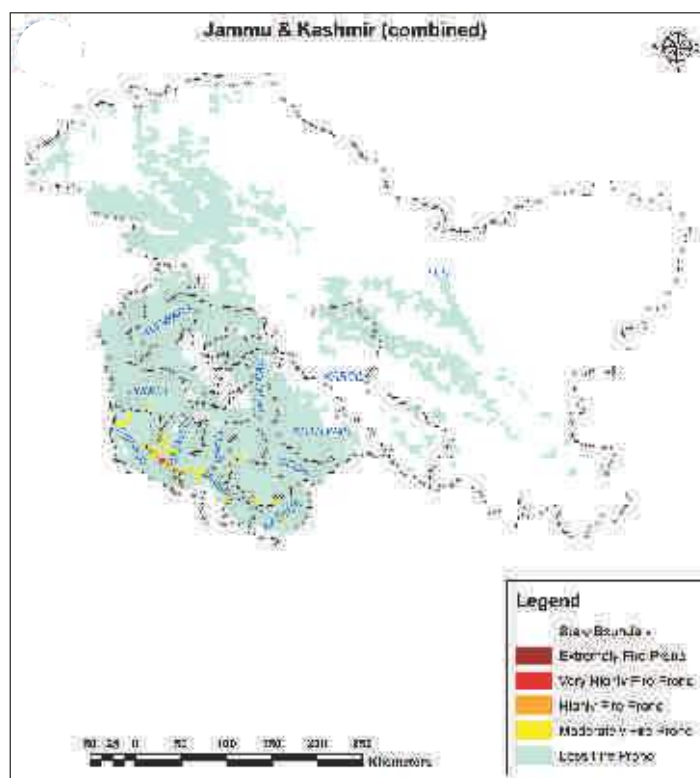
Geographical Areas under different forest fire class proneness are given in the following table:

TABLE 11.11.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	24.99	0.08
3.	Highly fire prone	124.96	0.38
4.	Moderately fire prone	924.51	2.65
5.	Less fire prone	70,420.60	96.89
	Total	71,495.06	100.00



FIGURE 11.11.4 Fire prone forest areas under different fire prone classes



11.11.5 Tree Cover

Forest cover presented in the section 11.11.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in UTs of Jammu & Kashmir and Ladakh (combined) has been estimated as given in table 11.11.12.

TABLE 11.11.13 Tree Cover in UTs of Jammu & Kashmir and Ladakh (combined)
(in sq km)

Tree Cover	Area
	7,944

Tree cover in UTs of Jammu & Kashmir and Ladakh (combined) has increased by 129 sq km as compared to the previous assessment reported in ISFR 2017.

11.11.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based methodology. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.11.14 Extent of TOF in UTs of Jammu & Kashmir and Ladakh (combined)
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
11,390	7,944	19,334

11.11.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in UTs of Jammu & Kashmir and Ladakh (combined) is given in the table 11.11.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.11.16

TABLE 11.11.15 Growing Stock in UTs of Jammu & Kashmir and Ladakh (combined) (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	291.63	6.82
Growing Stock in TOF	125.14	7.62

Table 11.11.16 Diameter class distribution of top five species inside RFA in UTs of Jammu & Kashmir and Ladakh (combined) (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Abies pindrow</i>	9,968	16,356	12,912
2.	<i>Pinus wallichiana</i>	17,877	23,291	6,048
3.	<i>Quercus leucotrichophora</i>	21,730	5,579	366
4.	<i>Cedrus deodara</i>	7,784	9,994	8,567
5.	<i>Pinus roxburghii</i>	12,047	8,695	2,364

11.11.8 Carbon Stock in Forest

The total Carbon stock of forests in the UTs including the TOF patches which are more than 1 ha in size is 390.20 million tonnes (1,430.73 million tonnes of CO₂ equivalent) which is 5.48% of total forest carbon of the country. Pool wise forest carbon in UTs of Jammu & Kashmir and Ladakh (combined) is given in the following table

TABLE 11.11.17 Forest Carbon in UTs of Jammu & Kashmir and Ladakh (combined) in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,70,222	47,806	3,813	3,706	1,64,648	3,90,195

11.11.9 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in UTs of Jammu & Kashmir and Ladakh (combined) in Rural and Urban areas are given in the table 11.11.18 and table 11.11.19 respectively

TABLE 11.11.18 Top five tree species in TOF (Rural) in UTs of Jammu & Kashmir and Ladakh (combined)

Sl. No.	Species	Relative Abundance (%)
1.	<i>Grewia oppositifolia</i>	15.12
2.	<i>Populus species</i>	6.62
3.	<i>Quercus leucotrichophora</i>	5.28
4.	<i>Pyrus species</i>	5.26
5.	<i>Salix species</i>	4.29

TABLE 11.11.19 Top five tree species in TOF (Urban) in UTs of Jammu & Kashmir and Ladakh (combined)

Sl. No.	Species	Relative Abundance (%)
1.	<i>Grewia oppositifolia</i>	12.76
2.	<i>Leucaena leucocephala</i>	7.19
3.	<i>Populus species</i>	6.13
4.	<i>Acacia modesta</i>	5.56
5.	<i>Salix species</i>	5.45

11.11.10 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.11.20

TABLE 11.11.20 Major Invasive Species in the UTs of Jammu & Kashmir and Ladakh (combined) inside the RFA/Green Wash (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	132
2.	<i>Parthenium hysterophorus</i>	50
3.	<i>Ageratum conyzoides</i>	18
4.	<i>Ipomoea fistulosa</i>	6
5.	<i>Solanum viarum</i>	5

Major invasive species are given in terms of their estimated extent.

11.11.11 Quantified estimation of Dependence of People living in forest fringe villages on forests in UTs of Jammu & Kashmir and Ladakh (combined)

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for UTs of Jammu & Kashmir and Ladakh (combined) is given in the table 11.11.21

TABLE 11.11.21 Estimation of Dependence of People in Forest Fringe Villages on Forests of UTs of Jammu & Kashmir and Ladakh (combined)

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
12,98,816	1,40,17,803	94	19,763



11.12

JHARKHAND

11.12.1 Introduction

The State of Jharkhand came into existence on 15th November 2000 after the reorganization of the erstwhile unified Bihar. Situated in the eastern part of the country, Jharkhand covers an area of 79,716 sq km, which is 2.42% of the geographical area of the country. The State lies between 22°00' N to 24°37' N latitudes and 83°15' E to 87°01' E longitudes and shares borders with Bihar in the north, Uttar Pradesh in the northwest, Chhattisgarh in the west, Odisha in the south and West Bengal in the east. Physiographically, the State has four major plateaus separated by narrow steep slopes, of which the Chhota Nagpur plateau is the most prominent. Jharkhand has tropical climate with annual rainfall of about 900 mm. Temperature varies between 4°C to 47°C. The important rivers of the State are Ganga, Son, South Koel, Baitarni and Damodar. Jharkhand has 24 districts of which 17 are tribal and none is a hill district. The State has a population of 32.99 million of which rural and urban population constitutes 75.95% and 24.05% respectively. Tribal population is 26.21% of the State's population. The population density of the State 414 per sq km which is slightly higher than the national average. The 19th Livestock census 2012 has reported a total livestock population of 18.05 million.

TABLE 11.12.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	7,972	
Reporting area for land utilization	7,970	100.00
Forests	2,239	28.10
Not available for land cultivation	1,274	15.98
Permanent pastures and other grazing lands	113	1.43
Land under misc. tree crops and groves	98	1.23
Culturable wasteland	353	4.43
Fallow land other than current fallows	1,122	14.08
Current fallows	1,386	17.38
Net area sown	1,385	17.37

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.12.1.1 A Brief Overview of Forestry Scenario

The State of Jharkhand is rich in forests and mineral wealth. As per the Champion & Seth classification of the Forest Types (1968), the forests in Jharkhand belong to two Forest Type Groups which are further divided into eight Forest Types. The State is known for its waterfalls, hills and forest landscapes. Various ethnic groups such as Munda, Oraon, Ho, Santhal, Paharia, Chero, Birjea, Asura and others live in the State and follow varying practices of agro-pastoralism. Traditionally, these indigenous people have symbiotic relationship with forests. Local festivals like Sarhul and Karma are customarily related with worshipping of trees. Jharkhand has a rich variety of flora and fauna.

Recorded Forest Area (RFA) in the State is 23,605 sq km of which 4,387 sq km is Reserved Forests, 19,185 sq km is Protected Forest and 33 sq km is Unclassed Forests. In Jharkhand, during the period 1st January 2015 to 5th Feb 2019, a total of 690.87 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). One National Park and 11 Wildlife Sanctuaries constitute the Protected Area network of the State covering 2.74% of its geographical area.

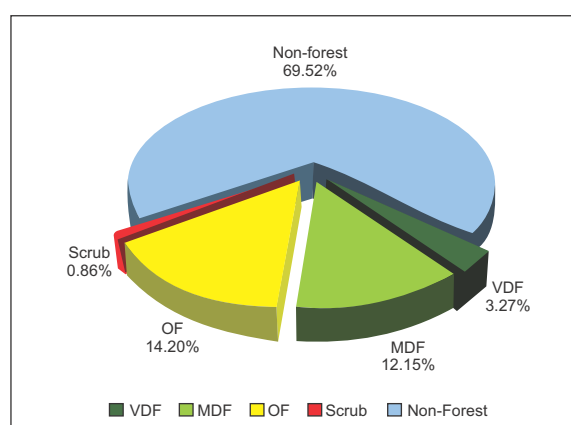
11.12.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Jan 2018, the Forest Cover in the State is 23,611.41 sq km which is 29.62 % of the State's geographical area. In terms of forest canopy density classes, the State has 2,603.20 sq km under Very Dense Forest (VDF), 9,687.36 sq km under Moderately Dense Forest (MDF) and 11,320.85 sq km under Open Forest (OF). Forest Cover in the State has increased by 58.41 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.12.2 Forest Cover of Jharkhand

(in sq. km)		
Class	Area	% of GA
VDF	2,603.20	3.27
MDF	9,687.36	12.15
OF	11,320.85	14.20
Total	23,611.41	29.62
Scrub	688.05	0.86

FIGURE 11.12.1 Forest Cover of Jharkhand



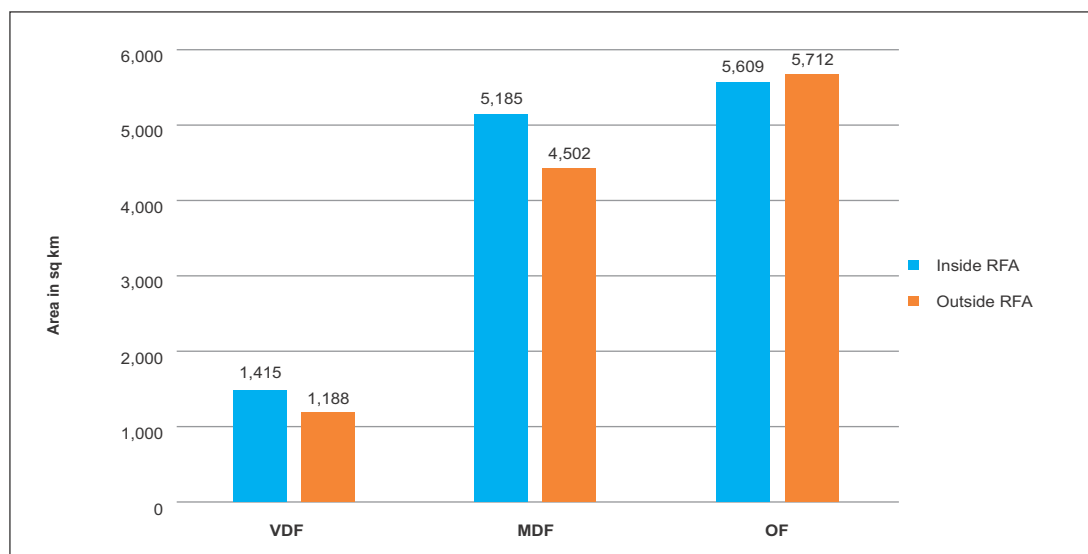
11.12.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 23,605 sq km which is 29.61% of its geographical area. The reserved, protected and unclassified forests are 18.58%, 81.28% and 0.14% of the recorded forest area in the State respectively. However as the digitized boundary of the recorded forest area from the state covers only 19,096.61 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.12.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Jharkhand

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1,415	5,185	5,609	12,209	1,188	4,502	5,712	11,402
11.59%	42.47%	45.94%		10.43%	39.48%	50.09%	

*in case of Jharkhand RFA boundaries have been used.

FIGURE 11.12.2 Forest Cover inside and outside RFA in Jharkhand**TABLE 11.12.4** District-wise Forest Cover in Jharkhand

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bokaro	2,883	61.00	232.00	280.55	573.55	19.89	3.55	38.85
Chatra	3,718	244.58	869.98	662.79	1,777.35	47.80	11.35	23.04
Deoghar ^T	2,477	0.00	14.41	189.30	203.71	8.22	1.71	15.80
Dhanbad	2,040	0.00	44.00	169.51	213.51	10.47	9.51	19.52
Dumka ^T	3,761	0.00	259.35	317.96	577.31	15.35	1.31	44.38
Garhwa ^T	4,093	125.00	415.34	851.25	1,391.59	34.00	1.59	62.56
Giridih	4,962	77.00	338.67	485.57	901.24	18.16	11.24	30.93
Godda ^T	2,266	13.00	272.09	138.26	423.35	18.68	2.35	16.00
Gumla ^T	5,360	304.86	586.08	551.32	1,442.26	26.91	1.26	11.00
Hazaribagh	3,555	230.00	349.00	773.77	1,352.77	38.05	1.77	19.76
Jamtara ^T	1,811	0.00	20.97	79.67	100.64	5.56	3.64	12.60
Khunti ^T	2,535	73.00	342.91	489.58	905.49	35.72	1.49	12.00
Kodarma	2,540	80.99	494.45	448.03	1,023.47	40.29	-0.53	6.50
Latehar ^T	4,291	480.63	1,308.74	616.97	2,406.34	56.08	2.34	9.30
Lohardaga ^T	1,502	173.95	218.49	112.18	504.62	33.60	0.62	8.00
Pakur ^T	1,811	3.00	172.00	112.13	287.13	15.85	0.13	20.00
Palamu ^T	4,393	63.19	512.62	624.97	1,200.78	27.33	0.78	99.72
Pashchimi Singhbhum ^T	7,224	462.00	1,353.61	1,550.51	3,366.12	46.60	0.12	52.06
Purbi Singhbhum ^T	3,562	55.00	591.33	433.05	1,079.38	30.30	3.38	21.15
Ramgarh	1,341	31.00	110.00	188.00	329.00	24.53	0.00	18.00
Ranchi ^T	5,097	63.04	364.19	737.26	1,164.49	22.85	0.49	35.35
Sahibganj ^T	2,063	17.96	259.16	295.23	572.35	27.74	-0.65	67.65
Saraikele-Kharsawan ^T	2,657	22.00	213.97	338.07	574.04	21.60	1.04	22.88
Simdega ^T	3,774	22.00	344.00	874.92	1,240.92	32.88	-0.08	21.00
Grand Total	79,716	2,603.20	9,687.36	11,320.85	23,611.41	29.62	58.41	688.05

TABLE 11.12.5 Forest Cover Change Matrix for Jharkhand

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	2,587	10	0	0	1	2,598
Moderately Dense Forest	16	9,660	3	0	7	9,686
Open Forest	0	11	11,230	1	27	11,269
Scrub	0	0	8	658	3	669
Non Forest	0	6	80	29	55,379	55,494
Total ISFR 2019	2,603	9,687	11,321	688	55,417	79,716
Net Change	5	1	52	19	-77	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.12.6 Altitude-wise Forest Cover in Jharkhand

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	61,272	1,032	6,705	8,382	16,119 (68.26 %)	644
500-1000	18,051	1,511	2,849	2,905	7,265 (30.78 %)	43
1000-2000	393	60	133	34	227 (0.96 %)	1
Total	79,716	2,603	9,687	11,321	23,611	688

(based on SRTM, Digital Elevation Model, 30 m, 2016)

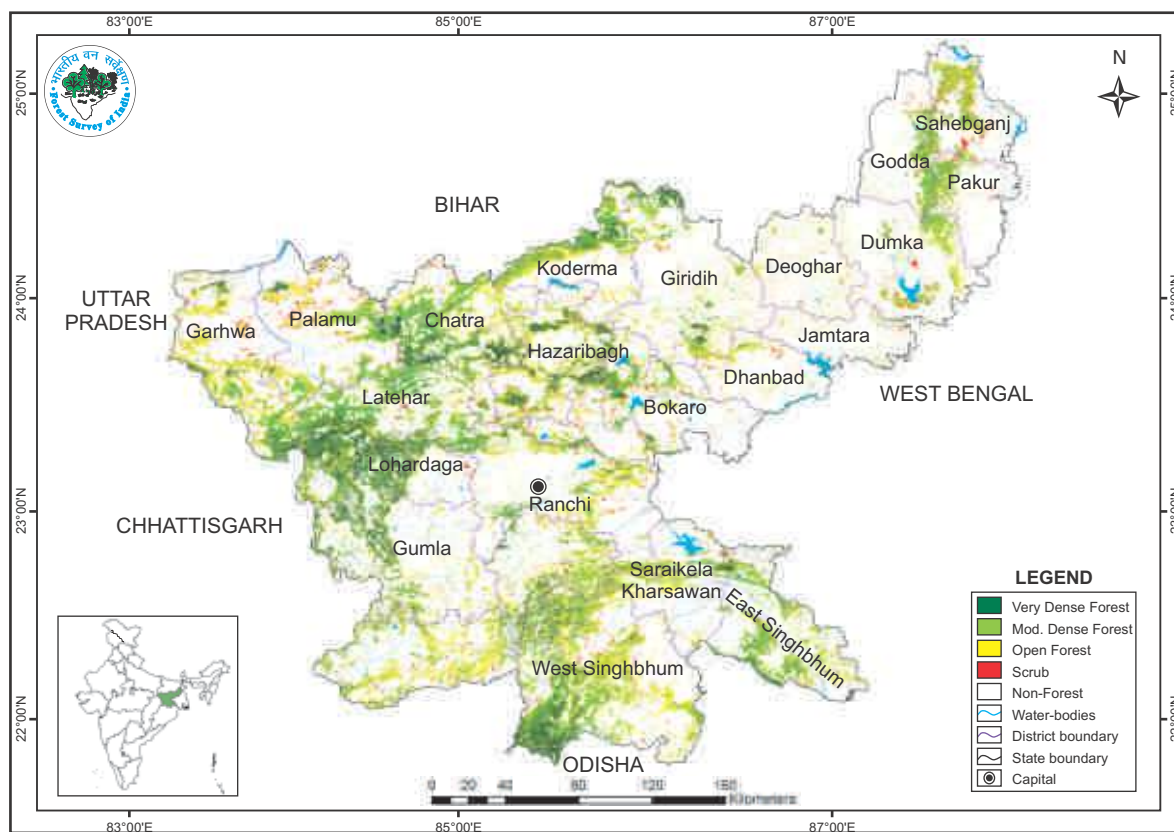
TABLE 11.12.7 Forest Cover in different slope classes in Jharkhand

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	65,120	1,223	4,835	6,844	12,902 (54.65%)	403
5-10	8,083	669	2,243	2,192	5,104 (21.62%)	129
10-15	3,260	376	1,253	1,091	2,720 (11.52%)	69
15-20	1,790	201	736	637	1,574 (6.67%)	44
20-25	915	90	383	346	819 (3.47%)	26
25-30	390	32	165	154	351 (1.49%)	12
>30	158	12	72	57	141 (0.58%)	5
Total	79,716	2,603	9,687	11,321	23,611	688

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.12.3 Forest Cover Map of Jharkhand**TABLE 11.12.8** Wetlands inside the Recorded Forest Area (or Green Wash) in Jharkhand (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Riverine wetland	6	12
Waterlogged	34	60
River/Stream	209	10,028
Sub - Total	249	10,100
Inland Wetlands - Man-made		
Reservoir/Barrage	408	5,128
Tank/Pond	140	434
Waterlogged	3	4
Sub - Total	551	5,566
Wetlands (<2.25 ha)	862	862
Total	1,662	16,528
Total Recorded Forest (or Green Wash) Area (in ha)		19,09,661
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.87%

(analysis based on the National Wetland Atlas: India, 2011)

11.12.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Jharkhand as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.12.9 Percentage area under different forest types of Jharkhand

Sl.No.	Forest Type	% of Forest cover
1.	3C/C2e (ii) Moist Peninsular Low Level Sal	2.34
2.	3C/C2e (iii) Moist Peninsular Valley Sal	0.28
3.	5/DS1 Dry Deciduous Scrub	2.36
4.	5/E2 Boswellia Forest	0.04
5.	5/E5 Butea Forest	0.00
6.	5/E9 Dry Bamboo Brake	0.55
7.	5B/C1c Dry Peninsular Sal Forest	53.77
8.	5B/C2 Northern Dry Mixed Deciduous Forest	35.01
9.	Plantation/ TOF	5.65
	Total	100.00

11.12.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.12.10 and table 11.12.11 in respect of Jharkhand.

TABLE 11.12.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	111
Shrub	26
Herb	40

TABLE 11.12.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Jharkhand

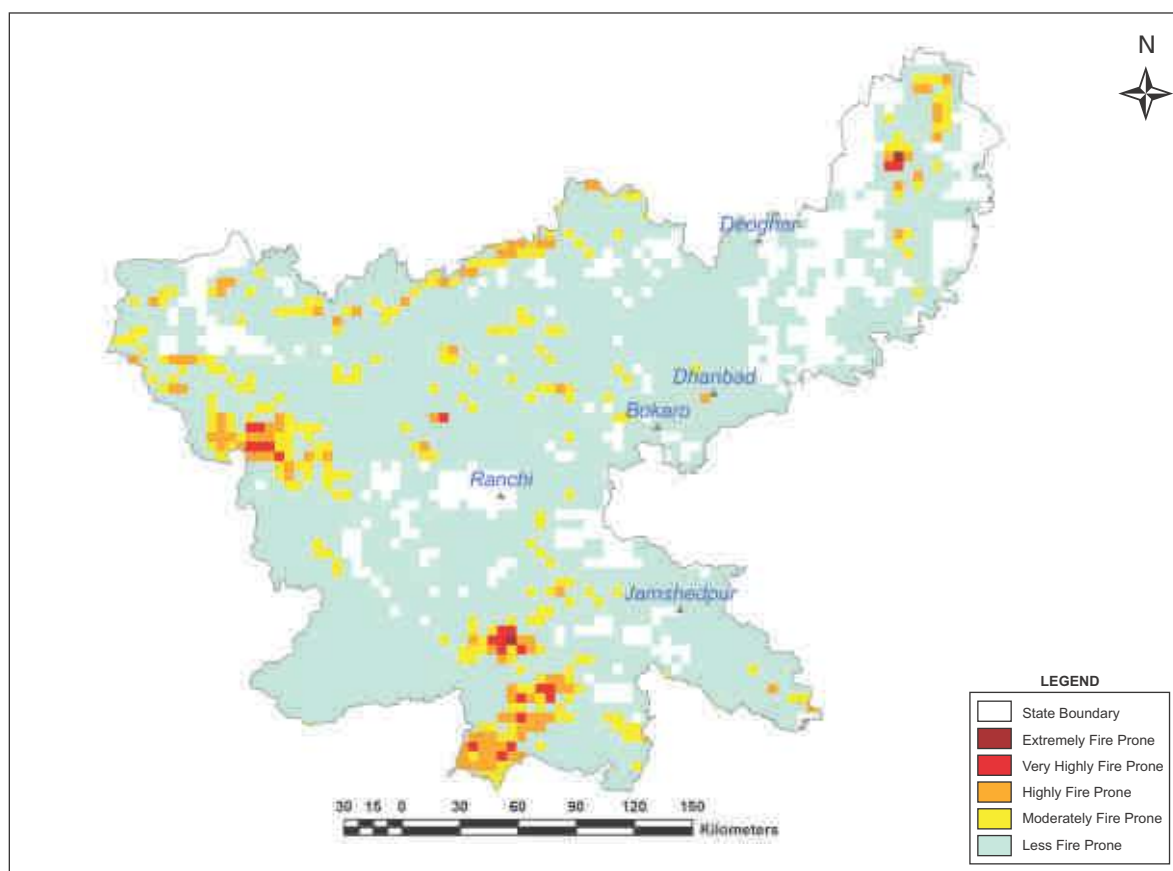
Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	2.18	1.77	2.43
2.	Group 5- Tropical Dry Deciduous Forests	2.70	2.04	3.04

11.12.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.12.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	49.91	0.21
2	Very highly fire prone	573.91	2.18
3	Highly fire prone	2,491.58	9.16
4	Moderately fire prone	6,035.46	19.54
5	Less fire prone	57,950.27	68.91
	Total	67,101.13	100.00

FIGURE 11.12.4 Fire prone forest areas under different fire prone classes

11.12.5 Tree Cover

Forest cover presented in the section 11.12.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Jharkhand has been estimated as given in table 11.12.13.

TABLE 11.12.13 Tree Cover in Jharkhand (in sq km)

Tree Cover	Area
	2,657

Tree cover of Jharkhand has decreased by 265 sq km as compared to the previous assessment reported in ISFR 2017.

11.12.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.12.14 Extent of TOF in Jharkhand (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
11,402	2,657	14,059

11.12.7 Growing Stock in Jharkhand

Growing stock in the recorded forest areas (RFA) in Jharkhand is given in the table 11.12.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.12.16

TABLE 11.12.15 Growing Stock in Jharkhand (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	96.22	2.25
Growing Stock in TOF	71.93	4.38

TABLE 11.12.16 Diameter class distribution of top five species inside RFA in Jharkhand (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	1,71,789	11,751	1,134
2.	<i>Madhuca latifolia</i>	14,252	3,426	351
3.	<i>Terminalia tomentosa</i>	25,871	3,218	271
4.	<i>Buchanania latifolia</i>	21,802	677	0
5.	<i>Anogeissus latifolia</i>	15,670	1,205	0

11.12.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 178.01 million tonnes (652.70 million tonnes of CO₂ equivalent) which is 2.50% of total forest carbon of the country. Pool wise forest carbon in Jharkhand is given in the following table

TABLE 11.12.17 Forest Carbon in Jharkhand in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
48,994	19,899	423	2,826	1,05,870	1,78,012

11.12.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.12.18

TABLE 11.12.18 Growing Stock of Bamboo in Jharkhand

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	4,123	2.58
Total number of culms (in millions)	876	2.22
Total equivalent green weight (000' tones)	4,573	1.65

11.12.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Jharkhand in Rural and Urban areas are given in the table 11.12.19 and table 11.12.20 respectively

TABLE 11.12.19 Occurrence of top five tree species in TOF (Rural) in Jharkhand

Sl. No.	Species	Relative Abundance (%)
1.	<i>Butea frondosa</i>	11.82
2.	<i>Mangifera indica</i>	10.25
3.	<i>Shorea robusta</i>	8.32
4.	<i>Acacia auriculiformis</i>	6.08
5.	<i>Zizyphus jujuba</i>	5.16

TABLE 11.12.20 Occurrence of top five tree species in TOF (Urban) in Jharkhand

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	11.18
2.	<i>Cassia siamea</i>	9.16
3.	<i>Azadirachta indica</i>	7.63
4.	<i>Moringa species</i>	6.70
5.	<i>Artocarpus integrifolia</i>	4.56

11.12.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.12.21 and table 11.12.22 respectively.

TABLE 11.12.21 Major NTFP species in the State of Jharkhand

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Shorea robusta</i>	Tree	67.97
2.	<i>Buchanania Lanza</i>	Tree	8.15
3.	<i>Madhuca indica</i>	Tree	6.77
4.	<i>Diospyrus melanoxylon</i>	Tree	5.33
5.	<i>Butea monosperma</i>	Tree	4.11

TABLE 11.12.22 Major invasive species in the State inside the RFA/Green Wash in Jharkhand (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	665
2.	<i>Chromolaena odorata</i>	166
3.	<i>Ageratum houstonianum</i>	36
4.	<i>Acacia farnesiana</i>	28
5.	<i>Imperata cylindrica</i>	6

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.12.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Jharkhand

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Jharkhand is given in the table 11.12.23

TABLE 11.12.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Jharkhand

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
73,72,340	5,54,82,427	50,535	1,83,240

11.13

KARNATAKA

11.13.1 Introduction

Karnataka, the seventh largest State of the country, with a geographical area of 1,91,791 sq km accounts for 5.83% of the geographical area of the country. The State is located in the south western region of India and lies between 11°30' N to 18°30' N latitudes and 74°00' E to 78°30' E longitudes and is bordered by Maharashtra and Goa in the North, Telangana and Andhra Pradesh in the east, Kerala & Tamil Nadu on the South and the Arabian Sea on the West. The State can be divided into two distinct physiographic regions viz the 'Malnad' or hilly region comprising Western Ghats and 'Maidan' or plain region comprising the inland plateau of varying heights. The average annual rainfall varies from 2,000 mm to 3,200 mm and the average annual temperature between 25°C and 35°C. The Western Ghats, which has an exceptionally high level of biological diversity and endemism, covers about 60% of forest area of the State. East flowing rivers in Karnataka mainly Cauvery & Krishna along with its tributaries drain into Bay of Bengal and west flowing rivers mainly Sharavathi & Kali drain into Arabian Sea. The State has 30 districts, amongst which 5 are tribal and 6 are hill districts. As per the 2011 census, Karnataka has a population of 61.13 million, which is 5.05% of India's population. The rural and urban populations constitute 61.43% and 38.57% respectively. Tribal population is 6.96% of the State's population. The population density of the State is 319 per sq km, which is less than the national average. The 19th Livestock census 2012 has reported a total livestock population of 27.70 million, which is about 5.4% of the livestock population of the country.

TABLE 11.13.1: Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	19,179	
Reporting area for land utilization	19,052	100.00
Forests	3,073	16.13
Not available for land cultivation	2,248	11.80
Permanent pastures and other grazing lands	904	4.74
Land under misc. tree crops and groves	277	1.45
Culturable wasteland	409	2.15
Fallow land other than current fallows	525	2.76
Current fallows	1,572	8.25
Net area sown	10,044	52.72

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.13.1.1 A Brief Overview of Forestry Scenario

The State is endowed with diverse climate, topography and soils which has resulted in rich biodiversity. The diverse ecological niches support characteristic flora and fauna. The evergreen forests of the Western Ghats, which cover about 60% of forest area of State, is recognized as one of the 35 Biodiversity Hotspots in the World and one of the four Biodiversity Hotspots of the India. As per the Champion & Seth classification of the Forest Types (1968), the forests in Karnataka belong to eight Forest Type Groups, which are further divided into 21 Forest Types. Protection and management of degraded forests through community participation is a major thrust area of the State Forest Department besides bio-diversity conservation and eco-tourism.

The major species found in the forests of the State are *Tectona grandis*, *Santalum album*, *Terminalia spp*, *Dalbergia latifolia*, *Pterocarpus spp*, etc. In the Scrub and Thorny Forests, *Acacia spp*, *Balanites roxburghii*, *Cordia myxa*, *Capparis spp.*, *Prosopis spp.*, etc are found.

Recorded Forest Area (RFA) in the state is 38,284 sq km of which 28,690 sq km is Reserved Forest, 3,931 sq km is Protected Forest and 5,663 sq km is Unclassed Forests. In Karnataka, during the period 1st January 2015 to 5th February 2019, a total of 802.75 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the state during that last two years 1,07,496 ha of plantations were raised in the State.

Five National Parks, 30 Wildlife Sanctuaries, 15 Conservation Reserves and one Community Reserve constitute the Protected Area network of the State covering 5.33% of its geographical area. Karnataka supports about 10% of total tiger population and 25% of elephant population of the country.

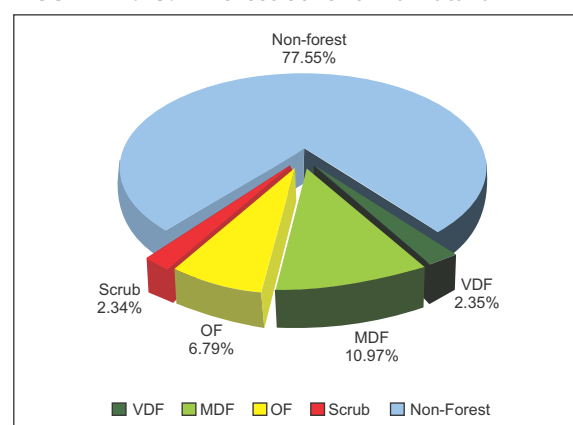
11.13.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to March 2018, the Forest Cover in the State is 38,575.48 sq km which is 20.11% of the State's geographical area. In terms of forest canopy density classes, the State has 4,501.15 sq km under Very Dense Forest (VDF), 21,048.09 sq km under Moderately Dense Forest (MDF) and 13,026.24 sq km under Open Forest (OF). Forest Cover in the State has increased by 1,025.48 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.13.2 Forest Cover of Karnataka
(in sq km)

Class	Area	% of GA
VDF	4,501.15	2.35
MDF	21,048.09	10.97
OF	13,026.24	6.79
Total	38,575.48	20.11
Scrub	4,484.07	2.34

FIGURE 11.13.1 Forest Cover of Karnataka



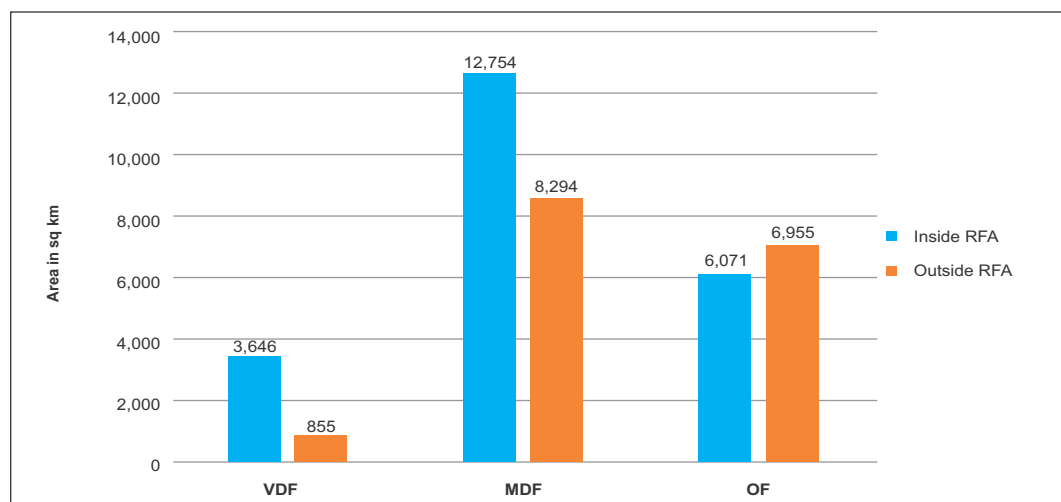
11.13.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 38,284 sq km which is 19.96% of its geographical area. The reserved, protected and unclassified forests are 74.94%, 10.27% and 14.79% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 31,036.84 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.13.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Karnataka (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
3,646	12,754	6,071	22,471	855	8,294	6,955	16,104
16.22%	56.76%	27.02%		5.31%	51.50%	43.19%	

*in case of Karnataka RFA boundaries have been used.

FIGURE 11.13.2 Forest Cover inside and outside RFA in Karnataka**TABLE 11.13.4** District- wise Forest Cover in Karnataka

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bagalkot	6,552	0.00	18.99	233.98	252.97	3.86	-0.03	399.00
Bangalore	2,196	0.00	24.64	262.79	287.43	13.09	53.43	8.00
Bangalore Rural	2,298	0.00	24.04	138.71	162.75	7.08	47.75	23.36
Belgaum ^H	13,433	35.99	736.85	368.76	1,141.60	8.50	7.60	688.00
Bellary	8,461	0.00	109.89	629.33	739.22	8.74	5.22	466.00
Bidar	5,448	0.00	22.00	66.42	88.42	1.62	3.42	37.00
Bijapur	10,498	0.00	0.00	25.05	25.05	0.24	1.05	10.00
Chamrajnagar	5,648	90.97	1,527.31	1,105.91	2,724.19	48.23	4.19	129.00
Chikkaballapura	4,244	0.00	18.56	251.14	269.70	6.35	20.70	181.00
Chikmagalur TH	7,202	901.80	2,581.08	468.90	3,951.78	54.87	15.78	74.00
Chitradurga	8,436	0.00	47.06	529.55	576.61	6.84	22.61	595.00
Dakshina Kannada TH	4,861	557.92	1,473.94	1,032.80	3,064.66	63.05	139.66	3.00
Davanagere	5,924	11.00	167.02	531.55	709.57	11.98	0.57	320.00
Dharwad	4,260	0.00	222.29	152.13	374.42	8.79	-7.58	3.00
Gadag	4,657	0.00	0.00	141.62	141.62	3.04	-1.38	117.00
Gulbarga	10,954	0.00	92.00	103.05	195.05	1.78	3.05	29.00
Hassan	6,814	147.95	774.31	556.18	1,478.44	21.70	34.44	68.00
Haveri	4,823	0.00	145.35	197.90	343.25	7.12	-17.75	103.00
Kodagu TH	4,102	795.90	1,888.21	579.27	3,263.38	79.56	12.38	2.00

Contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Kolar	3,979	0.00	58.97	322.42	381.39	9.59	61.39	68.00
Koppal	5,570	0.00	0.00	33.32	33.32	0.60	3.32	172.00
Mandya	4,962	0.00	114.21	385.11	499.32	10.06	127.32	96.70
Mysore ^T	6,307	124.96	586.20	341.67	1,052.83	16.69	23.83	29.92
Raichur	8,442	0.00	0.94	43.29	44.23	0.52	0.23	149.00
Ramanagara	3,516	0.00	196.45	468.24	664.69	18.90	53.69	170.09
Shimoga ^H	8,478	476.95	2,841.60	952.23	4,270.78	50.38	-49.22	23.00
Tumkur	10,597	0.00	72.89	1,211.15	1,284.04	12.12	308.04	387.00
Udupi ^T	3,582	214.96	1,405.09	663.33	2,283.38	63.75	145.38	0.00
Uttara Kannada ^H	10,277	1,142.75	5,881.18	1,099.82	8,123.75	79.04	5.75	2.00
Yadgir	5,270	0.00	17.02	130.62	147.64	2.80	0.64	131.00
Grand Total	1,91,791	4,501.15	21,048.09	13,026.24	38,575.48	20.11	1,025.48	4,484.07

TABLE 11.13.5 Forest Cover Change Matrix for Karnataka

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	4,501	1	0	0	0	4,502
Moderately Dense Forest	0	20,138	0	0	306	20,444
Open Forest	0	0	11,395	0	1,209	12,604
Scrub	0	0	0	4,484	0	4,484
Non Forest	0	909	1,631	0	1,47,217	1,49,757
Total ISFR 2019	4,501	21,048	13,026	4,484	1,48,732	1,91,791
Net Change	-1	604	422	0	-1,025	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.13.6 Altitude-wise Forest Cover in Karnataka

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	41,511	1,441	5,793	2,918	10,152 (26.32%)	284
500-1000	1,46,593	2,602	13,512	9,606	25,720 (66.67%)	4,119
1000-2000	3,687	458	1,743	502	2,703 (7.01%)	81
Total	1,91,791	4,501	21,048	13,026	38,575	4,484

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.13.7 Forest Cover in different slope classes in Karnataka

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	161,569	930	9,600	8,284	18,814 (48.77%)	2,528
5-10	15,763	982	5,399	2,365	8,746 (22.67%)	965
10-15	6,715	894	2,906	1,066	4,866 (12.61%)	466
15-20	3,796	712	1,642	609	2,963 (7.68%)	271
20-25	2,122	477	855	365	1,697 (4.40%)	155
25-30	1,085	277	403	201	881 (2.28%)	72
>30	741	229	243	136	608 (1.58%)	27
Total	1,91,791	4,501	21,048	13,026	38,575	4,484

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.13.3 Forest Cover Map of Karnataka

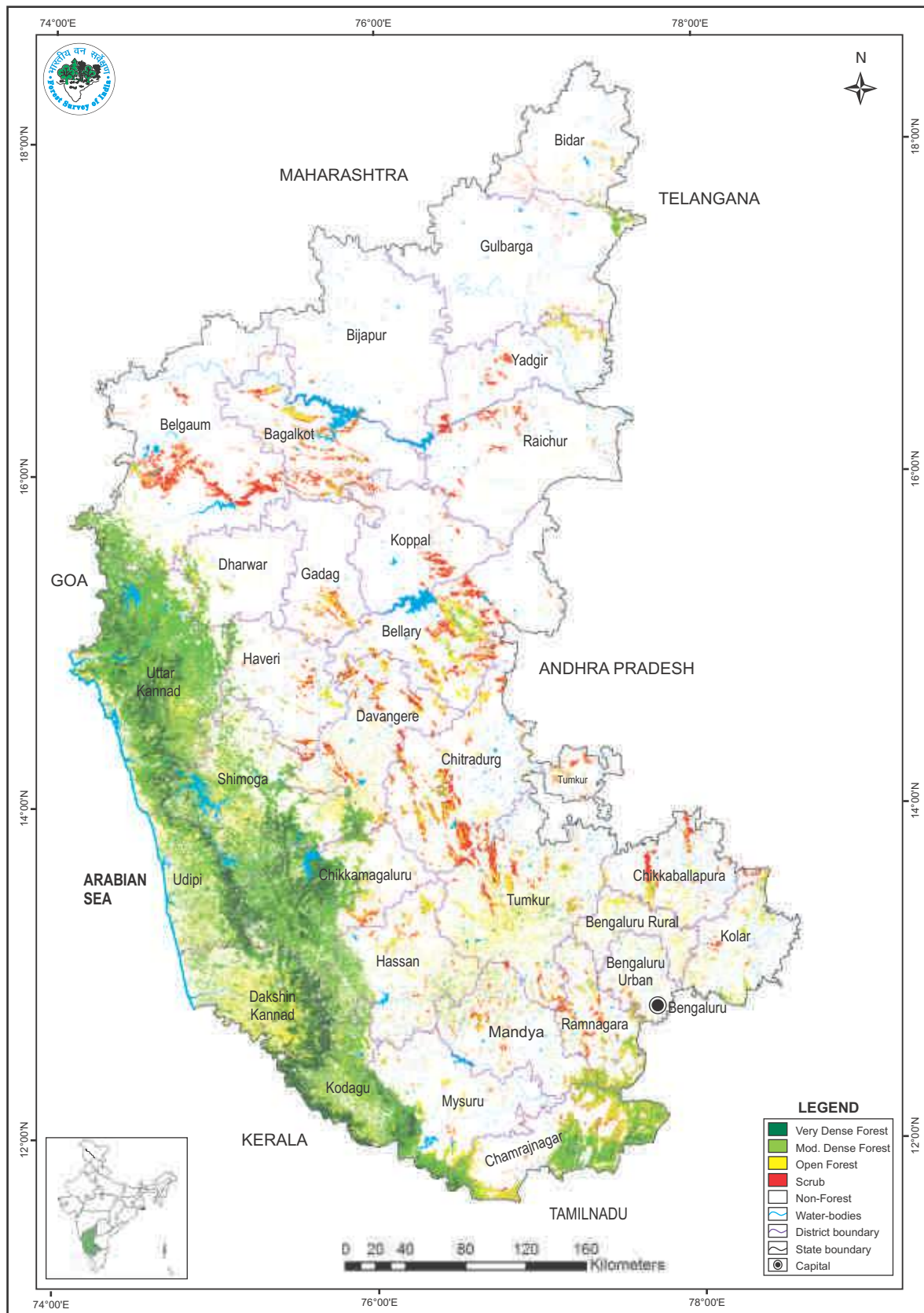


TABLE 11.13.8 Wetlands inside the Recorded Forest Area (or Green Wash)

(in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	13	396
Riverine wetland	2	8
Waterlogged	9	67
River/Stream	99	14,873
Sub - Total	123	15,344
Inland Wetlands - Man-made		
Reservoir/Barrage	38	31,292
Tank/Pond	595	5,196
Sub - Total	633	36,488
Coastal Wetlands - Natural		
Creek	3	8
Sand/Beach	9	10
Intertidal mud flat	7	6
Mangrove	2	2
Sub - Total	21	26
Wetlands (<2.25 ha)	1,261	1,261
Total	2,038	53,119
Total Recorded Forest (or Green Wash) Area (in ha)		31,03,684
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.71%

(analysis based on the National Wetland Atlas: India, 2011)

11.13.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Karnataka as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.13.9 Percentage area under different forest types of Karnataka

Sl.No.	Forest Type	% of Forest cover
1	1A/C4 West Coast Tropical Evergreen Forest	12.65
2	2/E3 Moist Bamboo Brakes	0.00
3	2/E4 Lateritic Semi-Evergreen Forest	0.39
4	2A/2S1 West Coast Secondary Evergreen Dipterocarp Forest	0.73
5	2A/C2 West Coast Semi-Evergreen Forest	10.52
6	3B/2S1 Southern Secondary Moist Mixed Deciduous Forest	1.62
7	3B/C1b Moist Teak Forest	4.67
8	3B/C1c Slightly Moist Teak Forest	2.37
9	3B/C2 Southern Moist Mixed Deciduous Forest	11.70
10	4B/TS1 Mangrove Scrub	0.02
11	5/2S1 Secondary Dry Deciduous Forest	0.09
12	5/DS1 Dry Deciduous Scrub	7.12
13	5/DS4 (Dry Grass Land)	0.26

Contd.

Sl.No.	Forest Type	% of Forest cover
14	5/E4 <i>Hardwickia</i> Forest	1.08
15	5/E7 Laterite Thorn Forest	0.28
16	5A/C1b Dry Teak Forest	6.07
17	5A/C3 Southern Dry Mixed Deciduous Forest	7.73
18	6A/C1 Southern Thorn Forest	4.63
19	6A/DS1 Southern Thorn Scrub	7.49
20	8A/C1 Nilgiri Sub Tropical Hill Forest	0.83
21	11A/DS2 Southern Montane Wet Grassland	0.18
22	Plantation/ TOF	19.57
	Total	100.00

11.13.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.13.10 and table 11.13.11 in respect of Karnataka.

TABLE 11.13.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	325
Shrub	140
Herb	40

TABLE 11.13.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Karnataka

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	4.19	3.09	2.22
2.	Group 2- Tropical Semi-Evergreen Forests	4.00	2.58	1.85
3.	Group 3- Tropical Moist Deciduous Forests	3.56	2.66	2.24
4.	Group 5- Tropical Dry Deciduous Forests	3.66	2.68	1.04
5.	Group 6- Tropical Thorn Forests	3.09	2.32	1.01
6.	Group 8- Subtropical Broadleaved Hill Forests	2.53	2.55	1.29
7.	Group 11- Montane Wet Temperate Forest	1.88	*	*

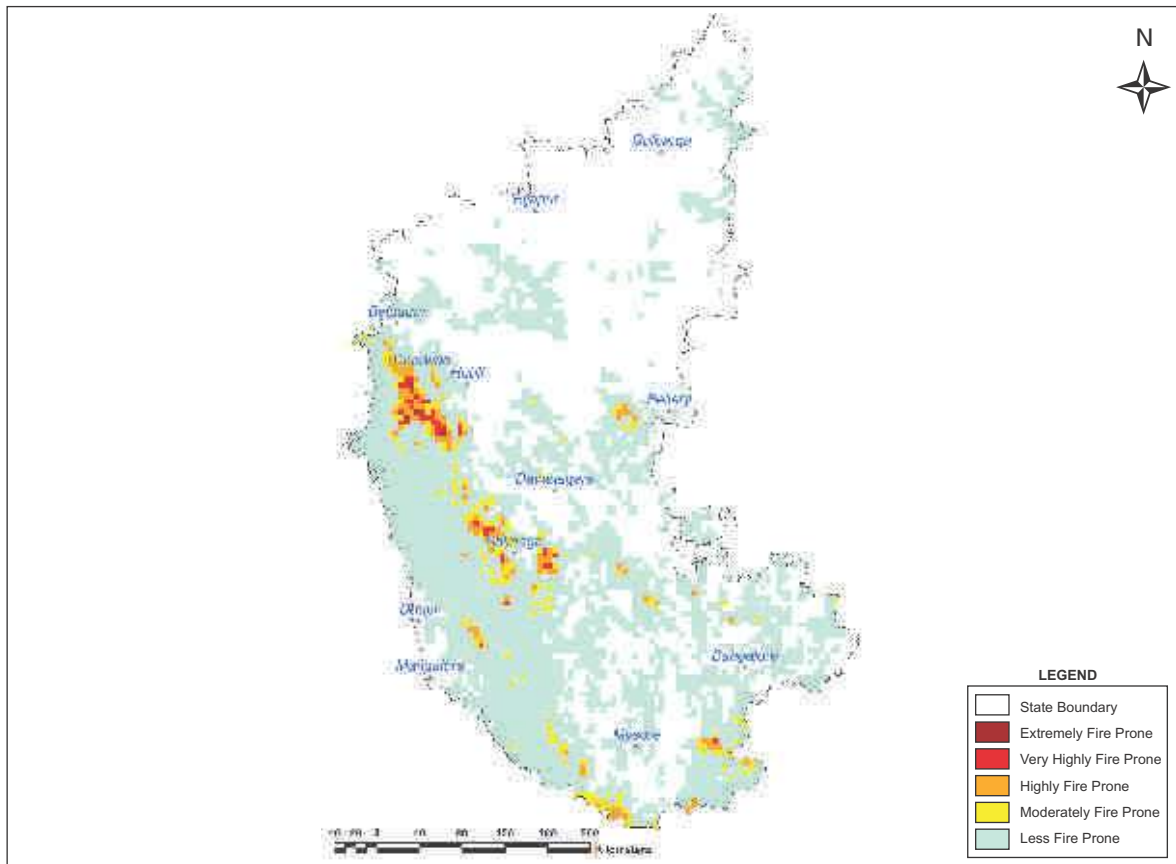
* adequate number of sample plots were not available

11.13.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.13.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	100.00	0.29
2.	Very highly fire prone	999.95	2.61
3.	Highly fire prone	3,067.40	6.96
4.	Moderately fire prone	5,056.71	9.99
5.	Less fire prone	80,436.10	80.15
	Total	89,660.16	100.00

FIGURE 11.13.4: Fire prone forest areas under different fire prone classes

11.13.5 Tree Cover

Forest cover presented in the section 11.13.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Karnataka has been estimated as given in table 11.13.13.

TABLE 11.13.13 Tree Cover in Karnataka (in sq km)

Tree Cover	Area
	6,257

Tree cover of Karnataka has increased by 544 sq km as compared to the previous assessment reported in ISFR 2017.

11.13.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.13.14 Extent of TOF in Karnataka (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
16,104	6,257	22,361

11.13.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Karnataka is given in the table 11.13.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.13.16

TABLE 11.13.15 Growing Stock in Karnataka (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	334.08	7.82
Growing Stock in TOF	103.03	6.27

TABLE 11.13.16 Diameter class distribution of top five species inside RFA in Karnataka (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Terminalia paniculata</i>	44,378	13,439	2,703
2.	<i>Terminalia tomentosa</i>	28,262	9,509	1,501
3.	<i>Tectona grandis</i>	43,773	10,957	857
4.	<i>Xylia xylocarpa</i>	35,123	10,236	832
5.	<i>Anogeissus latifolia</i>	34,644	4,040	245

11.13.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 383.76 million tonnes (1,407.12 million tonnes of CO₂ equivalent) which is 5.39% of total forest carbon of the country. Pool wise forest carbon in Karnataka is given in the following table.

TABLE 11.13.17 Forest Carbon in Karnataka in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,28,882	38,742	1,993	8,931	2,05,215	3,83,763

11.13.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.13.18

TABLE 11.13.18 Growing Stock of Bamboo in Karnataka

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	10181	6.36
Total number of culms (in millions)	1,910	4.84
Total equivalent green weight (in 000' tonnes)	26,456	9.53

11.13.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Karnataka in Rural and Urban areas are given in the table 11.13.19 and table 11.13.20 respectively.

TABLE 11.13.19 Top five tree species in TOF (Rural) in Karnataka

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	22.27
2.	<i>Areca catechu</i>	10.13
3.	<i>Cocos nucifera</i>	9.90
4.	<i>Mangifera indica</i>	6.65
5.	<i>Acacia arabica</i>	5.26

TABLE 11.13.20 Top five trees species in TOF (Urban) in Karnataka

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	22.62
2.	<i>Areca catechu</i>	20.75
3.	<i>Acacia auriculiformis</i>	8.24
4.	<i>Mangifera indica</i>	4.63
5.	<i>Tectona grandis</i>	3.02

11.13.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.13.21 and table 11.13.22 respectively.

TABLE 11.13.21 Major NTFP species in the State of Karnataka

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Solanum nigrum</i>	Herb	99.45
2.	<i>Rubus ellipticus</i>	Shrub	0.55

TABLE 11.13.22 Major invasive species in the State inside the RFA/Green Wash in Karnataka (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	2,863
2.	<i>Chromolaena odorata</i>	2,485
3.	<i>Ageratum conyzoides</i>	141
4.	<i>Acacia farnesiana</i>	122
5.	<i>Cassia tora</i>	109

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.13.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Karnataka

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Karnataka is given in the table 11.13.23

TABLE 11.13.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Karnataka

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
63,23,071	2,15,01,153	397	41,098



11.14

KERALA

11.14.1 Introduction

Kerala is situated along the Arabian Sea in the southern Malabar coast of the country. The geographical area of the State is 38,852 sq km, which is 1.18% of the geographical area of the country. The State lies between 8°17'N to 12°47'N latitude and 74°52'E to 77°24'E longitude. The State is bordered by Karnataka in the north & northeast, Tamil Nadu in the east & southeast and Lakshadweep Sea on the west. Physiographically, the State can be divided into coastal, midland and highland zones. The important rivers of the State are Periyar, Kaloda and Attingok which drain into the Arabian Sea. Climate of the State is humid with mean temperature ranging from 19.8°C to 36.7°C and the average annual rainfall from 1,520 mm to 4,075 mm. The State has 14 districts out of which 10 districts are hill and 9 districts are tribal. As per the 2011 census, Kerala has a population of 33.41 million which is 2.7% of India's population. The rural and urban population constitutes 66.64% and 33.36% respectively. The tribal population of the State is 6.99%. The population density of the State is 860 per sq km which is much higher than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 2.73 million in the State.

TABLE 11.14.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	3,886	
Reporting area for land utilization	3,886	100.00
Forests	1,081	27.83
Not available for land cultivation	538	13.85
Permanent pastures and other grazing lands	0.01	0.00
Land under misc. tree crops and groves	2.65	0.07
Culturable wasteland	101	2.59
Fallow land other than current fallows	55	1.41
Current fallows	65	1.68
Net area sown	2,043	52.57

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.14.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Kerala are divided into seven Type Groups which are further divided into 16 Forest Types. The wide range of forest types enables the growth of a rich variety of flora, including orchids and medicinal plants.

The backwaters form an attractive and economically valuable feature of the State. The rural folk and tribal communities reportedly make use of about 2,000 species of wild plants for various medicinal purposes. Recorded Forest Area (RFA) in the State is 11,309 sq km all of which is Reserved Forest. In Kerala, during the period 1st January 2015 to 5th February 2019, a total of 15.82 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

Six National Parks, 17 Wildlife Sanctuaries and one Community Reserve constitute the Protected Area network of the State covering 6.40% of its geographical area.

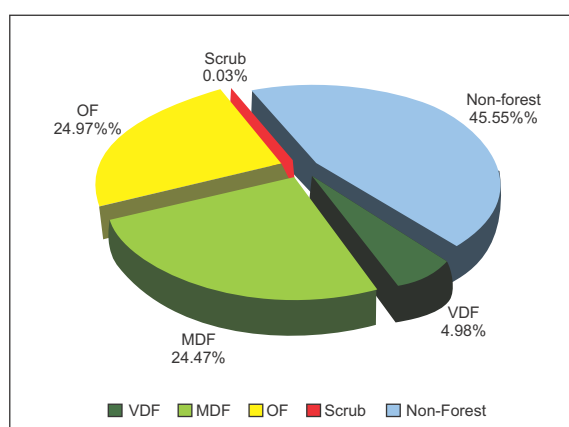
11.14.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Dec 2017 to March 2018, the Forest Cover in the State is 21,144.29 sq km which is 54.42% of the State's geographical area. In terms of forest canopy density classes, the State has 1,934.83 sq km under Very Dense Forest (VDF), 9,508.24 sq km under Moderately Dense Forest (MDF) and 9,701.22 sq km under Open Forest (OF). Forest Cover in the State has increased by 823.29sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.14.2 Forest Cover of Kerala

(in sq. km)		
Class	Area	% of GA
VDF	1,934.83	4.98
MDF	9,508.24	24.47
OF	9,701.22	24.97
Total	21,144.29	54.42
Scrub	13.37	0.03

FIGURE 11.14.1 Forest Cover of Kerala



11.14.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 11,309 sq km which is 29.11% of its geographical area. All the recorded forests in the state are reserved Forests. However as the digitized boundary of recorded forest area from the state covers 11,421.31 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.14.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Kerala (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1,791	5,300	2,546	9,637	144	4,208	7,155	11,507
18.58%	55.00%	26.42%		1.25%	36.57%	62.18%	

*in case of Kerala RFA boundaries have been used

FIGURE 11.14.2 Forest Cover inside and outside RFA in Kerala

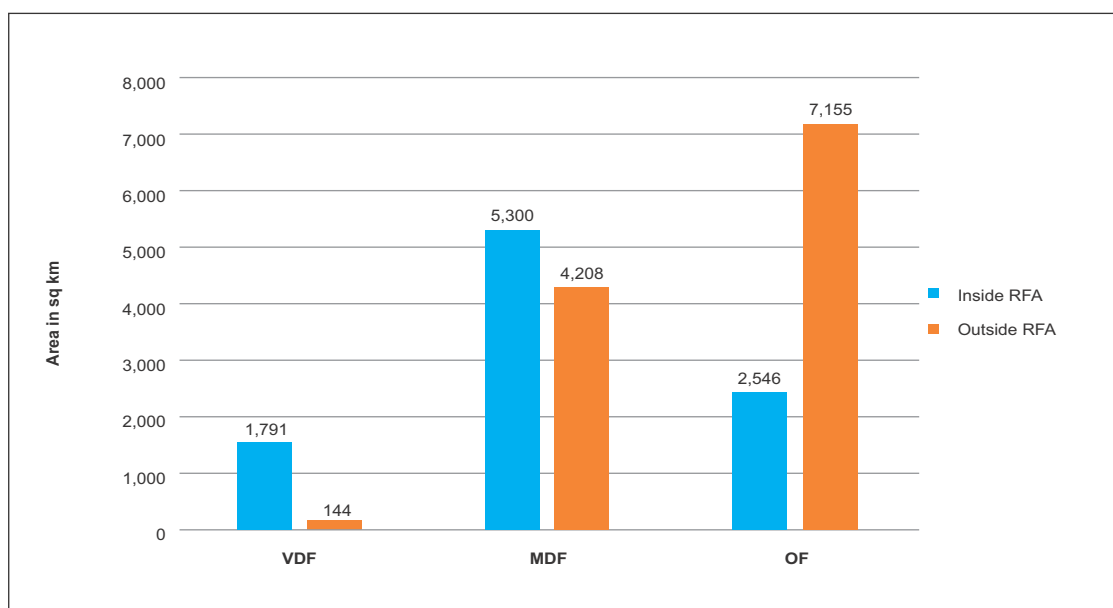


TABLE 11.14.4 District-wise Forest Cover in Kerala

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Alappuzha	1,415	0.00	27.00	52.90	79.90	5.65	11.90	0.00
Ernakulam TH	3,063	167.01	615.03	583.67	1,365.71	44.59	92.71	0.00
Idukki TH	4,356	348.36	1,795.63	1,006.66	3,150.65	72.33	11.65	0.93
Kannur TH	2,961	58.00	485.88	1,110.09	1,653.97	55.86	92.97	0.00
Kasaragod TH	1,989	1.90	294.31	670.27	966.48	48.59	19.48	0.00
Kollam TH	2,483	104.00	657.25	561.26	1,322.51	53.26	-33.49	0.00
Kottayam	2,206	12.00	531.95	560.34	1,104.29	50.06	137.29	0.00
Kozhikode ^H	2,345	70.81	409.89	956.27	1,436.97	61.28	-47.03	0.00
Malappuram TH	3,554	142.59	424.08	1,414.66	1,981.33	55.75	170.33	0.50
Palakkad TH	4,482	403.36	636.72	1,043.51	2,083.59	46.49	257.59	11.69
Pathanamthitta	2,652	161.95	1,235.81	557.76	1,955.52	73.74	125.52	0.00
Thiruvananthapuram TH	2,189	57.00	697.88	549.05	1,303.93	59.57	-23.07	0.00
Thrissur	3,027	218.86	475.81	464.55	1,159.22	38.30	7.22	0.25
Wayanad TH	2,130	188.99	1,221.00	170.23	1,580.22	74.19	0.22	0.00
Grand Total	38,852	1,934.83	9,508.24	9,701.22	21,144.29	54.42	823.29	13.37



TABLE 11.14.5 Forest Cover Change Matrix for Kerala

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1,608	55	0	0	0	1,663
Moderately Dense Forest	327	8,987	80	0	13	9,407
Open Forest	0	464	7,682	0	1,105	9,251
Scrub	0	0	9	13	1	23
Non Forest	0	2	1,930	0	16,576	18,508
Total ISFR 2019	1,935	9,508	9,701	13	17,695	38,852
Net Change	272	101	450	-10	-813	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation

TABLE 11.14.6 Altitude-wise Forest Cover in Kerala

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	28,678	185	5,241	7,894	13,320 (63.00 %)	1
500-1000	6,478	827	2,885	1,159	4,871 (23.04 %)	8
1000-2000	3,441	745	1,342	648	2,735 (12.93 %)	4
2000-3000	255	178	40	0	218 (1.03 %)	0
Total	38,852	1,935	9,508	9,701	21,144	13

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.14.7 Forest Cover in different slope classes in Kerala

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	17,923	169	2,193	3,821	6,183 (29.24 %)	1
5-10	8,347	268	2,254	2,559	5,081 (24.03 %)	1
10-15	4,607	319	1,705	1,396	3,420 (16.18 %)	2
15-20	3,051	333	1,266	843	2,442 (11.55 %)	2
20-25	2,137	302	928	529	1,759 (8.32 %)	3
25-30	1,402	233	614	312	1,159 (5.48 %)	2
>30	1,385	311	548	241	1,100 (5.20 %)	2
Total	38,852	1,935	9,508	9,701	21,144	13

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.14.3 Forest Cover Map of Kerala

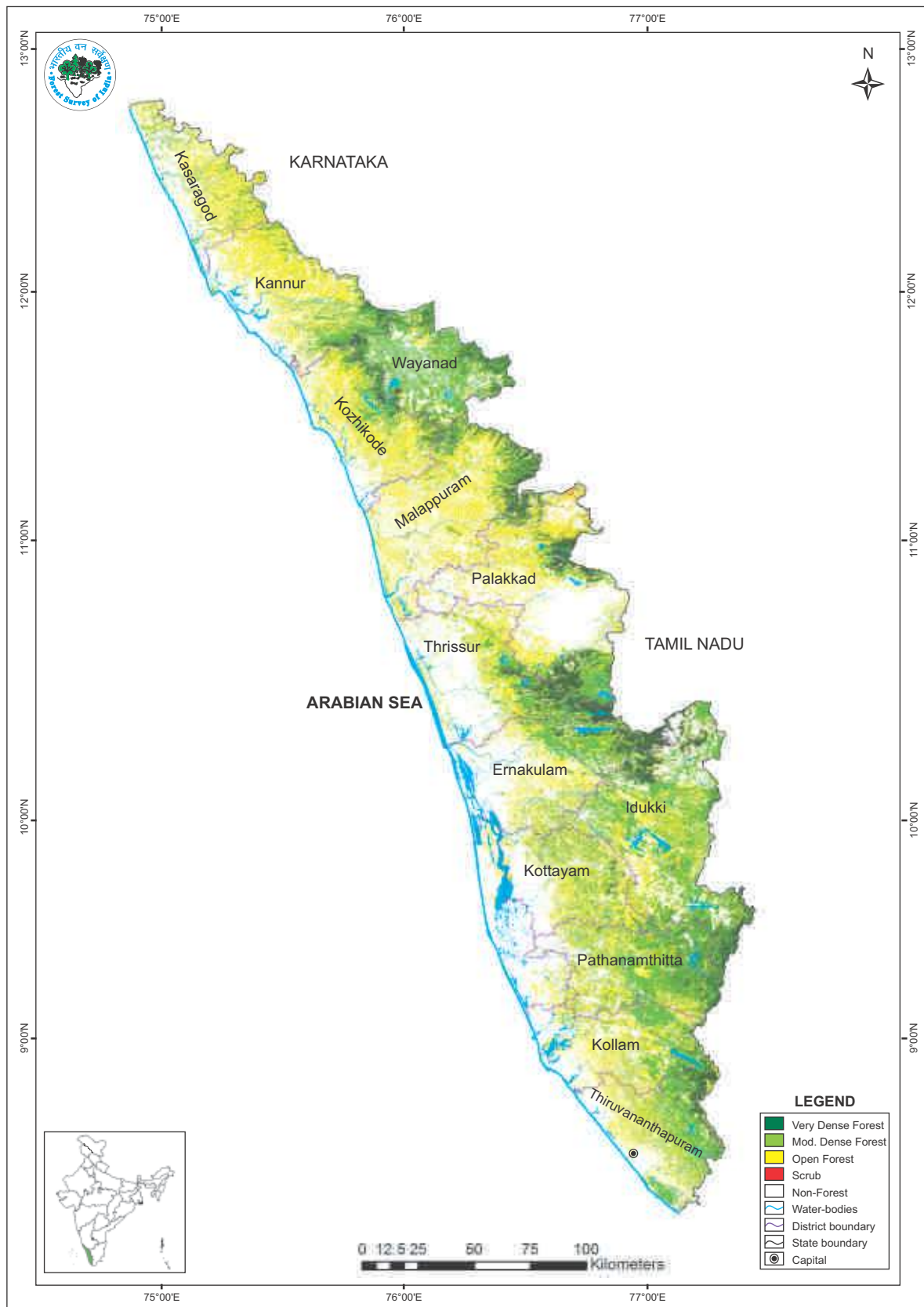


TABLE 11.14.8 Wetlands inside the Recorded Forest Area (or Green wash) in Kerala (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	2,042
Waterlogged	11	29
River/Stream	131	8,002
Sub - Total	143	10,073
Inland Wetlands -Man-made		
Reservoir/Barrage	30	12,796
Tank/Pond	46	148
Sub - Total	76	12,944
Wetlands (<2.25 ha)	140	140
Total	359	23,157
Total Recorded Forest (or Green Wash) Area (in ha)		11,42,131
% of Wetland area inside Recorded Forest (or Green Wash) Area		2.03%

(analysis based on the National Wetland Atlas: India, 2011)

11.14.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Kerala as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.14.9 Percentage area under different forest types of Kerala

Sl.No.	Forest Type	% of Forest cover
1.	1A/C3 Southern Hilltop Tropical Evergreen Forest	1.39
2.	1A/C4 West Coast Tropical Evergreen Forest	15.13
3.	1/E2 Wet Bamboo Brakes	0.15
4.	1/2S1 Pioneer Euphorbiaceous Scrub	0.10
5.	2A/C2 West Coast Semi-Evergreen Forest	13.79
6.	3B/C1a Very Moist Teak Forest	0.82
7.	3B/C1b Moist Teak Forest	0.68
8.	3B/C1c Slightly Moist Teak Forest	2.17
9.	3B/C2 Southern Moist Mixed Deciduous Forest	8.80
10.	4B/TS2 Mangrove Forest	0.04
11.	4C/FS1 Myristica Swamp Forest	0.01
12.	5A/C3 Southern Dry Mixed Deciduous Forest	1.60
13.	5/DS4 (Dry Grass Land)	0.05
14.	6A/C1 Southern Thorn Forest	0.00
15.	11A/C1 Southern Montane Wet Temperate Forest	1.52
16.	11A/DS2 Southern Montane Wet Grassland	0.62
17.	Plantation/ TOF	53.13
	Total	100.00

11.14.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.14.10 and table 11.14.11 in respect of Kerala.

TABLE 11.14.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	238
Shrub	158
Herb	81

TABLE 11.14.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Kerala

Sl. No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	3.78	3.26	2.94
2.	Group 2- Tropical Semi-Evergreen Forests	3.80	2.87	2.15
3.	Group 3- Tropical Moist Deciduous Forests	3.48	2.97	2.62
4.	Group 4- Littoral and Swamp Forests	*	1.42	0.95
5.	Group 5- Tropical Dry Deciduous Forests	3.10	2.63	2.45
6.	Group 6- Tropical Thorn Forests	*	2.46	1.43
7.	Group 11- Montane Wet Temperate Forests	1.84	2.20	2.14

* adequate number of sample plots were not available

11.14.4 Fire Prone Forest Areas

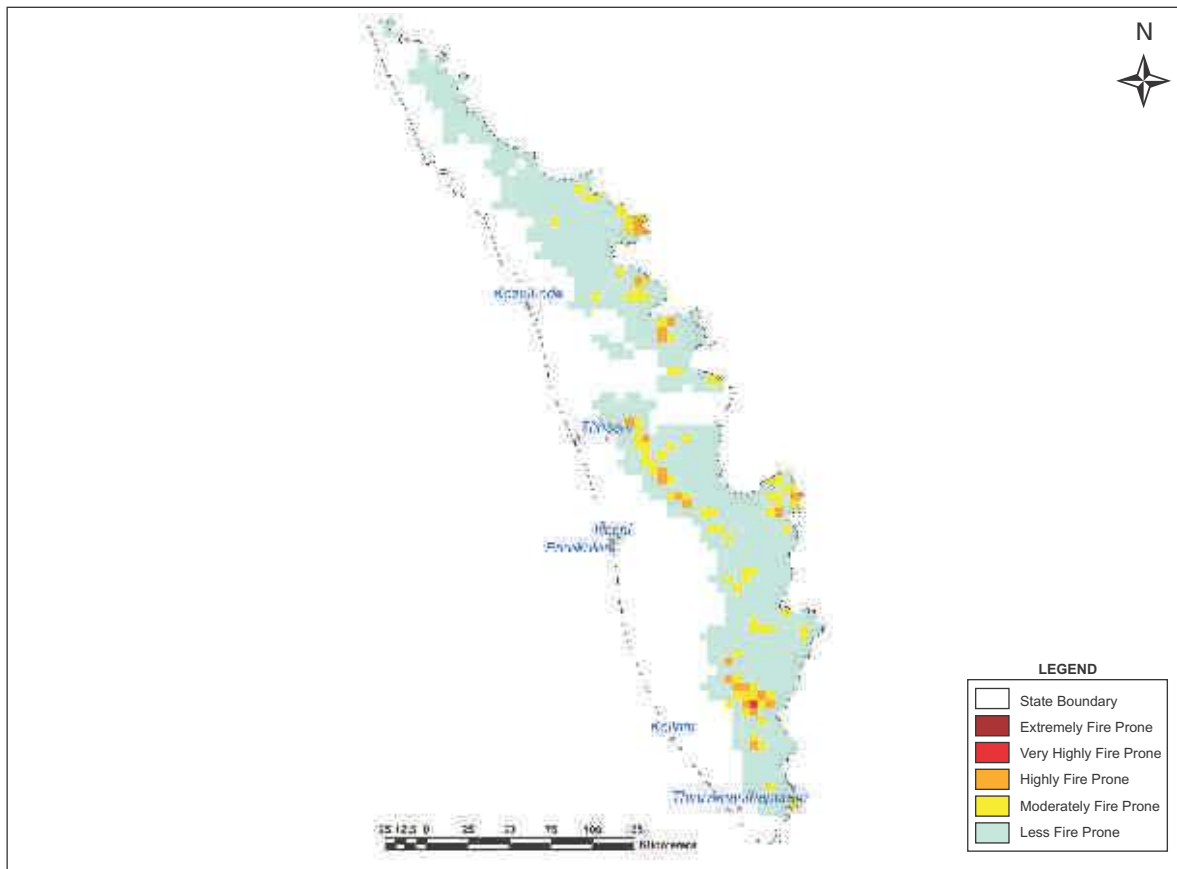
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.14.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	0.00	0.00
2	Very highly fire prone	25.03	0.18
3	Highly fire prone	593.68	3.84
4	Moderately fire prone	1,975.47	11.67
5	Less fire prone	18,020.16	84.31
	Total	20,614.34	100.00



FIGURE 11.14.4 Fire prone forest areas under different fire prone classes



11.14.5 Tree Cover

Forest cover presented in the section 11.14.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Kerala has been estimated as given in table 11.14.13.

TABLE 11.14.13 Tree Cover in Kerala (in sq km)

Tree Cover	Area
	2,936

Tree cover of Kerala has decreased by 23 sq km as compared to the previous assessment reported in ISFR 2017.

11.14.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the Forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.14.14 Extent of TOF in Kerala (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
11,507	2,936	14,443

11.14.7 Growing Stock in Kerala

Growing stock in the recorded forest areas (RFA) in Kerala is given in the table 11.14.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.14.16

TABLE 11.14.15 Growing Stock in Kerala (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	147.10	3.44
Growing Stock in TOF	55.26	3.36

TABLE 11.14.16 Diameter class distribution of top five species inside RFA in Kerala (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Tectona grandis</i>	14,568	6,399	492
2.	<i>Terminalia paniculata</i>	7,843	4,724	1,087
3.	<i>Hevea brasiliensis</i>	9,362	835	0
4.	<i>Xylia xylocarpa</i>	10,635	3,300	486
5.	<i>Areca catechu</i>	7,079	72	0

11.14.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 212.96 million tonnes (780.85 million tonnes of CO₂ equivalent) which is 2.99% of total forest carbon of the country. Pool wise forest carbon in Kerala is given in the following table

TABLE 11.14.17 Forest Carbon in Kerala in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
67,979	19,070	1,017	5,001	1,19,889	2,12,956

11.14.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.14.18

TABLE 11.14.18 Growing Stock of Bamboo in Kerala

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green wash (in sq km)	2,849	1.78
Total number of culms (in millions)	1,030	2.61
Total equivalent green weight (in 000' tonnes)	13,092	4.72

11.14.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Kerala in Rural and Urban areas are given in the table 11.14.19 and table 11.14.20 respectively

TABLE 11.14.19 Top five tree species in TOF (Rural) in Kerala

Sl. No.	Species	Relative Abundance (%)
1.	<i>Hevea brasiliensis</i>	36.99
2.	<i>Areca catechu</i>	14.91
3.	<i>Cocos nucifera</i>	11.48
4.	<i>Artocarpus integrifolia</i>	4.48
5.	<i>Artocarpus hirsute</i>	3.74

TABLE 11.14.20 Top five tree species in TOF (Urban) in Kerala

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	35.41
2.	<i>Areca catechu</i>	13.22
3.	<i>Hevea brasiliensis</i>	11.08
4.	<i>Mangifera indica</i>	6.48
5.	<i>Artocarpus hetrophyllus</i>	5.93

11.14.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.14.21 and table 11.14.22 respectively.

TABLE 11.14.21 Major NTFP species in the State of Kerala

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Hydrocotyle asiatica</i>	Herb	75.12
2.	<i>Solanum nigrum</i>	Herb	12.32
3.	<i>Curucuma zedoria</i>	Herb	5.31
4.	<i>Phyllanthus amarus</i>	Herb	3.86
5.	<i>Ocimum species</i>	Herb	3.38

TABLE 11.14.22 Major invasive species in the State inside the RFA/Green Wash in Kerala (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	773
2.	<i>Lantana camara</i>	185
3.	<i>Ageratum conyzoides</i>	62
4.	<i>Ageratina adenophora</i>	21
5.	<i>Mikania micrantha</i>	8

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.14.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Kerala

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Kerala is given in the table 11.14.23.

TABLE 11.14.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Kerala

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
33,89,705	34,72,044	851	1,00,259

11.15

MADHYA PRADESH

11.15.1 Introduction

Located in Central India, Madhya Pradesh is the second largest State covering an area of 3,08,252 sq km which is 9.38% of the geographical area of the country and is bordered on the west by Gujarat, on the northwest by Rajasthan, on the northeast by Uttar Pradesh, on the east by Chhattisgarh, and on the south by Maharashtra. The State lies between 21°17' N to 26°52' N latitude and 74°08' E to 82°49' E longitudes. Physiographically, the State can be divided into four regions, viz the low lying areas in north and north-west of Gwalior, Malwa Plateau, Satpuda and Vindhyan Ranges. Madhya Pradesh has a subtropical climate. The annual rainfall ranges 800 mm to 1,800 mm and the annual temperature varies from 22°C to 25°C. The State is drained by a number of rivers, which include Narmada, Tapti, Son, Betwa, Shipra and Chambal. The State has 50 districts, of which 21 are tribal districts. The State does not have any hill district. As per the 2011 census, Madhya Pradesh has a population of 72.63 million accounting to 6 percent of India's population. The rural and urban population stands at 72.37% and 27.63% respectively. Tribal population of the State is 21.09%. The population density of the State is 236 per sq km, which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 36.33 million.

TABLE 11.15.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	30,825	
Reporting area for land utilization	30,756	100.00
Forests	8,694	28.27
Not available for land cultivation	3,506	11.40
Permanent pastures and other grazing lands	1,303	4.24
Land under misc. tree crops and groves	20	0.06
Culturable wasteland	1,010	3.29
Fallow land other than current fallows	483	1.57
Current fallows	389	1.26
Net area sown	15,351	49.91

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.15.1.1 A Brief Overview of Forestry Scenario

Madhya Pradesh is a forest rich State and is ranked first among the States in terms of the RFA. The State has a sizeable tribal and rural population which is dependent on the forests for their livelihood and basic needs. As per the Champion & Seth Classification of Forest Types (1968), the forests in Madhya Pradesh belong to five Forest Type Groups, which are further divided into 21 Forest Types. Madhya Pradesh is a pioneering State in the implementation of the Joint Forest Management (JFM) movement in the country. The State has a strong JFM network through 15,228 JFMC/VSS/EDCs covering an area of 66,874 sq km.

In order to provide benefits to forest dwellers in collection and trade of forest produce, the Madhya Pradesh State Minor Forest Produce (Trading & Development) Co-operative Federation was formed in 1984. The Federation co-ordinates collection, processing and marketing of Tendu leaves, Sal Seed, Kullu Gum and other NTFPs through Primary Forest Produce Co-operative Societies. The Madhya Pradesh Raja Van Vikas Nigam Ltd. Undertakes the scientific harvest of forests and its regeneration.

Recorded Forest Area (RFA) in the State is 94,689 sq km of which 61,886 sq km is Reserved Forests, 31,098 sq km is Protected Forests and 1,705 sq km is Unclassed Forests. In Madhya Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 12,785.98 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

As per the information received from the State during that last two years, 85,535 ha of plantations were raised in the State.

Ten National Parks and 25 Wildlife Sanctuaries constitute the Protected Area network of the State covering 3.51% of its geographical area. There are 6 Tiger Reserves in the State covering an area of 6117.26 sq km. Eco-sensitive zones have been declared for 19 protected areas. The State with a population of 526 Tigers, is recognized as Tiger State of India, as per the 'All India Tiger Estimation 2018' released recently.

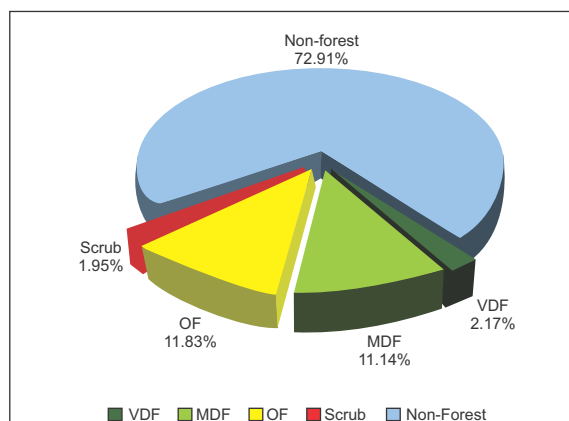
11.15.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to January 2018, the Forest Cover in the State is 77,482.49 sq km which is 25.14 % of the State's geographical area. In terms of forest canopy density classes, the State has 6,676.02 sq km under Very Dense Forest (VDF), 34,341.40 sq km under Moderately Dense Forest (MDF) and 36,465.07 sq km under Open Forest (OF). Forest Cover in the State has increased by 68.49 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.15.2 Forest Cover of Madhya Pradesh

(in sq. km)		
Class	Area	% of GA
VDF	6,676.02	2.17
MDF	34,341.40	11.14
OF	36,465.07	11.83
Total	77,482.49	25.14
Scrub	6,001.91	1.95

FIGURE 11.15.1 Forest Cover of Madhya Pradesh



11.15.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 94,689 sq km which is 30.72% of its geographical area. The reserved, protected and unclassified forests are 65.36%, 32.84% and 1.80% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 88,956.01 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.15.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Madhya Pradesh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
6,259	30,270	28,223	64,752	417	4,071	8,242	12,730
9.66%	46.75%	43.59%		3.28%	31.98%	64.74%	

*in case of Madhya Pradesh RFA boundaries have been used.

FIGURE 11.15.2 Forest Cover inside and outside RFA in Madhya Pradesh

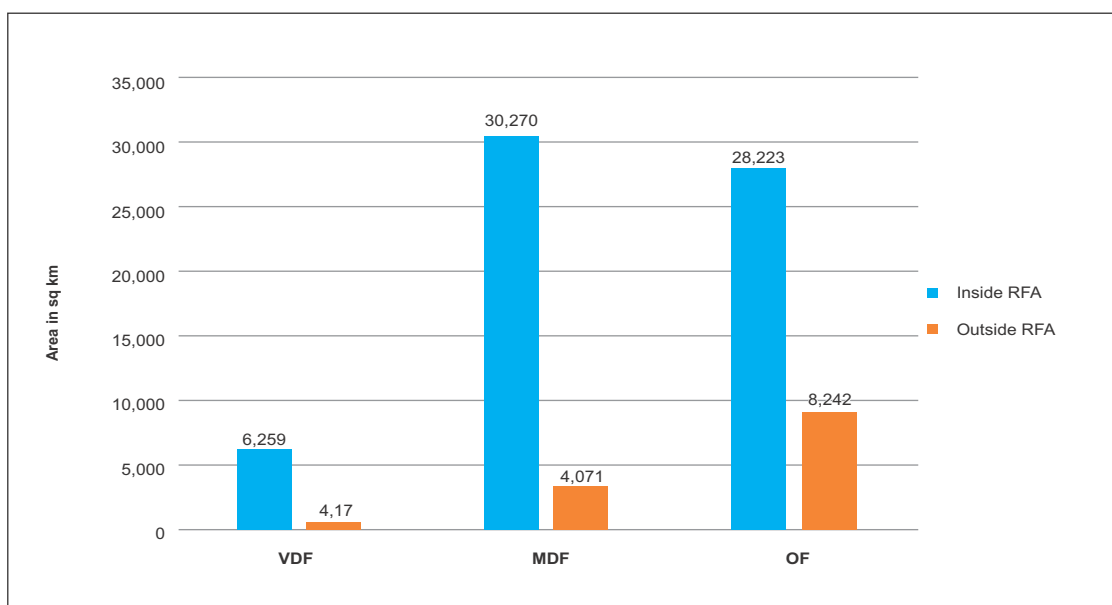


TABLE 11.15.4 District-wise Forest Cover in Madhya Pradesh

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Alirajpur ^T	3,182	0.00	211.82	472.60	684.42	21.51	9.42	30.27
Anuppur ^T	3,747	108.97	345.30	414.41	868.68	23.18	20.68	64.96
Ashoknagar	4,674	0.00	266.08	422.96	689.04	14.74	-10.96	122.85
Balaghat ^T	9,229	1,409.25	2,638.97	883.84	4,932.06	53.44	-1.94	29.71
Barwani ^T	5,427	0.00	186.96	741.03	927.99	17.10	-6.01	36.44
Betul ^T	10,043	230.34	1,938.14	1,495.22	3,663.70	36.48	10.70	167.00
Bhind	4,459	0.00	28.55	78.20	106.75	2.39	-1.25	412.91
Bhopal	2,772	0.00	120.92	207.75	328.67	11.86	-25.33	70.55
Burhanpur	3,427	57.92	631.09	605.55	1,294.56	37.78	-14.44	37.64
Chhatarpur	8,687	184.06	817.52	756.97	1,758.55	20.24	13.55	304.16
Chhindwara ^T	11,815	576.94	2,027.09	1,983.98	4,588.01	38.83	28.01	302.21
Damoh	7,306	2.00	845.79	1,739.39	2,587.18	35.41	-6.82	127.61
Datia	2,902	0.00	92.11	110.17	202.28	6.97	3.28	80.39
Dewas ^T	7,020	12.00	936.85	1,007.02	1,955.87	27.86	39.87	52.00
Dhar ^T	8,153	0.00	116.14	535.11	651.25	7.99	-34.75	90.53
Dindori ^T	7,470	1,086.94	1,281.17	663.85	3,031.96	40.59	4.96	136.92
Guna	6,390	2.00	414.33	913.41	1,329.74	20.81	-22.26	158.55
Gwalior	4,560	1.00	329.23	890.95	1,221.18	26.78	21.18	150.25
Harda ^T	3,334	19.00	527.69	409.57	956.26	28.68	-51.74	3.44
Hoshangabad ^T	6,703	271.89	1,370.32	780.44	2,422.65	36.14	-11.35	10.20
Indore	3,898	0.00	349.08	329.65	678.73	17.41	-0.27	24.25
Jabalpur ^T	5,211	41.00	502.50	570.43	1,113.93	21.38	-25.07	111.82
Jhabua ^T	3,600	0.00	30.97	190.70	221.67	6.16	-7.33	163.17
Katni	4,950	93.90	608.58	658.82	1,361.30	27.50	9.30	41.17
Khandwa (East Nimar) ^T	7,352	147.80	1,156.80	784.52	2,089.12	28.42	57.12	19.61
Khargone (West Nimar) ^T	8,025	1.00	474.50	830.56	1,306.06	16.27	-2.94	64.98
Mandla ^T	5,800	691.31	1,091.05	795.15	2,577.51	44.44	8.51	40.78
Mandsaur	5,535	0.00	40.00	201.59	241.59	4.36	-2.41	111.51
Morena ^T	4,989	0.00	96.18	643.99	740.17	14.84	-1.83	402.24
Narsimhapur	5,133	61.00	657.34	624.42	1,342.76	26.16	4.76	103.52
Neemuch	4,256	0.00	120.64	675.05	795.69	18.70	12.69	385.12
Panna	7,135	83.01	1,478.26	1,181.44	2,742.71	38.44	75.71	193.28
Raisen	8,466	23.00	1,306.51	1,346.75	2,676.26	31.61	-0.74	153.21
Rajgarh	6,153	0.00	37.99	134.10	172.09	2.80	4.09	84.80
Ratlam ^T	4,861	0.00	2.53	57.32	59.85	1.23	4.85	121.98
Rewa	6,314	61.00	386.58	333.57	781.15	12.37	3.15	167.53
Sagar	10,252	1.00	1,141.57	1,651.97	2,794.54	27.26	-19.46	197.17
Satna	7,502	12.00	909.70	831.20	1,752.90	23.37	22.90	196.06
Sehore	6,578	23.90	614.85	719.15	1,357.90	20.64	-46.10	58.74
Seoni ^T	8,758	237.08	1,791.14	1,041.37	3,069.59	35.05	-33.41	73.23

contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Shahdol ^T	6,205	122.00	820.54	1,028.17	1,970.71	31.76	48.71	43.11
Shajapur	6,195	0.00	2.44	60.91	63.35	1.02	17.35	69.06
Sheopur ^T	6,606	6.00	1,395.23	2,058.77	3,460.00	52.38	-26.00	128.96
Shivpuri	10,066	18.00	779.84	1,742.08	2,539.92	25.23	13.92	202.28
Sidhi ^T	4,851	315.99	884.30	768.87	1,969.16	40.59	37.16	90.54
Singrauli ^T	5,675	394.41	1,002.52	783.20	2,180.13	38.42	-8.87	53.98
Tikamgarh	5,048	1.00	89.96	295.68	386.64	7.66	-16.36	132.38
Ujjain	6,091	0.00	2.60	33.62	36.22	0.59	9.22	61.89
Umaria ^T	4,076	378.31	1,096.22	548.05	2,022.58	49.62	-9.42	24.00
Vidisha	7,371	1.00	344.91	431.55	777.46	10.55	-25.54	92.95
Grand Total	3,08,252	6,676.02	34,341.40	36,465.07	77,482.49	25.14	68.49	6,001.91

TABLE 11.15.5 Forest Cover Change Matrix for Madhya Pradesh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	6,553	0	2	0	8	6,563
Moderately Dense Forest	120	34,239	11	2	199	34,571
Open Forest	2	50	35,265	55	908	36,280
Scrub	0	1	207	5,740	331	6,279
Non Forest	1	51	980	205	223,322	224,559
Total ISFR 2019	6,676	34,341	36,465	6,002	224,768	3,08,252
Net Change	113	-230	185	-277	209	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.15.6 Altitude-wise Forest Cover in Madhya Pradesh

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	2,31,982	2,098	21,093	25,636	48,827 (63.02%)	4,866
500-1000	75,712	4,465	13,098	10,739	28,302 (36.53%)	1,129
1000-2000	558	113	150	90	353 (0.45%)	7
Total	3,08,252	6,676	34,341	36,465	77,482	6,002

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.15.7 Forest Cover in different slope classes in Madhya Pradesh

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	265,973	3,346	21,178	25,153	49,677 (64.11%)	4,843
5-10	25,674	1,606	7,037	5,887	14,530 (18.75%)	774
10-15	9,369	906	3,368	2,807	7,081 (9.14%)	248
15-20	4,283	471	1,625	1,484	3,580 (4.62%)	92
20-25	1,884	219	719	716	1,654 (2.14%)	30
25-30	708	86	271	276	633 (0.82%)	9
>30	361	42	143	142	327 (0.42%)	6
Total	3,08,252	6,676	34,341	36,465	77,482	6,002

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.15.3 Forest Cover Map of Madhya Pradesh

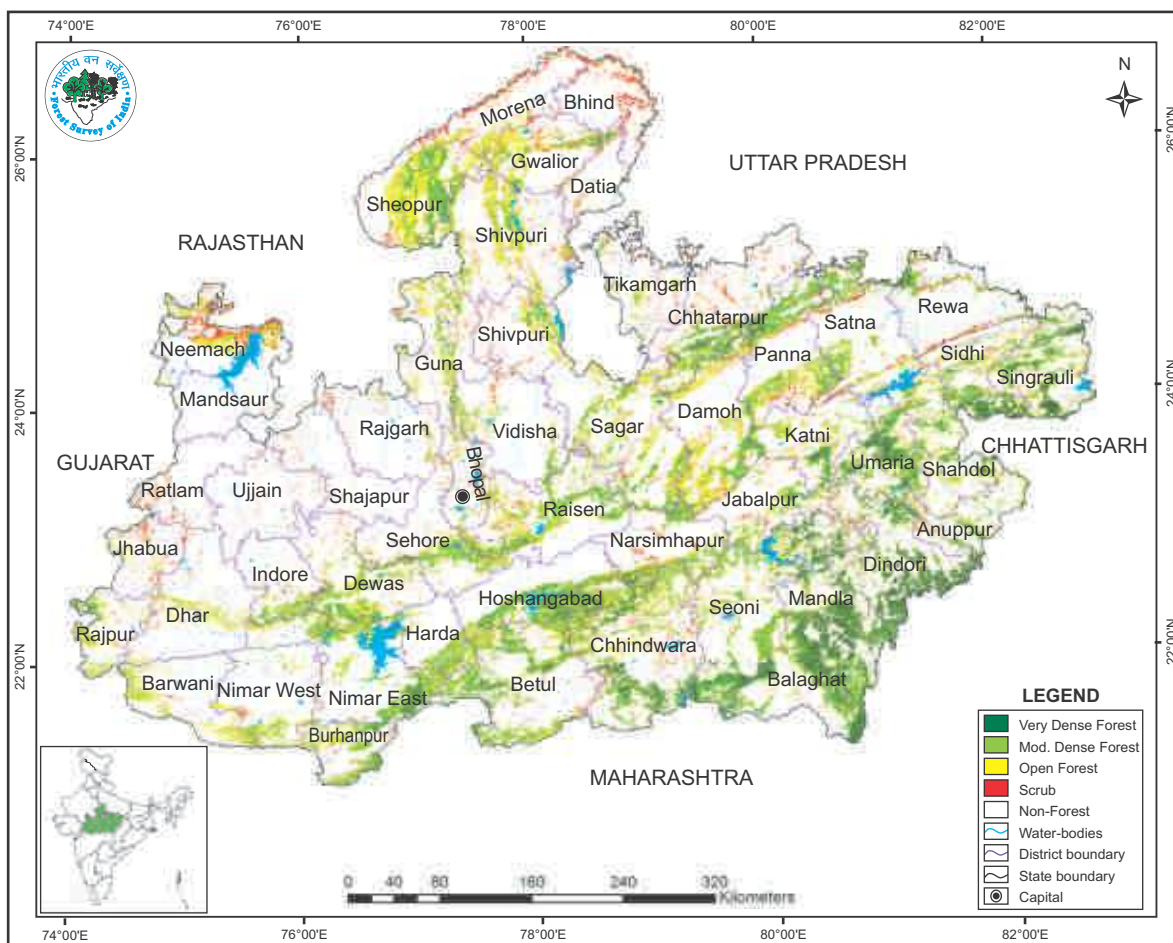


TABLE 11.15.8 Wetlands inside the Recorded Forest Area (or Green wash) in Madhya Pradesh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	9	22
Waterlogged	1	4
River/Stream	239	71,090
Sub - Total	249	71,116
Inland Wetlands - Man-made		
Reservoir/Barrage	636	80,246
Tank/Pond	2,019	5,575
Sub - Total	2,655	85,821
Wetlands (<2.25 ha)	5,636	5,636
Total	8,540	1,62,573
Total Recorded Forest (or Green Wash) Area (in ha)		88,95,601
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.83%

(analysis based on the National Wetland Atlas: India, 2011)

11.15.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Madhya Pradesh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.15.9 Percentage area under different forest types of Madhya Pradesh

Sl.No.	Forest Type	% of Forest cover
1.	3B/C1c Slightly Moist Teak Forest	2.28
2.	3B/C2 Southern Moist Mixed Deciduous Forest	2.29
3.	3C/DS1 Moist Sal Savannah	0.04
4.	3C/C2e (i) Moist Peninsular High Level Sal	3.25
5.	4E/RS1 Riparian Fringing Forest	0.02
6.	5/1S2 Khair-Sissu Forest	1.67
7.	5/E1/DS1 Anogeissus Pendula Scrub	0.39
8.	5/DS1 Dry Deciduous Scrub	8.10
9.	5/DS2 Dry Savannah Forest	0.00
10.	5/DS4 (Dry Grass Land)	0.01
11.	5/E1 Anogeissus Pendula Forest	3.43
12.	5/E2 Boswellia Forest	0.49
13.	5/E5 Butea Forest	0.24
14.	5/E9 Dry Bamboo Brake	0.90
15.	5A/C1a Very Dry Teak Forest	0.86
16.	5A/C1b Dry Teak Forest	26.40
17.	5A/C3 Southern Dry Mixed Deciduous Forest	24.55
18.	5B/C1c Dry Peninsular Sal Forest	5.10
19.	5B/C2 Northern Dry Mixed Deciduous Forest	18.55
20.	6B/C2 Ravine Thorn Forest	0.23
21.	8A/C3 Central Indian Subtropical Hill Forest	0.00
22.	Plantation/TOF	1.20
	Total	100.00

11.15.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.15.10 and table 11.15.11 in respect of Madhya Pradesh

TABLE 11.15.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	146
Shrub	79
Herb	72

TABLE 11.15.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Madhya Pradesh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	2.91	2.55	2.77
2.	Group 4- Littoral & Swamp Forest	0.94	*	*
3.	Group 5- Tropical Dry Deciduous Forests	3.16	1.21	2.60
4.	Group 6- Tropical Thorn Forests	*	2.11	2.35
5.	Group 8- Subtropical Broadleaved Hill Forests	*	2.49	2.09

* adequate number of sample plots were not available

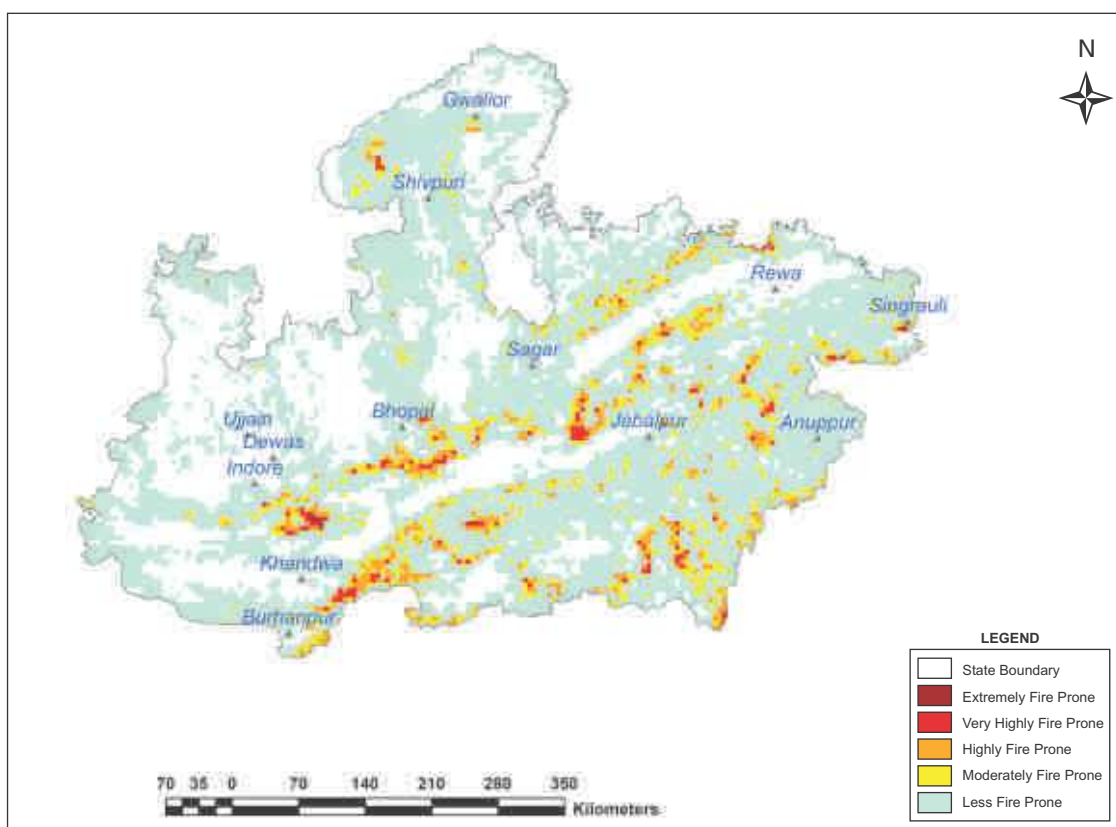
11.15.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in following table.

TABLE 11.15.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geo graphical Area	% of Total forest cover
1.	Extremely fire prone	125.01	0.13
2.	Very highly fire prone	3,118.24	3.79
3.	Highly fire prone	10,598.48	11.87
4.	Moderately fire prone	20,223.12	19.36
5.	Less fire prone	177,471.32	64.85
	Total	2,11,536.17	100.00

FIGURE 11.15.4 Fire prone forest areas under different fire prone classes



11.15.5 Tree Cover

Forest cover presented in the section 11.15.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Madhya Pradesh has been estimated as given in table 11.15.13.

TABLE 11.15.13 Tree Cover in Madhya Pradesh
(in sq km)

Tree Cover	Area
	8,339

Tree cover of Madhya Pradesh has increased by 266 sq km as compared to the previous assessment reported in ISFR 2017

11.15.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.15.14 Extent of TOF in Madhya Pradesh
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
12,730	8,339	21,069

11.15.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Madhya Pradesh is given in the table 11.15.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.15.16

TABLE 11.15.15 Growing Stock in Madhya Pradesh
(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	342.62	8.02
Growing Stock in TOF	106.39	6.48

TABLE 11.15.16 Diameter class distribution of top five species inside RFA in Madhya Pradesh
(in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Tectona grandis</i>	2,62,655	32,563	0
2.	<i>Shorea robusta</i>	97,688	31,724	786
3.	<i>Lagerstroemia parviflora</i>	84,757	4,235	98
4.	<i>Diospyros melanoxylon</i>	81,134	7,287	101
5.	<i>Anogeissus latifolia</i>	73,994	6,515	395

11.15.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1 ha in size is 588.73 million tonnes (2,158.68 million tonnes of CO₂ equivalent) which is 8.26% of total forest carbon of the country. Pool wise forest carbon in Madhya Pradesh is given in the following table

TABLE 11.15.17 Forest Carbon in West Bengal in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,65,067	64,630	1,535	8,156	3,49,339	5,88,727

11.15.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.15.18

TABLE 11.15.18 Growing Stock of Bamboo in Madhya Pradesh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green wash (in sq km)	20,867	13.04
Total number of culms (in millions)	3,595	9.11
Total equivalent green weight (in 000' tonnes)	14,088	5.08

11.15.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Madhya Pradesh in Rural and Urban areas are given in the table 11.15.19 and table 11.15.20 respectively.

TABLE 11.15.19 Top five tree species in TOF (Rural) in Madhya Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Butea frondosa</i>	19.91
2.	<i>Acacia Arabica</i>	12.05
3.	<i>Azadirachta indica</i>	7.67
4.	<i>Zizyphus jujuba</i>	7.43
5.	<i>Tectona grandis</i>	6.30

TABLE 11.15.20 Top five tree species in TOF (Urban) Madhya Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	12.32
2.	<i>Mangifera indica</i>	12.16
3.	<i>Leucaena leucocephala</i>	7.59
4.	<i>Psidium guyava</i>	7.34
5.	<i>Zizyphus jujuba</i>	4.08

11.15.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.15.21 and table 11.15.22 respectively.

TABLE 11.15.21 Major NTFP species in the State of Madhya Pradesh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Calamus longisetus</i>	Shrub	91.77
2.	<i>Corchorus capsularis</i>	Shrub	4.01
3.	<i>Calotropis gigantea</i>	Shrub	1.64
4.	<i>Rizophora mucronata</i>	Shrub	1.39
5.	<i>Calamus flagellum</i>	Shrub	1.19

TABLE 11.15.22 Major invasive species in the State inside the RFA/Green wash in Madhya Pradesh (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	4,416
2.	<i>Cassia tora</i>	2,050
3.	<i>Ageratina adenophora</i>	848
4.	<i>Ageratum conyzoides</i>	679
5.	<i>Senna occidentalis</i>	355

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.15.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Madhya Pradesh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Madhya Pradesh is given in the table 11.15.23

TABLE 11.15.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Madhya Pradesh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
76,63,131	22,27,19,564	6,30,663	14,73,754



11.16

MAHARASHTRA

11.16.1 Introduction

Situated in the western peninsular region of the country, Maharashtra has geographical area of 3,07,713 sq km, which is 9.36% of the geographical area of the country. The State lies between 15°35' N to 22°02' N latitude and 72°36' E to 80°54' E longitude and state is bordered by Gujarat & Madhya Pradesh in the north, Chhattisgarh in the east, Telangana, Karnataka and Goa in the south and Arabian sea on the west. The State has three physiographic zones namely Deccan Plateau, Western Ghats and West Coast. It experiences a tropical monsoon climate with hot, rainy and cold weather seasons and dry summers. The annual rainfall ranges between 400 mm to 6,000 mm and the annual temperature varies from 25°C to 27°C. The State is drained by number of rivers which include Godavari, Bhima, Narmada, Tapi, Koyna and Krishna. The State has 35 districts, amongst which 12 are tribal and 7 are hill districts. As per the 2011 census, Maharashtra has a population of 112.37 million accounting to 9.28% of India's population. The rural and urban population constitutes 54.78% and 45.22% respectively. The tribal population of the State is 9.35%. The population density of the State is 365 per sq km, which is close to the national average. The 19th Livestock census 2012 has reported a total livestock population of 32.48 million in the State.

TABLE 11.16.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	30,771	
Reporting area for land utilization	30,758	100.00
Forests	5,201	16.91
Not available for land cultivation	3,209	10.43
Permanent pastures and other grazing lands	1,249	4.06
Land under misc. tree crops and groves	249	0.81
Culturable wasteland	919	2.99
Fallow land other than current fallows	1,188	3.86
Current fallows	1,399	4.55
Net area sown	17,344	56.39

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.16.1.1 A Brief Overview of Forestry Scenario

Maharashtra, the third largest State in the country is ranked second among the States in terms of the recorded forest area. Western Ghats of the State have very rich biodiversity. As per the Champion & Seth Classification of Forest Types (1968), the forests in Maharashtra belong to six Forest Type Groups which are further divided into 17 Forest Types. The high rural population of the State depends on the forests considerably for livelihood and basic needs. The State forest department encourages the village communities and other stakeholders to participate in plantation activities. Several initiatives have been undertaken by the State Forest Department like training the farming communities; the concept of easy farming through 'Maharashtra Green Tube Channel' wherein the farmers could learn the advance technologies of agriculture and forestry related activities through online media.

In a first of its kind, a 24-hour toll free helpline number 1926 called 'Hello Forest' has been set up to provide information regarding plantations, protection and mass awareness. The Forest Department has created a mobile application called 'My Plants' to record details of the plantations such as numbers, species and location into the Forest Department's data base. To encourage public participation, the SFD has initiated the 'Maharashtra Harit Sena or Green Army, which is a body of dedicated volunteers to participate in the plantation, protection, and related activities.

Recorded Forest Area (RFA) in the State is 61,579 sq km of which 49,546 sq km is Reserved Forests, 6,733 sq km is Protected Forest and 5,300 sq km is Unclassed Forests. In Maharashtra, during the period 1st January 2015 to 5th February 2019, a total of 3797.16 hectares of forestland was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the SFD, a total area of 1,47,814 ha has been notified as reserved forests during 2014 to 2019.

Six National Parks, 48 Wildlife Sanctuaries and 6 Conservation Reserves constitute the Protected Area network of the State covering 3.03% of its geographical area.

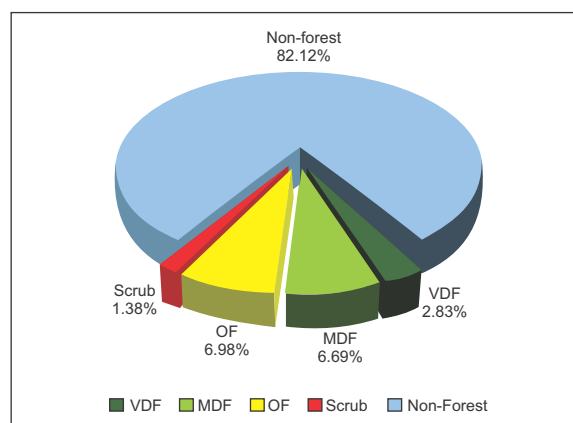
11.16.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Jan 2018, the Forest Cover in the State is 50,777.56 sq km which is 16.50 % of the State's geographical area. In terms of forest canopy density classes, the State has 8,720.53 sq km under Very Dense Forest (VDF), 20,572.35 sq km under Moderately Dense Forest (MDF) and 21,484.68 sq km under Open Forest (OF). Forest Cover in the State has increased by 95.56 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.16.2 Forest Cover of Maharashtra

(in sq km)		
Class	Area	% of GA
VDF	8,720.53	2.83
MDF	20,572.35	6.69
OF	21,484.68	6.98
Total	50,777.56	16.50
Scrub	4,256.49	1.38

FIGURE 11.16.1 Forest Cover of Maharashtra



11.16.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 61,579 sq km which is 20.01% of its geographical area. The reserved, protected and unclassified forests are 80.46%, 10.93% and 8.61% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 56,373.92 sq km and the analysis of forest cover inside and outside this area is depicted below.

TABLE 11.16.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Maharashtra (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
8,200	14,477	11,962	34,639	521	6,095	9,523	16,139
23.67%	41.80%	34.53%		3.23%	37.77%	59.00%	

*in case of Maharashtra RFA boundaries have been used.

FIGURE 11.16.2 Forest Cover inside and outside RFA in Maharashtra

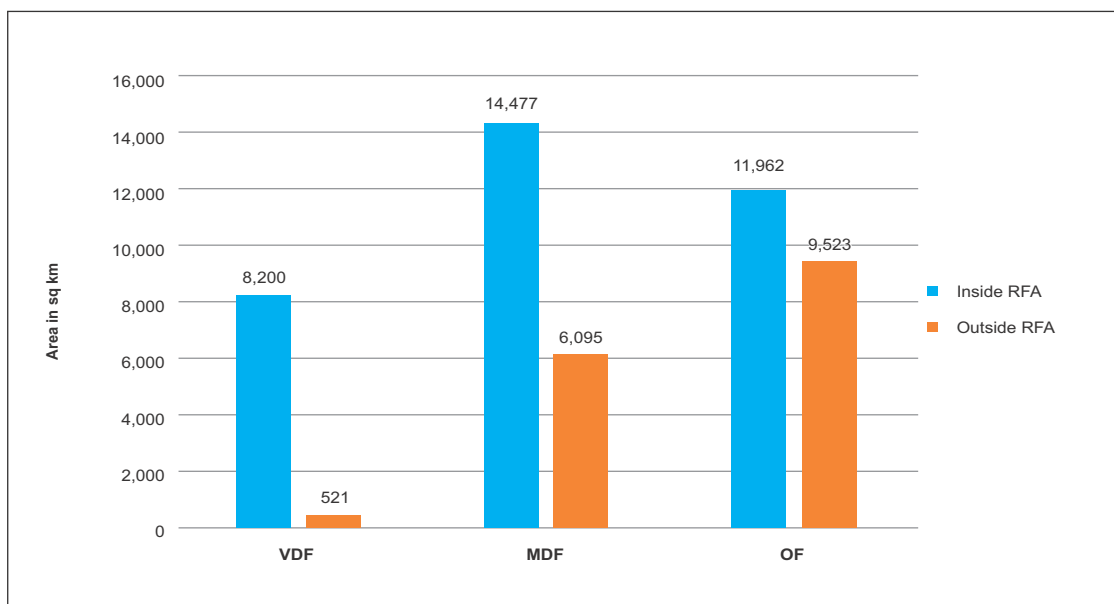


TABLE 11.16.4 District-wise Forest Cover in Maharashtra

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Ahmadnagar ^T	17,048	0.00	68.82	198.07	266.89	1.57	-3.11	557.39
Akola	5,673	11.00	108.44	220.93	340.37	6.00	1.37	16.00
Amravati ^T	12,210	618.89	1,461.53	1,087.35	3,167.77	25.94	-0.23	112.76
Aurangabad	10,131	20.00	106.26	441.67	567.93	5.61	-2.07	171.29
Bhandara	4,087	170.86	563.13	264.93	998.92	24.44	-7.08	18.57
Bid	10,693	0.00	13.00	151.03	164.03	1.53	-10.97	362.79
Buldana	9,661	25.00	143.95	422.65	591.60	6.12	-3.40	162.00
Chandrapur ^T	11,443	1,323.03	1,559.44	1,171.99	4,054.46	35.43	-32.54	44.23
Dhule ^T	7,195	0.00	68.57	232.70	301.27	4.19	-6.73	111.37
Gadchiroli ^T	14,412	4,699.29	3,307.73	1,909.92	9,916.94	68.81	-87.06	24.58
Gondiya	5,234	888.61	732.23	317.75	1,938.59	37.04	15.59	32.25
Hingoli	4,827	0.00	9.00	101.01	110.01	2.28	-0.99	49.23
Jalgaon ^T	11,765	51.00	347.94	747.90	1,146.84	9.75	2.84	94.51
Jalna	7,694	0.00	9.65	26.83	36.48	0.47	-1.52	51.21
Kolhapur ^H	7,685	64.00	1,020.44	701.88	1,786.32	23.24	-9.68	102.83
Latur	7,157	0.00	0.04	12.98	13.02	0.18	1.02	19.67
Mumbai	157	0.00	0.00	3.00	3.00	1.91	0.00	0.00
Mumbai Suburban	446	0.00	67.00	72.86	139.86	31.36	-0.14	0.43
Nagpur ^T	9,892	401.06	902.56	696.76	2,000.38	20.22	-18.62	73.68
Nanded	10,528	58.00	442.91	435.85	936.76	8.90	2.76	123.08
Nandurbar ^T	5,955	0.00	404.15	791.84	1,195.99	20.08	3.99	30.00
Nashik TH	15,530	0.00	346.34	730.21	1,076.55	6.93	8.55	337.66
Osmanabad	7,569	0.00	2.08	47.58	49.66	0.66	2.66	47.43
Parbhani	6,214	0.00	3.57	36.86	40.43	0.65	-7.57	47.78
Pune TH	15,643	0.00	760.93	949.93	1,710.86	10.94	2.86	508.03
Raigarh ^H	7,152	13.00	1,250.34	1,676.12	2,939.46	41.10	22.46	77.60
Ratnagiri ^H	8,208	33.00	1,892.01	2,287.89	4,212.90	51.33	46.90	3.36
Sangli	8,572	0.00	95.00	55.13	150.13	1.75	0.13	171.03
Satara ^H	10,480	117.00	569.68	591.69	1,278.37	12.20	2.37	365.70
Sindhudurg ^H	5,207	88.82	1,391.73	1,347.43	2,827.98	54.31	138.98	32.27
Solapur	14,895	0.00	5.50	44.17	49.67	0.33	1.67	60.72
Thane ^T	9,558	0.00	1,300.11	1,697.98	2,998.09	31.37	35.09	261.07
Wardha	6,309	9.97	410.03	441.95	861.95	13.66	-1.05	55.93
Washim	4,901	5.00	101.89	189.87	296.76	6.06	-2.24	31.65
Yavatmal ^T	13,582	123.00	1,106.35	1,377.97	2,607.32	19.20	1.32	98.39
Total	3,07,713	8,720.53	20,572.35	21,484.68	50,777.56	16.50	95.56	4,256.49

TABLE 11.16.5 Forest Cover Change Matrix for Maharashtra

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	8,719	2	3	0	12	8,736
Moderately Dense Forest	2	20,541	13	4	92	20,652
Open Forest	0	1	20,853	57	383	21,294
Scrub	0	0	13	4,102	45	4,160
Non Forest	0	28	603	93	2,52,147	2,52,871
Total ISFR 2019	8,721	20,572	21,485	4,256	2,52,679	3,07,713
Net Change	-15	-80	191	96	-192	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.16.6 Altitude-wise Forest Cover in Maharashtra

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	2,37,017	7,591	15,456	16,128	39,175 (77.15%)	1,339
500-1000	66,142	1,082	4,733	5,053	10,868 (21.40%)	2,812
1000-2000	4,554	48	383	304	735 (1.45%)	105
Total	3,07,713	8,721	20,572	21,485	50,778	4,256

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.16.7 Forest Cover in different slope classes in Maharashtra

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	2,58,651	6,161	9,322	10,359	25,842 (50.89%)	1,538
5-10	23,811	1,212	3,932	4,376	9,520 (18.75%)	1,043
10-15	11,555	665	2,970	2,923	6,558 (12.92%)	724
15-20	6,633	378	2,045	1,816	4,239 (8.35%)	467
20-25	3,707	184	1,223	1,065	2,472 (4.87%)	275
25-30	1,896	78	637	549	1,264 (2.49%)	138
>30	1,459	43	443	397	883 (1.73%)	71
Total	3,07,713	8,721	20,572	21,485	50,778	4,256

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.16.3 Forest Cover Map of Maharashtra

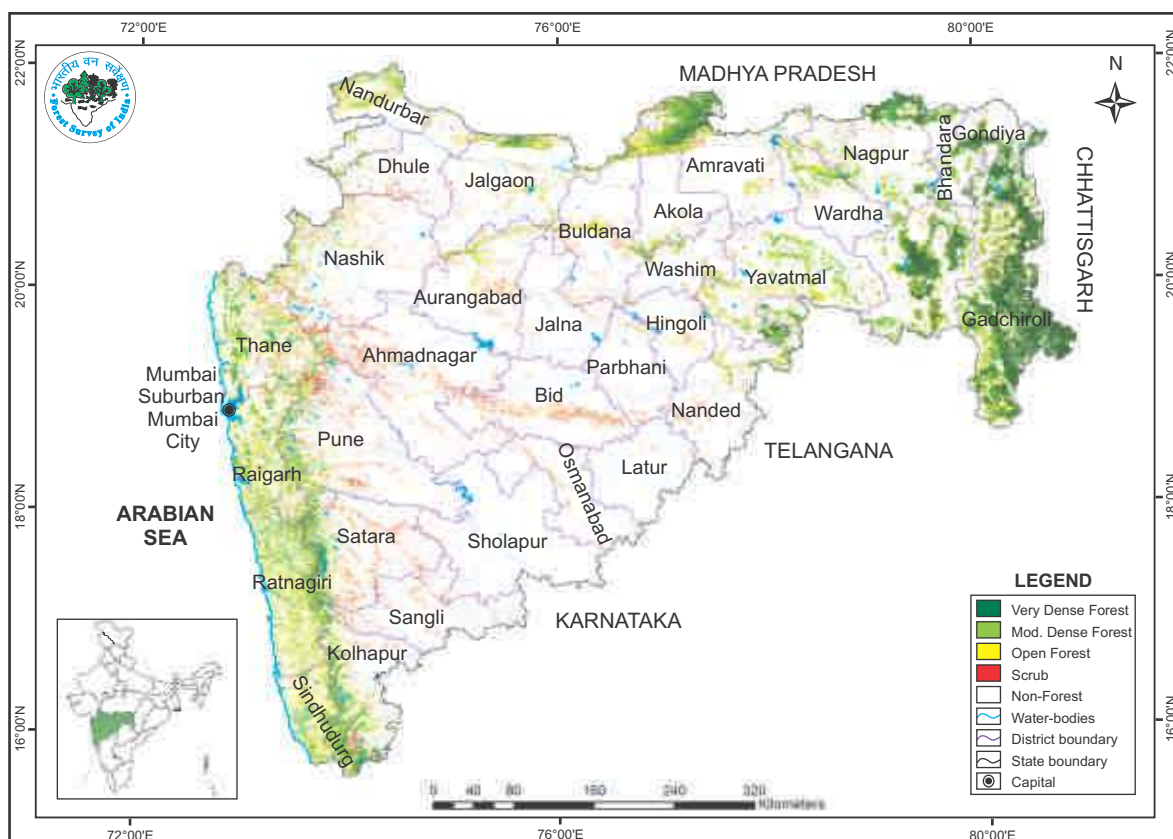


TABLE 11.16.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Maharashtra (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	7	459
Waterlogged	5	37
River/Stream	674	29,451
Sub - Total	686	29,947
Inland Wetlands - Man-made		
Reservoir/Barrage	247	46,610
Tank/Pond	4,008	26,447
Waterlogged	2	2
Sub - Total	4,257	73,062
Coastal Wetlands - Natural		
Creek	54	1,116
Sand/Beach	26	139
Intertidal mud flat	157	1,360
Salt Marsh	18	268
Mangrove	177	7,499
Sub -Total	432	10,382
Wetlands (<2.25 ha)	3,446	3,446
Total	8,821	1,16,837
Total Recorded Forest (or Green Wash) Area (in ha)		56,37,392
% of Wetland area inside Recorded Forest (or Green Wash) Area		2.07%

(analysis based on the National Wetland Atlas: India, 2011)

11.16.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Maharashtra as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.16.9 Percentage area under different forest types of in Maharashtra

Sl.No.	Forest Type	% of Forest cover
1	2A/C2 West Coast Semi-Evergreen Forest	11.87
2	3B/C2 Southern Moist Mixed Deciduous Forest	21.01
3	3B/C1b Moist Teak Forest	10.71
4	4B/TS2 Mangrove Forest	0.50
5	4B/TS1 Mangrove Scrub	0.05
6	4A/L1 Littoral Forest	0.01
7	4E/RS1 Riparian Fringing Forest	0.00
8	5A/C3 Southern Dry Mixed Deciduous Forest	26.30
9	5A/C1b Dry Teak Forest	17.40
10	5/DS1 Dry Deciduous Scrub	7.53
11	5/E9 Dry Bamboo Brake	0.46
12	5/E2 <i>Boswellia</i> Forest	0.12
13	5/E4 <i>Hardwickia</i> Forest	0.11
14	5/E3 Babul Forest	0.03
15	5/E5 <i>Butea</i> Forest	0.02
16	6A/C1 Southern Thorn Forest	0.41
17	8A/C2 Western Sub Tropical Hill Forest	1.19
18	Plantation/ TOF	2.28
	Total	100.00

11.16.3.1 Assessment of Biodiversity in Maharashtra

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.16.10 and table 11.16.11 in respect of Maharashtra.

TABLE 11.16.10 Assessment of Biodiversity in Maharashtra

Plant Type	Number of Species
Tree	170
Shrub	135
Herb	54

TABLE 11.16.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Maharashtra

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	3.38	2.65	2.44
2	Group 3- Tropical Moist Deciduous Forests	3.57	2.60	2.09
3	Group 4- Littoral and Swamp Forests	0.56	0.77	*
4	Group 5- Tropical Dry Deciduous Forests	3.03	2.83	2.76
5	Group 6- Tropical Thorn Forests	1.51	2.51	1.96
6	Group 8- Subtropical Broadleaved Hill Forests	0.78	2.40	1.07

*adequate number of sample plots were not available

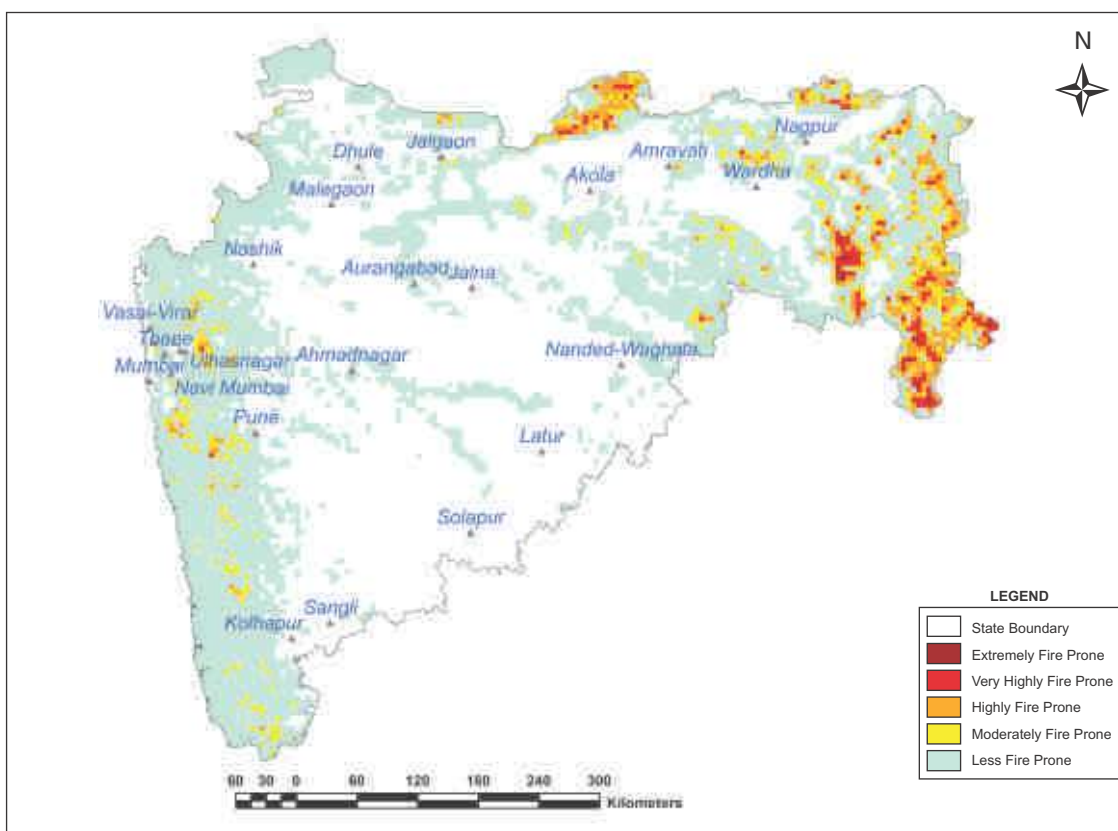
11.16.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.16.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	1,821.51	3.40
2	Very highly fire prone	2,135.42	4.01
3	Highly fire prone	9,191.46	15.60
4	Moderately fire prone	12,902.40	16.65
5	Less fire prone	1,16,890.40	60.34
	Total	1,42,941.19	100.00

FIGURE 11.16.4 Fire prone forest areas under different fire prone classes



11.16.5 Tree Cover

Forest cover presented in the section 11.16.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Maharashtra has been estimated as given in table 11.16.13.

TABLE 11.16.13 Tree Cover in Maharashtra (in sq km)

Tree Cover	Area
	10,806

Tree cover of Maharashtra has increased by 975 sq km as compared to the previous assessment reported in ISFR 2017.

11.16.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.16.14 Extent of TOF in Maharashtra (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
16,139	10,806	26,945

11.16.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Maharashtra is given in the table 11.16.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.16.16

TABLE 11.16.15 Growing Stock in Maharashtra (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	231.76	5.42
Growing Stock in TOF	177.12	10.78

TABLE 11.16.16 Diameter class distribution of top five species inside RFA in Maharashtra (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Tectona grandis</i>	1,87,997	21,226	499
2.	<i>Terminalia tomentosa</i>	96,126	13,731	613
3.	<i>Anogeissus latifolia</i>	47,465	5,928	210
4.	<i>Lannea coromandelica</i>	33,158	6,325	97
5.	<i>Cleistanthus collinus</i>	54,605	1,962	0

11.16.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1ha in size is 440.51 million tonnes (1,615.20 million tonnes of CO₂ equivalent) which is 6.18% of total forest carbon of the country. Pool wise forest carbon in Maharashtra is given in the following table.

TABLE 11.16.17 Forest Carbon in Maharashtra in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,31,249	40,380	1,586	10,687	2,56,606	4,40,508

11.16.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.16.18

TABLE 11.16.18 Growing Stock of Bamboo in Maharashtra

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	15,408	9.63
Total number of culms (in millions)	2,971	7.53
Total equivalent green weight (in 000' tonnes)	26,515	9.55

11.16.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Maharashtra in Rural and Urban areas are given in the table 11.16.19 and table 11.16.20 respectively

TABLE 11.16.19 Top five tree species in TOF (Rural) in Maharashtra

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	19.01
2.	<i>Mangifera indica</i>	8.21
3.	<i>Acacia Arabica</i>	7.86
4.	<i>Terminalia tomentosa</i>	6.89
5.	<i>Zizyphus jujuba</i>	5.78

TABLE 11.16.20 Top five tree species in TOF (Urban) in Maharashtra

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	12.45
2.	<i>Mangifera indica</i>	10.84
3.	<i>Azadirachta indica</i>	8.18
4.	<i>Polyalthia species</i>	3.05
5.	<i>Moringa species</i>	2.96

11.16.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.16.21 and table 11.16.22 respectively.

TABLE 11.16.21 Major NTFP species in the state of Maharashtra

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Calamus longisetus</i>	Shrub	46.40
2.	<i>Butea monosperma</i>	Tree	14.35
3.	<i>Pterocarpus marsupium</i>	Tree	7.20
4.	<i>Acacia catechu</i>	Tree	6.96
5.	<i>Buchanania lanzan</i>	Tree	6.53

TABLE 11.16.22 Major invasive species in the state inside the RFA/Green Wash in Maharashtra (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	1,185
2.	<i>Cassia tora</i>	891
3.	<i>Cyperus rotundus</i>	287
4.	<i>Triumfetta rhomboidea</i>	258
5.	<i>Ageratum conyzoides</i>	145

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.16.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Maharashtra

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Maharashtra is given in the table 11.16.23

TABLE 11.16.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Maharashtra

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
95,39,132	15,71,36,100	1,28,673	8,62,138



11.17

MANIPUR

11.17.1 Introduction

Manipur, a hilly State in northeastern India, lies between latitude 23°50' N to 25°42'N and longitude 92°59' E to 94°46' E, sharing international border with Myanmar on eastern side. Its covering an area of 22,327 sq km, which constitutes 0.68% of the geographical area of the country. Physiographically, Manipur can be characterized in two distinct physical regions – an outlying area of rugged hills and narrow valleys and the inner area of flat plain, with associated land forms. Manipur has a tropical climate with average annual rainfall ranging from 1,200 mm to 2,700mm and the average annual temperature ranging from 14.5°C to 38°C. The State is drained by Imphal and Bara rivers. The state has 9 districts, all of which are hilly as well as tribal. As per the 2011 census, Manipur has a population of 2.86 million of which urban and rural population are 29.20% and 70.80% respectively. The urban population of the state is an increasing trend of last decade mainly in Imphal, the capital of state. The average population density of the state is 115 persons per sq km. The Livestock population of the State as per 19th Livestock Census, 2012 is 0.70 million.

TABLE 11.17.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	2,233	
Reporting area for land utilization	2,117	100.00
Forests	1,699	80.25
Not available for land cultivation	27	1.27
Permanent pastures and other grazing lands	1.37	0.07
Land under misc. tree crops and groves	5.95	0.28
Culturable wasteland	0.74	0.04
Fallow land other than current fallows	0.06	0.00
Current fallows	0.14	0.01
Net area sown	383	18.08

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.17.1.1 A Brief Overview of Forestry Scenario

The State of Manipur is endowed with rich biodiversity with many endemic flora and fauna. As per the Champion & Seth Classification of Forests Types (1968), the forests in Manipur belong to five Forest Type Groups which are further divided into 11 Forest Types. Out of 126 species of bamboos reported in India, 53 species are found in Manipur. Among the trees, Teak, Pine, Oak, Uningthou (*Phoebe* spp.) Leihao (*Michelia* spp.) are the major species. Forests in Manipur are largely under the community and private ownership. Being a predominantly tribal State, lives of rural people residing in hills of the State are dependent on forests in socio-economic and socio-cultural context. Nearly 1,200 species of medicinal plants are reported from the State.

Recorded Forest Area (RFA) in the State is 17,418 sq km of which 1,467 sq km is Reserved Forest, 4,171 sq km is Protected Forest and 11,780 sq km is Unclassified Forests. In Manipur, during the period 1st January 2015 to 5th February 2019, a total of 263.20 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019). As per the information received from the State during that last two years, 11,346 ha of plantations were raised in the State.

One National Park, two Wildlife Sanctuaries and four Community Reserves constitute the Protected Area network of the State covering 1.01% of its geographical area. Loktak Lake is the largest fresh water lake in Eastern India, and has been declared a Ramsar site. The Keibul Lamjao National Park situated on the southern shore of the Loktak Lake is home to the endangered *Rucervus eldii* (brow-antlered deer or Sangai) also known as the dancing deer. *Lilium mackliniae* or Siroi Lily is a rare species that is only found in Manipur's Siroi hill ranges.

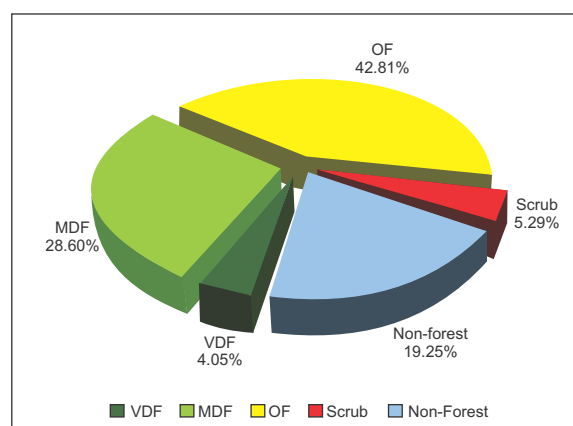
11.17.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Feb 2018, the Forest Cover in the State is 16,846.90 sq km which is 75.46 % of the State's geographical area. In terms of forest canopy density classes, the State has 905.27 sq km under Very Dense Forest (VDF), 6,386.29 sq km under Moderately Dense Forest (MDF) and 9,555.34 sq km under Open Forest (OF). Forest Cover in the State has decreased by 499.10 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.17.2 Forest Cover of Manipur
(in sq. km)

Class	Area	% of GA
VDF	905.27	4.05
MDF	6,386.29	28.60
OF	9,555.34	42.81
Total	16,846.90	75.46
Scrub	1,181.47	5.29

FIGURE 11.17.1 Forest Cover of Manipur



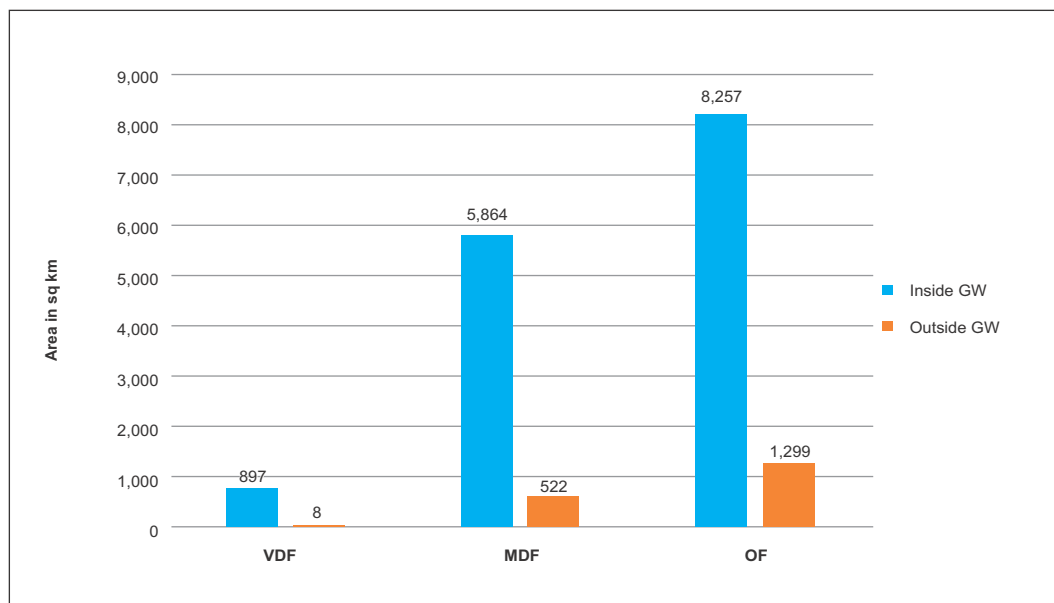
11.17.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 17,418 sq km which is 78.01% of its geographical area. The reserved, protected and unclassified forests are 8.42%, 23.95% and 67.63% respectively of the recorded forest area in the State. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 17,542.42 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.17.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
897	5,864	8,257	15,018	8	522	1,299	1,829
5.97%	39.05%	54.98%		0.44%	28.54%	71.02%	

*in case of Manipur Green Wash boundaries have been used.

FIGURE 11.17.2 Forest Cover inside and outside Green Wash in Manipur

TABLE 11.17.4 District-wise Forest Cover in Manipur (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bishnupur TH	496	0.00	0.99	20.51	21.50	4.33	-0.50	2.00
Chandel TH	3,313	10.76	950.42	1902.17	2,863.35	86.43	-43.65	139.09
Churachandpur TH	4,570	41.92	1,614.50	2,263.09	3,919.51	85.77	-249.49	164.67
Imphal East TH	709	0.00	60.90	213.36	274.26	38.68	-3.74	15.00
Imphal West TH	519	0.00	15.66	36.09	51.75	9.97	-2.25	9.22
Senapati TH	3,271	270.75	744.46	1,121.37	2,136.58	65.32	-47.42	287.56
Tamenglong TH	4,391	388.90	1,726.75	1,728.79	3,844.44	87.55	-108.56	166.67
Thoubal TH	514	0.00	2.00	68.76	70.76	13.77	-2.24	11.14
Ukhrul TH	4,544	192.94	1,270.61	2,201.20	3,664.75	80.65	-41.25	386.12
Grand Total	22,327	905.27	6,386.29	9,555.34	16,846.90	75.46	-499.10	1,181.47

TABLE 11.17.5 Forest Cover Change Matrix for Manipur

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	905	0	0	0	3	908
Moderately Dense Forest	0	6,386	9	2	113	6,510
Open Forest	0	0	9,445	15	468	9,928
Scrub	0	0	1	1,094	16	1,111
Non Forest	0	0	101	70	3,699	3,870
Total ISFR 2019	905	6,386	9,556	1,181	4,299	22,327
Net Change	-3	-124	-372	70	429	

TABLE 11.17.6 Altitude-wise Forest Cover in Manipur

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,303	11	1,012	2,009	3,032 (18.00%)	56
500-1000	9,066	28	2,116	3,709	5,853 (34.74%)	427
1000-2000	9,342	516	3,124	3,752	7,392 (43.88%)	652
2000-3000	616	350	134	86	570 (3.38%)	46
Total	22,327	905	6,386	9,556	16,847	1,181

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.17.7 Forest Cover in different slope classes in Manipur

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	2,934	27	233	516	776 (4.61%)	49
5-10	2,361	86	566	1,098	1,750 (10.39%)	137
10-15	3,630	148	986	1,764	2,898 (17.20%)	234
15-20	4,275	173	1,273	2,104	3,550 (21.07%)	272
20-25	3,902	160	1,274	1,888	3,322 (19.72%)	233
25-30	2,753	128	993	1,260	2,381 (14.13%)	151
>30	2,472	183	1,061	926	2,170 (12.88%)	105
Total	22,327	905	6,386	9,556	16,847	1,181

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.17.3 Forest Cover Map of Manipur

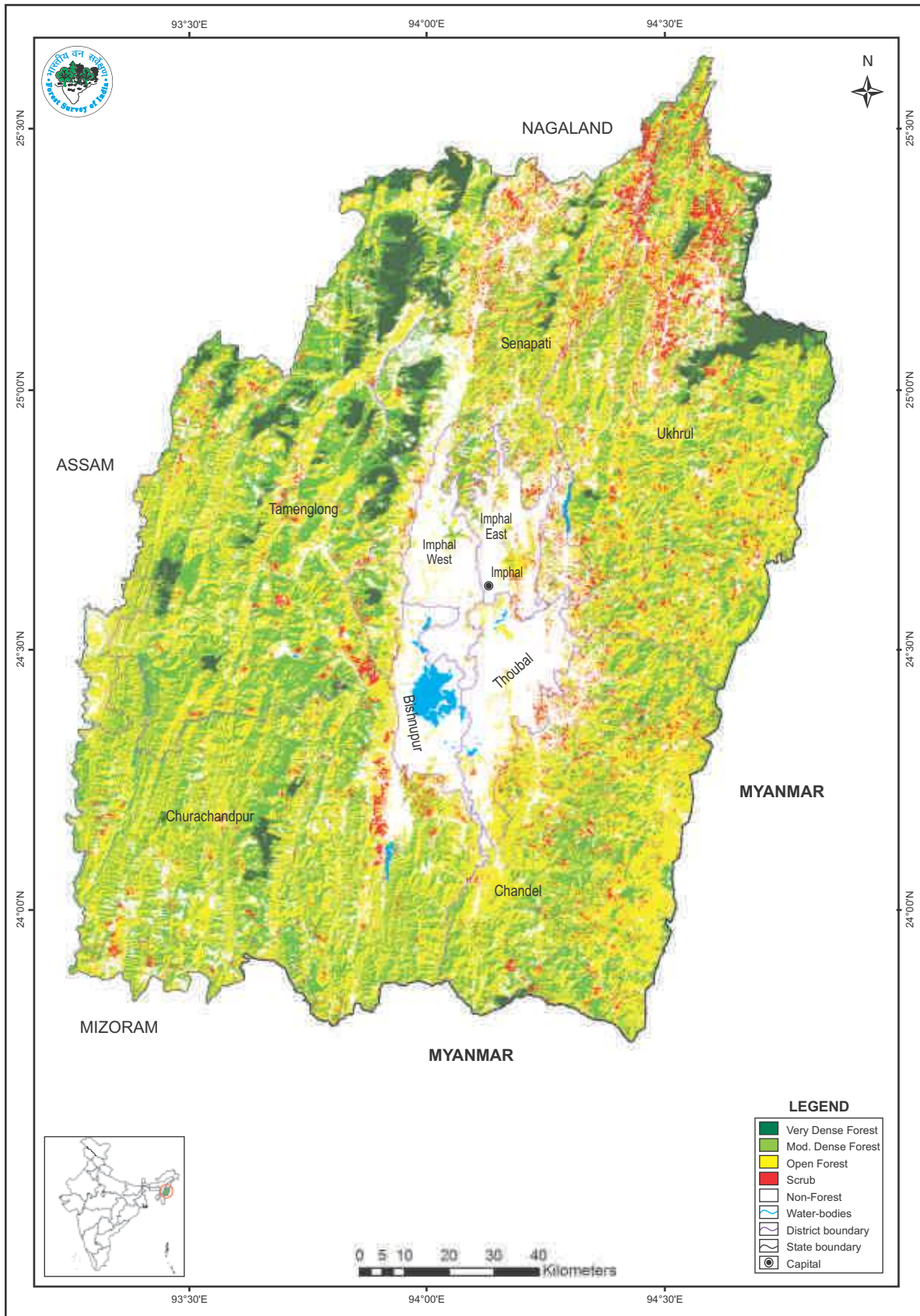


TABLE 11.17.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Manipur (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	4	10
Waterlogged	9	53
River/Stream	13	12,012
Sub - Total	26	12,075
Inland Wetlands - Man-made		
Reservoir/Barrage	3	161
Tank/Pond	6	17
Sub - Total	9	178
Wetlands (<2.25 ha)	171	171
Total	206	12,424
Total Recorded Forest (or Green Wash) Area (in ha)		17,54,242
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.71%

(analysis based on the National Wetland Atlas: India, 2011)

11.17.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Manipur as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.17.9 Percentage area under different forest types of Manipur

Sl. No.	Forest Type	% of Forest cover
1.	2B/C2 Cachar Semi-Evergreen Forest	15.39
2.	2B/2S1 (Pioneer Euphorbiaceous Scrub)	7.49
3.	2/2S1 Secondary Moist Bamboo Brakes	7.47
4.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	24.48
5.	4D/2S2 Eastern Wet Alluvial Grassland	0.72
6.	8B/C1 East Himalayan Sub-Tropical Wet Hill Forest	33.69
7.	8B/C2 Khasi Sub-Tropical Wet Hill Forest	2.37
8.	9/C2 Assam Sub-Tropical Pine Forest	3.54
9.	9/C2/DS1 Assam Subtropical Pine Savannah	0.30
10.	11B/C1b Buk Oak Forest	2.88
11.	11B/C2 Naga Hill Wet Temperate Forest	1.30
12.	12/DS1 Montane Bamboo Brakes	0.06
13.	Plantation/ TOF	0.31
	Total	100.00

11.17.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.17.10 and table 11.17.11 in respect of Manipur.

TABLE 11.17.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	43
Shrub	89
Herb	56

TABLE 11.17.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Manipur

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	2.49	1.56	2.02
2	Group 3- Tropical Moist Deciduous Forests	2.25	2.47	1.15
3	Group 8- Subtropical Broadleaved Hill Forests	2.26	3.71	2.88
4	Group 9- Subtropical Pine Forests	1.12	2.45	1.58
5	Group 11- Montane Wet Temperate Forests	1.48	2.67	1.75

11.17.4 Fire Prone Forest Areas

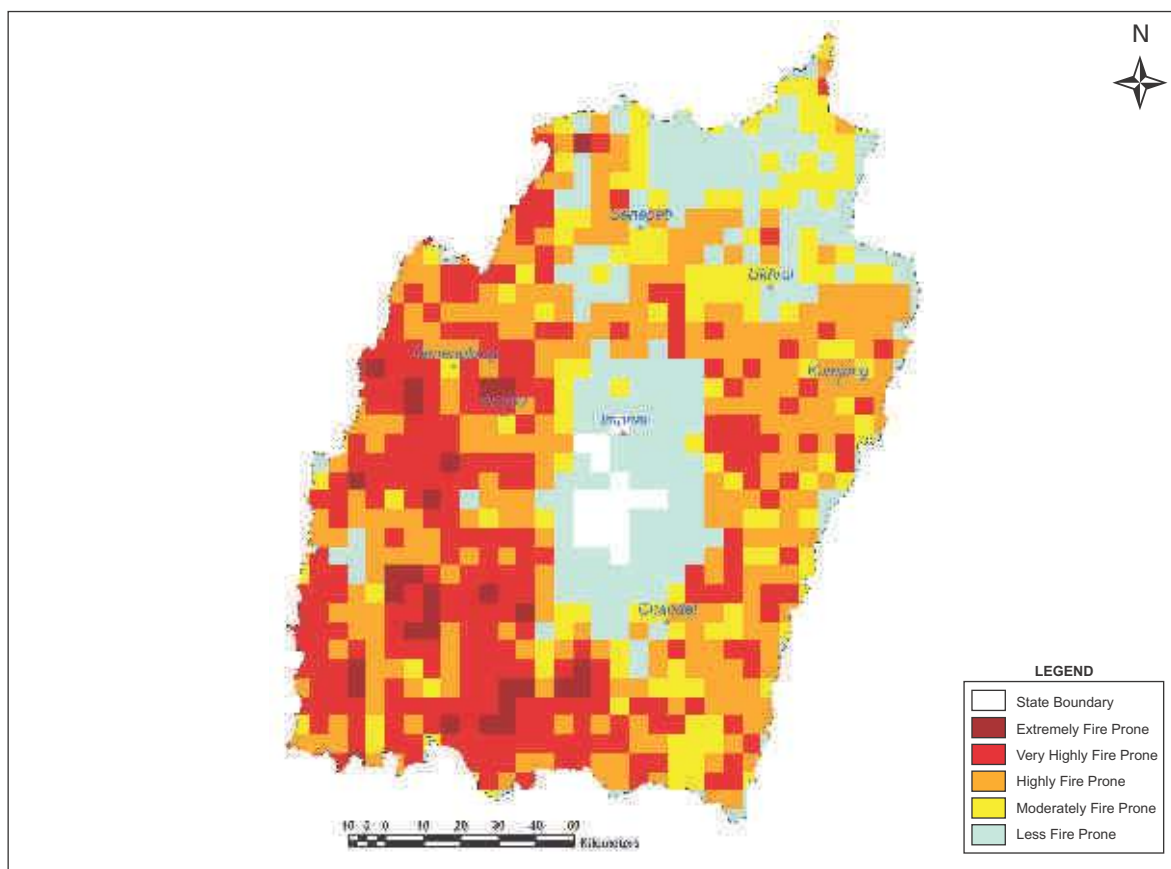
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.17.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	837.76	4.48
2	Very highly fire prone	6,269.58	33.13
3	Highly fire prone	7,008.53	35.85
4	Moderately fire prone	3,381.03	15.36
5	Less fire prone	4,404.59	11.18
	Total	21,901.49	100.00



FIGURE 11.17.4 Fire prone forest areas under different fire prone classes



11.17.5 Tree Cover

Forest cover presented in the section 11.17.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Manipur has been estimated as given in table 11.17.13

TABLE 11.17.13 Tree Cover in Manipur (in sq km)

Tree Cover	Area
	173

Tree cover of Manipur has decreased by 47 sq km as compared to the previous assessment reported in ISFR 2017.

11.17.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.17.14 Extent of TOF in Manipur (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
1,829	173	2,002

11.17.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Manipur is given in the table 11.17.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.17.16

TABLE 11.17.15 Growing Stock in Forest (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	42.03	0.98
Growing Stock in TOF	6.07	0.37

TABLE 11.17.16 Diameter class distribution of top five species inside RFA in Manipur (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Pinus kasya</i>	9,713	2,914	0
2.	<i>Castanopsis species</i>	19,160	0	0
3.	<i>Quercus species</i>	38,152	2,948	0
4.	<i>Schima wallichii</i>	17,686	1,474	0
5.	<i>Ficus species</i>	11,791	4,422	0

11.17.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1ha in size is 178.72 million tonnes (655.31 million tonnes of CO₂ equivalent) which is 2.51% of total forest carbon of the country. Pool wise forest carbon in Manipur is given in the following table

TABLE 11.17.17 Forest Carbon in Manipur in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
44,723	13,317	508	3,924	1,16,251	1,78,723

11.17.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.17.18

TABLE 11.17.18 Growing Stock of Bamboo in Manipur

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	9,903	6.19
Total number of culms (in millions)	1,126	2.85
Total equivalent green weight (in '000' tonnes)	7,754	2.79

11.17.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Manipur in Rural and Urban areas are given in the table 11.17.19 and table 11.17.20 respectively

TABLE 11.17.19 Top five tree species in TOF (Rural) in Manipur

Sl. No.	Species	Relative Abundance (%)
1.	<i>Quercus species</i>	19.81
2.	<i>Castanopsis species</i>	12.12
3.	<i>Pinus kasya</i>	12.05
4.	<i>Schima wallichii</i>	8.66
5.	<i>Albizia species</i>	3.57

TABLE 11.17.20 Top five tree species in TOF (Urban) in Manipur

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	10.86
2.	<i>Eucalyptus species</i>	8.16
3.	<i>Toona ciliate</i>	7.54
4.	<i>Betula cylindrostachys</i>	6.64
5.	<i>Syzygium cumini</i>	5.73

11.17.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.17.21 and table 11.17.22 respectively.

TABLE 11.17.21 Major NTFP species in the State of Manipur

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Diplagium species</i>	Herb	70.77
2.	<i>Thysanolaena maxima</i>	Herb	9.23
3.	<i>Parkia javancia</i>	Tree	9.23
4.	<i>Embilica officinalis</i>	Tree	6.15
5.	<i>Acquillaria mallaccensis</i>	Tree	3.08

TABLE 11.17.22 Major invasive species inside the State with RFA/Green Wash in Manipur (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena naodorata</i>	88
2.	<i>Mikania micrantha</i>	78
3.	<i>Microcystis aeruginosa</i>	15

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.17.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Manipur

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Manipur is given in the table 11.17.23

TABLE 11.17.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Manipur

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
38,909	2,62,086	2,923	8,618

11.18

MEGHALAYA

11.18.1 Introduction

Situated in the North Eastern part of the country, Meghalaya covers an area of 22,429 sq km, which is 0.68% of the geographical area of the country. The State lies between 24°58'N to 26°07'N latitude and 89°48' E to 92°51'E longitude and is bordered by Assam in the north and east and shares international boundary with Bangladesh in the south and west. The State has three distinct regions namely, Garo Hills, Khasi Hills and Jaintia hills. It falls in the high rainfall region and the average annual rainfall is in the range of 4,000 mm to about 11,500 mm. The wettest place on the earth Mawsynram is located in the State. Western part of the State is warmer with mean temperature ranging between 12°C to 33°C. The central upland is relatively cooler with mean temperature ranging between 2°C to 24°C. The State is drained by a number of rivers which include Sanda, Simsang Umngot and Myntdu. The State has 11 districts all of which are tribal and hill districts. As per the 2011 census, Meghalaya has a population of 2.96 million accounting to 0.24% of India's population. The rural and urban population constitute 79.93% and 20.07% respectively. The population density of the State is 132 per sq km which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 1.95 million in the State.

TABLE 11.18.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	2,243	
Reporting area for land utilization	2,242	100.00
Forests	946	42.20
Not available for Land Cultivation	240	10.69
Permanent pastures & other grazing lands	-	-
Land under misc. tree crops and groves	165	7.36
Culturable wasteland	390	17.38
Fallow lands other than current fallows	155	6.91
Current fallows	60	2.69
Net area Sown	286	12.77

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.18.1.1 A Brief Overview of Forestry Scenario

Meghalaya is a forest rich State. Being a predominantly tribal State, lives of rural people are significantly dependent on forests in socio-economic and socio-cultural contexts. Unlike other States, forests in Meghalaya are largely under the community and private ownership. Only 1,113 sq km of forests, in Reserved Forests, Protected Forests, National Parks and Sanctuaries are under the direct control of the State Forest Department. Community and private forests are under the administrative control of the three Autonomies District Councils viz Khasi Hills, Jaintia Hills and Garo Hills. Shifting cultivation is still prevalent in the State. According to the official communication received from the State, extent of forest area diverted for non-forestry purposes under the FC Act, 1980 in the last five years i.e. from 2014-15 to 2018-19 is 178.7 ha. The SFD has raised 2,982 ha of plantations in the same period. The State in the year 2012 has promulgated an Act defining forest. According to the Act, 'Forest' has been defined as a compact and continuous tract of minimum 4 ha land, irrespective of ownership and where more than 250 naturally growing trees per ha of 15 cm and higher diameter at breast height (DBH) over bark are present or more than 100 naturally growing bamboo clumps per ha are present. Two National Parks, four Wildlife Sanctuaries and 65 Community Reserves constitute the Protected Area network of the State covering 2.22% of its geographical area.

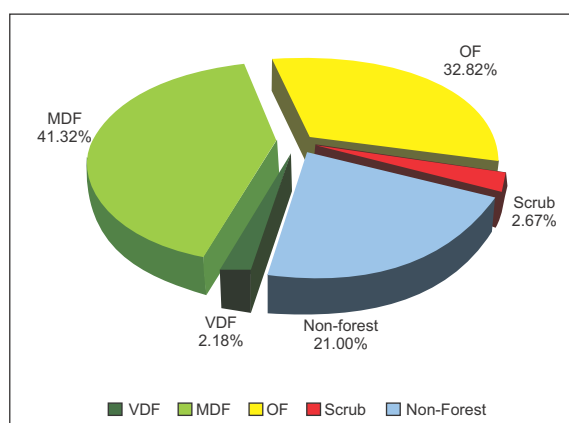
11.18.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Jan 2018, the Forest Cover in the State is 17,118.79 sq km which is 76.32 % of the State's geographical area. In terms of forest canopy density classes, the State has 488.98 sq km under Very Dense Forest (VDF), 9,267.29 sq km under Moderately Dense Forest (MDF) and 7,362.52 sq km under Open Forest (OF). Forest Cover in the State has decreased by 27.21 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.18.2 Forest Cover of Meghalaya
(in sq. km)

Class	Area	% of GA
VDF	488.98	2.18
MDF	9,267.29	41.32
OF	7,362.52	32.82
Total	17,118.79	76.32
Scrub	599.83	2.67

FIGURE 11.18.1 Forest Cover of Meghalaya



11.18.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 9,496 sq km which is 42.34% of its geographical area. The reserved, protected and unclassified forests are 11.72%, 0.13% and 88.15% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 17,563.20 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.18.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
442	7,743	6,659	14,844	47	1,524	704	2,275
2.98%	52.16%	44.86%		2.05%	67.01%	30.94%	

*in case of Meghalaya Green Wash boundaries have been used.

FIGURE 11.18.2 Forest Cover inside and outside Green Wash in Meghalaya

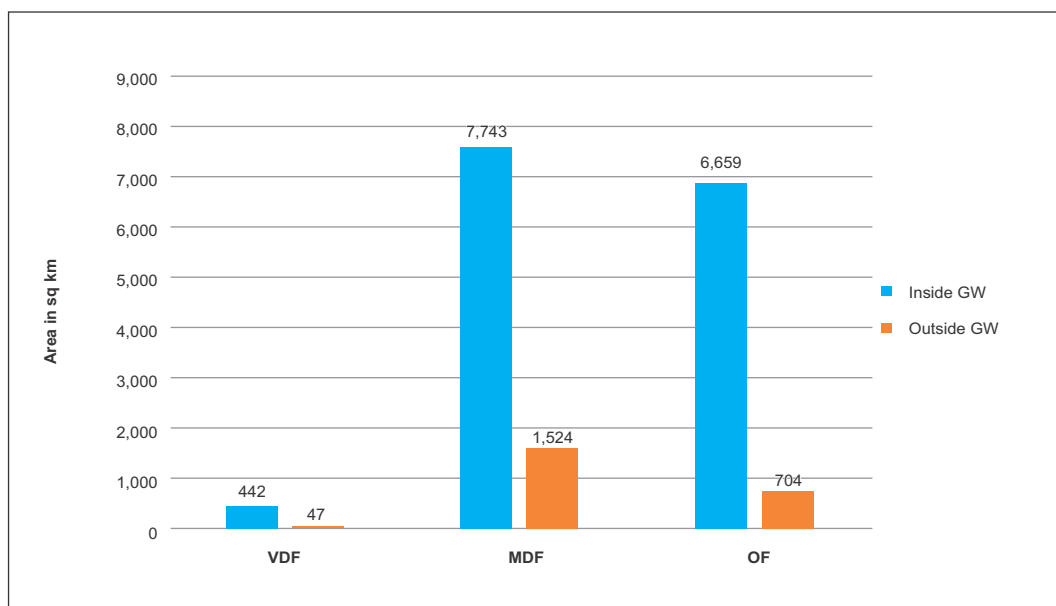


TABLE 11.18.4 District-wise Forest Cover in Meghalaya (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
East Garo Hills TH	2,603	62.73	1,085.89	1,139.34	2,287.96	87.90	21.96	60.73
East Khasi Hills TH	2,748	19.39	969.24	723.56	1,712.19	62.31	-38.81	109.73
Jaintia Hills TH	3,819	103.31	1,448.69	985.89	2,537.89	66.45	34.89	104.59
Ribhoi TH	2,448	127.36	1,097.30	912.68	2,137.34	87.31	-5.66	51.16
South Garo Hills TH	1,887	65.39	990.45	646.36	1,702.20	90.21	14.20	17.68
West Garo Hills TH	3,677	0.00	1,260.41	1,599.81	2,860.22	77.79	23.22	70.64
West Khasi Hills TH	5,247	110.80	2,415.31	1,354.88	3,880.99	73.97	-77.01	185.30
Grand Total	22,429	488.98	9,267.29	7,362.52	17,118.79	76.32	-27.21	599.83



TABLE 11.18.5 Forest Cover Change Matrix for Meghalaya

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	438	13	1	0	1	453
Moderately Dense Forest	50	9,202	27	7	100	9,386
Open Forest	0	3	7,095	47	162	7,307
Scrub	0	0	22	453	30	505
Non Forest	1	49	218	93	4,417	4,778
Total ISFR 2019	489	9,267	7,363	600	4,710	22,429
Net Change	36	-119	56	95	-68	

TABLE 11.18.6 Altitude-wise Forest Cover in Meghalaya

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	10,152	272	4,264	4,091	8,6270 (50.39%)	197
500-1000	6,239	182	2,704	2,312	5,198 (30.37%)	291
1000-2000	6,038	35	2,299	960	3,294 (19.24%)	112
Total	22,429	489	9,267	7,363	17,119	600

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.18.7 Forest Cover in different slope classes in Meghalaya

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	6,169	120	1,925	1,629	3,674 (21.46%)	122
5-10	6,115	0	2,489	2,115	4,604 (26.89%)	146
10-15	4,403	114	1,985	1,612	3,711 (21.68%)	115
15-20	2,670	96	1,292	967	2,355 (13.76%)	78
20-25	1,488	71	759	517	1,347 (7.87%)	53
25-30	806	45	420	271	736 (4.30%)	37
>30	778	43	397	252	692 (4.04%)	49
Total	22,429	489	9,267	7,363	17,119	600

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.18.3 Forest Cover Map of Meghalaya

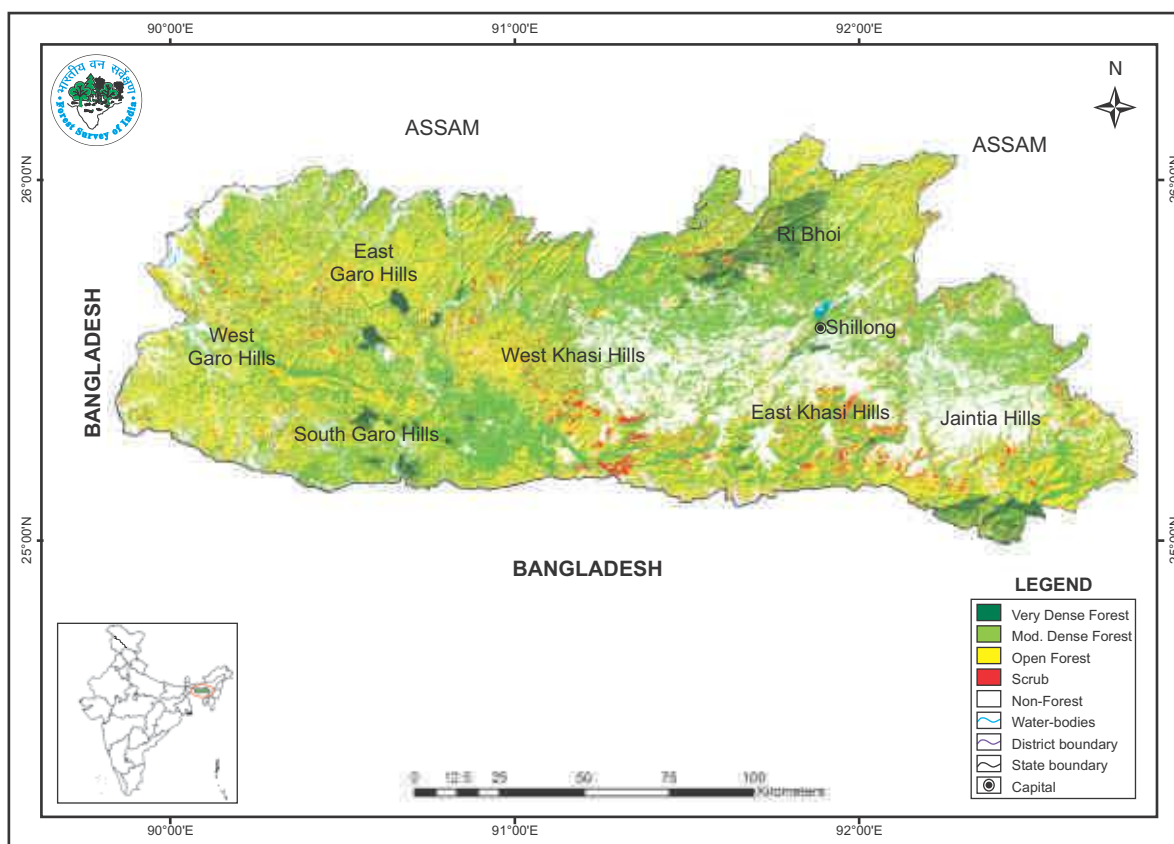


TABLE 11.18.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Meghalaya (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	11	87
Riverine wetland	4	278
Waterlogged	31	137
River/Stream	92	20,125
Sub - Total	138	20,627
Inland Wetlands -Man-made		
Reservoir/Barrage	8	677
Tank/Pond	23	91
Waterlogged	1	1
Sub - Total	32	769
Wetlands (<2.25 ha)	74	74
Total	244	21,470
Total Recorded Forest (or Green Wash) Area (in ha)		17,56,320
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.22%

(analysis based on the National Wetland Atlas: India, 2011)

11.18.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Meghalaya as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.18.9 Percentage area under different forest types of Meghalaya

Sl. No.	Forest Type	% of Forest cover
1.	1B/C3 Cachar Tropical Evergreen Forest	8.52
2.	1/2S1 Pioneer Euphorbiaceous Scrub	2.95
3.	2B/C1a Assam Alluvial Plains Semi-Evergreen Forest	0.72
4.	2/2S1 Secondary Moist Bamboo Brakes	2.13
5.	3C/C1a (ii) Khasi hill Sal	6.81
6.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	47.73
7.	8B/C2 Khasi Sub-Tropical Wet Hill Forest	20.43
8.	9/C2 Assam Sub-Tropical Pine Forest	6.99
9.	9/C2/DS1 Assam sub-tropical pine savannah	1.30
10.	Plantation/TOF	2.42
	Total	100.00

11.18.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.18.10 and table 11.18.11 in respect of Meghalaya.

TABLE 11.18.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	93
Shrub	176
Herb	42

TABLE 11.18.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Meghalaya

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	2.79	3.54	2.17
2.	Group 2- Tropical Semi-Evergreen Forests	1.95	3.10	0.59
3.	Group 3- Tropical Moist Deciduous Forests	3.06	3.94	1.19
4.	Group 8- Subtropical Broadleaved Hill Forests	1.76	3.66	1.86
5.	Group 9- Subtropical Pine Forests	2.01	2.36	2.59

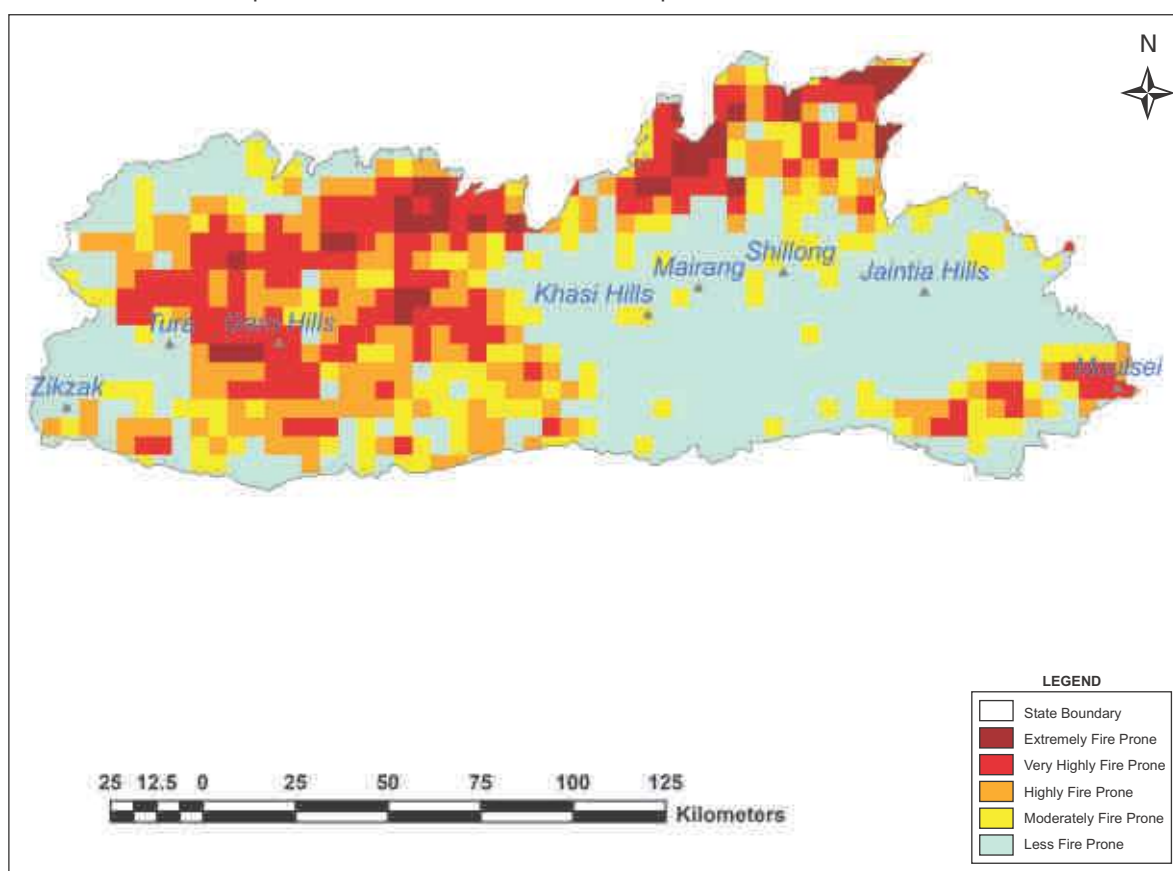
11.18.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.18.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	1,085.11	5.74
2.	Very highly fire prone	3,479.43	18.38
3.	Highly fire prone	3,958.67	20.13
4.	Moderately fire prone	3,741.04	17.77
5.	Less fire prone	10,151.34	37.98
	Total	22,415.59	100.00

FIGURE 11.18.4 Fire prone forest areas under different fire prone classes



11.18.5 Tree Cover

Forest cover presented in the section 11.18.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Meghalaya has been estimated as given in table 11.18.13.

TABLE 11.18.13 Tree Cover in Meghalaya (in sq km)

Tree Cover	Area
	710

Tree cover of Meghalaya has increased by 53 sq km as compared to the previous assessment reported in ISFR 2017.

11.18.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based methodology. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.18.14 Extent of TOF in Meghalaya (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
2,275	710	2,985

11.18.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Meghalaya is given in the table 11.18.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.18.16

TABLE 11.18.15 Growing Stock in Meghalaya (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	31.28	0.73
Growing Stock in TOF	18.84	1.15

TABLE 11.18.16 Diameter class distribution of top five species inside RFA in Meghalaya (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Schima wallichii</i>	26,279	2,362	90
2.	<i>Pinus kasya</i>	13,510	3,170	262
3.	<i>Areca catechu</i>	19,248	0	0
4.	<i>Macaranga species</i>	5,623	179	0
5.	<i>Callicarpa arborea</i>	6,083	0	0

11.18.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1 ha in size is 180.97 million tonnes (663.56 million tonnes of CO₂ equivalent) which is 2.54% of total forest carbon of the country. Pool wise forest carbon in Meghalaya is given in the following table

TABLE 11.18.17 Forest Carbon in Meghalaya in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
52,302	14,963	731	4,328	1,08,642	1,80,966

11.18.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.18.18

TABLE 11.18.18 Growing Stock of Bamboo in Meghalaya

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	5,410	3.38
Total number of culms (in millions)	1,521	3.86
Total equivalent green weight (in '000' tonnes)	12,323	4.44

11.18.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Meghalaya in Rural and Urban areas are given in the table 11.18.19 and table 11.18.20 respectively

TABLE 11.18.19 Top five tree species in TOF (Rural) in Meghalaya

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus kasya</i>	36.73
2.	<i>Schima wallichii</i>	17.44
3.	<i>Areca catechu</i>	10.34
4.	<i>Castanopsis species</i>	4.34
5.	<i>Erythrina species</i>	1.41

TABLE 11.18.20 Top five tree species in TOF (Urban) in Meghalaya

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus kasya</i>	66.88
2.	<i>Areca catechu</i>	3.87
3.	<i>Shorea robusta</i>	2.58
4.	<i>Pyrus communis</i>	2.27
5.	<i>Schima wallichii</i>	1.74

11.18.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.18.21 and table 11.18.22 respectively

TABLE 11.18.21 Major NTFP species in the State of Meghalaya

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Terminalia belerica</i>	Tree	24.74
2.	<i>Careya arborea</i>	Tree	17.53
3.	<i>Bauhinia variegata</i>	Tree	17.53
4.	<i>Embilica officirvalis</i>	Tree	15.46
5.	<i>Cinnamomum tamala</i>	Tree	11.34

TABLE 11.18.22 Major invasive species inside the State of Meghalaya with RFA/Green Wash (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	135
2.	<i>Mikania micrantha</i>	39
3.	<i>Lantana camara</i>	39
4.	<i>Microcystis aeruginosa</i>	1

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.18.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Meghalaya

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Meghalaya is given in the table 11.18.23

TABLE 11.18.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Meghalaya

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
93,381	2,20,307	898	5,821

11.19

MIZORAM

11.19.1 Introduction

Situated in the North Eastern part of India, Mizoram covers geographical area of 21,081 sq km, which is 0.64% of the geographical area of the country. The State lies between 21°56'N to 24°31'N latitude and 92°16'E to 93°26'E longitude and shares borders with Tripura in the west, Assam and Manipur in the north. Mizoram also shares international border with Myanmar on the east and Bangladesh in the south and west. Physiographically, the State is comprised of rugged, steep hill ranges and interspersed valleys. The State has a climate ranging from moist tropical to moist sub-tropical. The annual rainfall ranges between 2,100 mm to 3,500 mm and the annual temperature during winter, 11°C to 24°C and in summer between 18°C to 29°C. It rains heavily from May to September. The State has 8 districts, all of which are tribal and hill districts. As per the 2011 census, Mizoram has a population of 1.09 million which is 0.09% of India's population. The rural and urban population constitute 47.89% and 52.11% respectively. The tribal population of the State is 94.43%. The population density of the State is 52 per sq km which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 0.31 million.

TABLE 11.19.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	2,108	
Reporting area for land utilization	2,039	100.00
Forests	1,585	77.75
Not available for land cultivation	75	3.69
Permanent pastures and other grazing lands	11	0.54
Land under misc. tree crops and groves	41	2.03
Culturable wasteland	8	0.37
Fallow land other than current fallows	127	6.24
Current fallows	47	2.28
Net area sown	145	7.10

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.19.1.1 A Brief Overview of Forestry Scenario

The State has rich flora and fauna including many rare and endemic species of plants and animals. Amongst all the States, Mizoram has the highest area under forest cover in terms of percentage of geographical area. The forests of the State are under a three tier management viz those owned and controlled by the State, district councils and village councils.

As per the Champion & Seth Classification of Forest Types (1968), the forests in Mizoram belong to four Type Groups, which are further divided into six Forest Types. Tropical wet-evergreen forests of the State have valuable species in the top canopy such as *Dipterocarpus turbinatus*, *Artocarpus chaplasha*, *Terminalia myriocarpa*, *Amoora wallichii*, *Michelia champaca*, *Mesua ferrea* etc. Bamboos occur abundantly in the middle and lower stories in the evergreen forest type, Canes are also present in this type of forest. 27 species of bamboo are reported from the State.

The eastern fringes of the State bordering Chin Hills of Myanmar are higher in elevation and fall under Montane subtropical pine forests. This area is relatively cooler and experiences less annual precipitation. The common species of montane sub-tropical pine forests include *Pinus kesiya*, *Quercus* spp, *Castanopsis* spp, *Schima wallichii*, *Rhododendron arboreum*, *Rhus semialata* etc. Mizoram is one of the leading producers of bamboo in India supplying 14% of the country's commercial bamboo.

Recorded Forest Area (RFA) in the State is 5,641 sq km of which 4,483 sq km is Reserved Forest and 1,158 sq km is Unclassed Forests. In Mizoram, during the period 1st January 2015 to 5th February 2019, a total of 0.24 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Two National Parks and eight Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.89% of its geographical area.

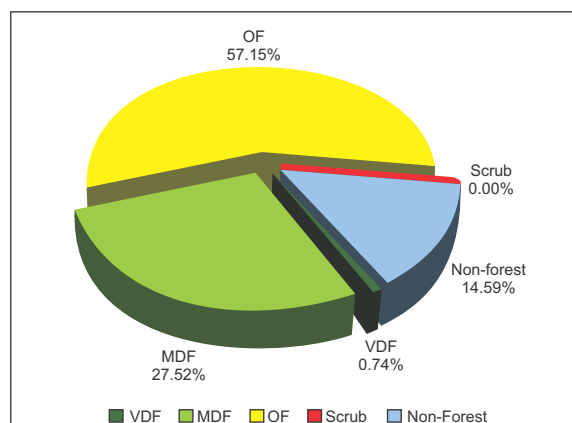
11.19.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Dec 2017 to February 2018, the Forest Cover in the State is 18,005.51 sq km which is 85.41% of the State's geographical area. In terms of forest canopy density classes, the State has 157.05 sq km under Very Dense Forest (VDF), 5,800.75 sq km under Moderately Dense Forest (MDF) and 12,047.71 sq km under Open Forest (OF). Forest Cover in the State has decreased by 180.49 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.19.2 Forest Cover of Mizoram
(in sq. km)

Class	Area	% of GA
VDF	157.05	0.74
MDF	5,800.75	27.52
OF	12,047.71	57.15
Total	18,005.51	85.41
Scrub	0.90	0.00

FIGURE 11.19.1 Forest Cover of Mizoram



11.19.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 5,641 sq km which is 26.76% of its geographical area. The reserved and unclassed forests are 79.47% and 20.53 % of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 20,662.83 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.19.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
156	5,708	11,872	17,736	1	93	176	270
0.88%	32.18%	66.94%		0.37%	34.39%	65.24%	

*in case of Mizoram Green Wash boundaries have been used.

FIGURE 11.19.2 Forest Cover inside and outside Green Wash in Mizoram

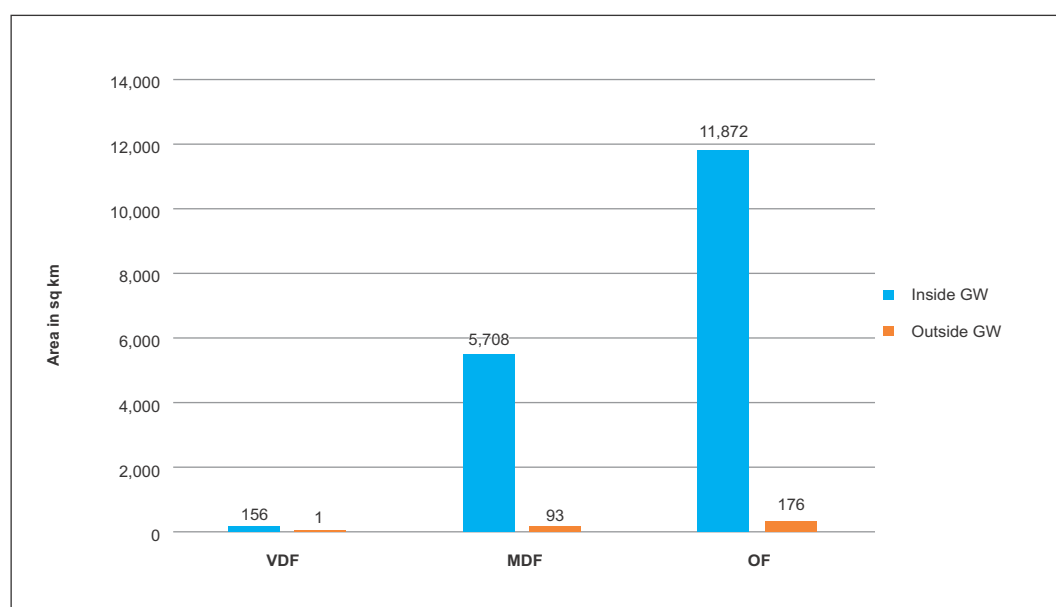


TABLE 11.19.4 District-wise Forest Cover in Mizoram (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Aizawl TH	3,576	30.30	1,071.37	1,977.24	3,078.91	86.10	-15.09	0.03
Champhai TH	3,185	55.62	1,003.68	1,428.49	2,487.79	78.09	-115.21	0.11
Kolasib TH	1,382	1.24	168.37	982.94	1,152.55	83.40	-29.45	0.00
Lawngtlai TH	2,557	0.00	703.59	1,496.49	2,200.08	86.04	-21.92	0.07
Lunglei TH	4,536	0.99	1,190.13	2,831.05	4,022.17	88.67	0.17	0.69
Mamit TH	3,025	52.02	757.80	1,907.05	2,716.87	89.81	16.87	0.00
Saiha TH	1,399	0.00	545.11	640.38	1,185.49	84.74	-19.51	0.00
Serchhip TH	1,421	16.88	360.70	784.07	1,161.65	81.75	3.65	0.00
Grand Total	21,081	157.05	5,800.75	12,047.71	18,005.51	85.41	-180.49	0.90

TABLE 11.19.5 Forest Cover Change Matrix for Mizoram

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	130	0	0	0	1	131
Moderately Dense Forest	24	5,784	3	0	50	5,861
Open Forest	3	6	11,768	0	417	12,194
Scrub	0	0	0	0	0	0
Non Forest	0	11	277	1	2,606	2,895
Total ISFR 2019	157	5,801	12,048	1	3,074	21,081
Net Change	26	-60	-146	1	179	

Main reasons for the decrease in forest cover in the State are shifting cultivation and development activities.

TABLE 11.19.6 Altitude-wise Forest Cover in Mizoram

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	9,163	8	1,822	6,197	8,027 (44.58 %)	0
500-1000	8,205	55	2,676	4,297	7,028 (39.03 %)	1
1000-2000	3,710	93	1,302	1,554	2,949 (16.38 %)	0
2000-3000	3	1	1	0	2 (0.01 %)	0
Total	21,081	157	5,801	12,048	18,006	1

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.19.7 Forest Cover in different slope classes in Mizoram

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,565	7	238	898	1,143 (6.35%)	0
5-10	2,668	22	568	1,591	2,181 (12.11%)	0
10-15	3,625	34	892	2,134	3,060 (17.00%)	0
15-20	4,058	31	1,108	2,358	3,497 (19.42%)	1
20-25	3,713	23	1,112	2,116	3,251 (18.06%)	0
25-30	2,745	16	887	1,534	2,437 (13.53%)	0
>30	2,707	24	996	1,417	2,437 (13.53%)	0
Total	21,081	157	5,801	12,048	18,006	1

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.19.3 Forest Cover Map of Mizoram

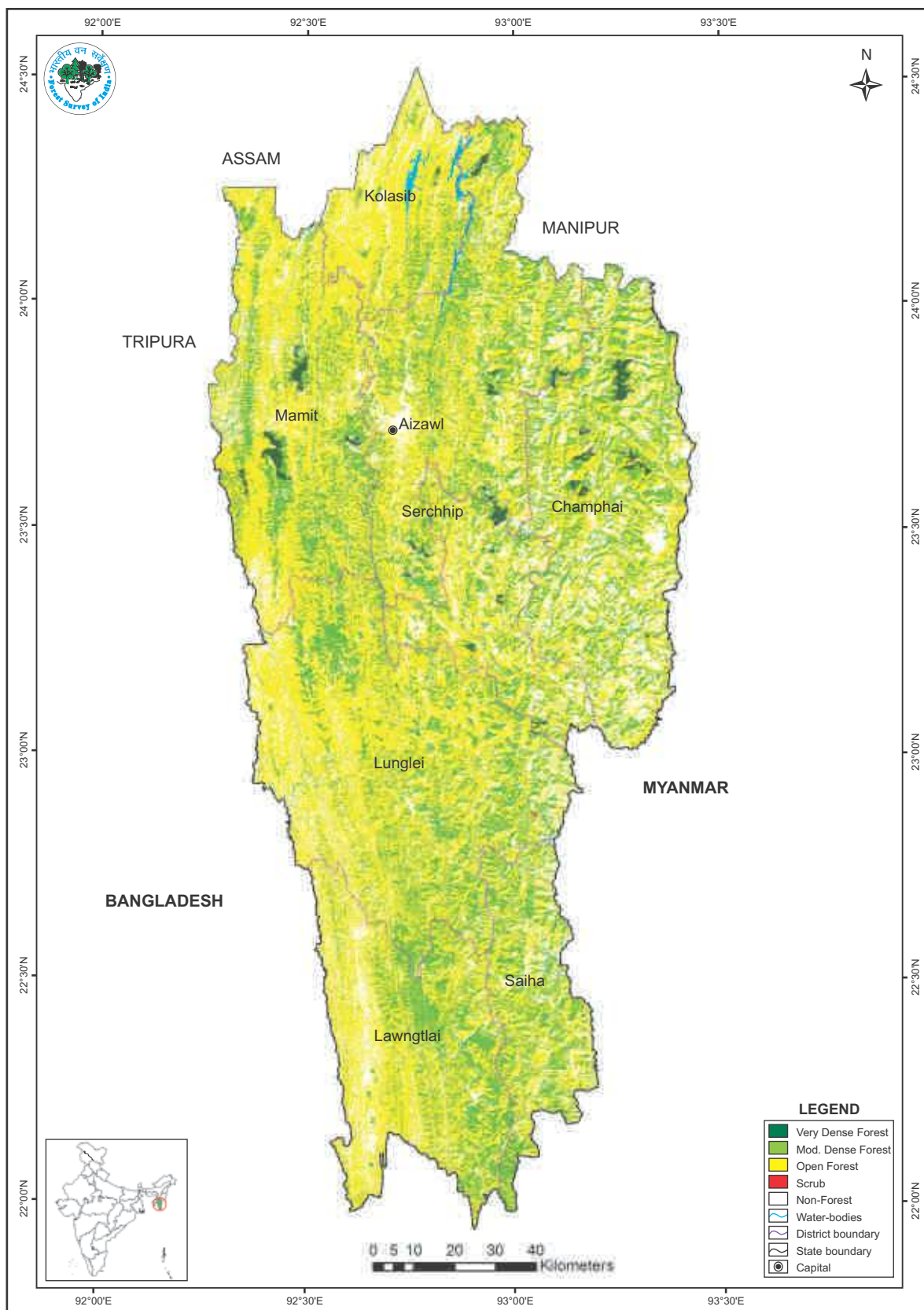


TABLE 11.19.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Mizoram (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	24	188
Ox-bow lake/Cut-off meander	1	3
Waterlogged	15	129
River/Stream	32	11,977
Sub - Total	72	12,297
Inland Wetlands -Man-made		
Reservoir/Barrage	2	27
Sub - Total	2	27
Wetlands (<2.25 ha)	132	132
Total	206	12,456
Total Recorded Forest (or Green Wash) Area (in ha)		20,66,283
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.60%

(analysis based on the National Wetland Atlas: India, 2011)

11.19.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Mizoram as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.19.9 Percentage area under different forest types of Mizoram

Sl. No.	Forest Type	% of Forest cover
1.	2B/2S1 Pioneer Euphorbiaceous Scrub	0.44
2.	2B/C2 Cachar Tropical Semi-Evergreen Forest	30.70
3.	2/2S1 Secondary Moist Bamboo Brakes	37.42
4.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	30.79
5.	8B/C1 East Himalayan Subtropical Wet Hill Forest	0.04
6.	9/C2 Assam Subtropical Pine Forests	0.61
	Total	100.00

11.19.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.19.10 and table 11.19.11 in respect of Mizoram.

TABLE 11.19.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	87
Shrub	96
Herb	56

TABLE 11.19.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Mizoram

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 2- Tropical Semi-Evergreen Forests	3.08	3.37	3.15
2.	Group 3- Tropical Moist Deciduous Forests	2.78	3.38	3.26
3.	Group 9- Subtropical Pine Forests	*	2.45	2.19

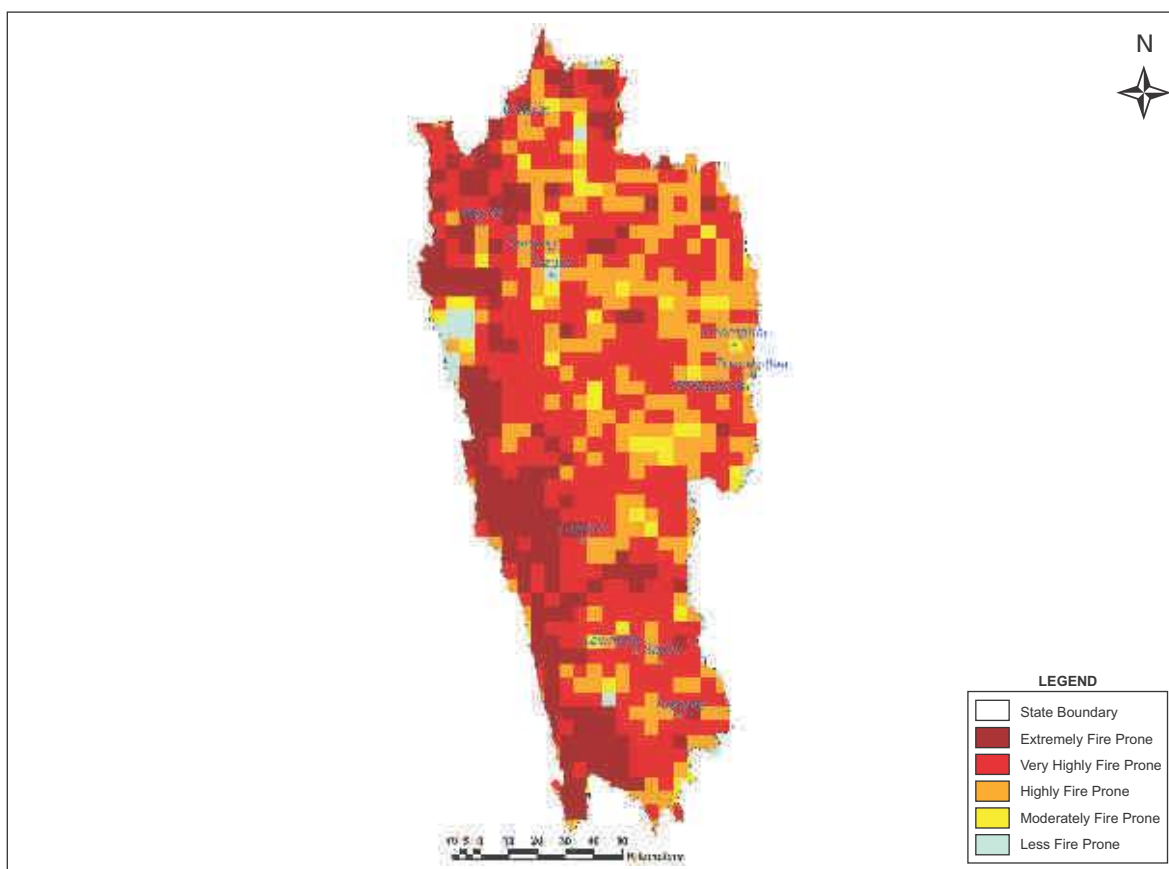
*adequate number of sample plots were not available

11.19.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.19.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	6,270.27	29.91
2	Very highly fire prone	8,104.05	38.46
3	Highly fire prone	5,213.18	24.64
4	Moderately fire prone	1,132.42	5.35
5	Less fire prone	359.86	1.64
	Total	21,079.78	100.00

FIGURE 11.19.4 Fire prone forest areas under different fire prone classes

11.19.5 Tree Cover

Forest cover presented in the section 11.19.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Mizoram has been estimated as given in table 11.19.13.

TABLE 11.19.13 Tree Cover in Mizoram (in sq km)

Tree Cover	Area
	441

Tree cover of Mizoram has decreased by 26 sq km as compared to the previous assessment reported in ISFR 2017.

11.19.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.19.14 Extent of TOF in Mizoram (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
270	441	711

11.19.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Mizoram is given in the table 11.19.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.19.16

TABLE 11.19.15 Growing Stock in Mizoram (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	21.30	0.50
Growing Stock in TOF	44.11	2.69

TABLE 11.19.16 Diameter class distribution of top five species inside RFA in Mizoram (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Schima wallichii</i>	10,208	949	52
2.	<i>Tectona grandis</i>	4,462	1,189	0
3.	<i>Callicarpa species</i>	9,173	33	0
4.	<i>Castanopsis species</i>	8,185	596	0
5.	<i>Macaranga species</i>	12,704	0	0

11.19.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1 ha in size is 156.55 million tonnes (574.02 million tonnes of CO₂ equivalent) which is 2.20% of total forest carbon of the country. Pool wise forest carbon in Mizoram is given in the following table.

TABLE 11.19.17 Forest Carbon in Mizoram in different pools

(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
44,973	9,925	451	4,516	96,689	1,56,554

11.19.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.19.18

TABLE 11.19.18 Growing Stock of Bamboo in Mizoram

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/ Green Wash (in sq km)	3,476	2.17
Total number of culms (in millions)	1,074	2.72
Total equivalent green weight (in 000' tonnes)	8,812	3.17

11.19.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Mizoram in Rural and Urban areas are given in the table 11.19.19 and table 11.19.20 respectively

TABLE 11.19.19 Top five tree species in TOF (Rural) in Mizoram

Sl. No.	Species	Relative Abundance (%)
1.	<i>Schima wallichii</i>	10.66
2.	<i>Castanopsis species</i>	9.43
3.	<i>Tectona grandis</i>	6.21
4.	<i>Macaranga species</i>	4.98
5.	<i>Albizia species</i>	3.85

TABLE 11.19.20 Top five tree species in TOF (Urban) in Mizoram

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	17.60
2.	<i>Areca catechu</i>	11.32
3.	<i>Artocarpus integrifolia</i>	9.77
4.	<i>Parkia Joyrica</i>	8.14
5.	<i>Schima wallichii</i>	6.01

11.19.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.19.21 and table 11.19.22 respectively

TABLE 11.19.21 Major NTFP species in the State of Mizoram

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	Thatch Grass	Herb	35.29
2.	<i>Parkia javancia</i>	Tree	23.53
3.	<i>Oroxylum indicum</i>	Tree	11.76
4.	<i>Spondias pinnata</i>	Tree	8.82
5.	<i>Dillenia pentagyna</i>	Tree	5.88

TABLE 11.19.22 Major invasive species inside the State of Mizoram with RFA/Green Wash

(in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	31
2.	<i>Mikania micrantha</i>	13
3.	<i>Imperata cylindrica</i>	5

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.19.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Mizoram

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Mizoram is given in the table 11.19.23

TABLE 11.19.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Mizoram

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
17,841	22,628	423	849



11.20

NAGALAND

11.20.1 Introduction

Nagaland is a North Eastern State covering an area of 16,579 sq km which constitutes 0.50% of the geographical area of the country. The state lies between 25°10' N to 27°4' N longitude and 93°15' E to 95°6' E longitude and is bordered by Arunachal Pradesh and Assam in the north, and Manipur in the south. It shares the international border in the east with Myanmar. Physiographically, Nagaland consists of a narrow strip of hilly country running Northeast to Southwest and facing the Assam plains to its North and Northwest. The State is drained by a number of important rivers, of which Barak river is the major river. The annual rainfall ranges between 1,800 mm to 2,500 mm and the annual temperature varies from 21°C to 40°C. The State has 11 districts, all of which are tribal as well as hill districts. As per the 2011 census, Nagaland has a population of 1.98 million which is 0.16% of India's population. The rural and urban population constitute 71.14% and 28.86% respectively. The tribal population of the State is 86.48%. The population density of the State is 119 per sq km which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 0.91 million.

TABLE 11.20.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	1,658	
Reporting area for land utilization	1,652	100.00
Forests	863	52.23
Not available for land cultivation	95	5.77
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	92	5.58
Culturable wasteland	69	4.15
Fallow land other than current fallows	99	5.99
Current fallows	50	3.05
Net area sown	384	23.23

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.20.1.1 A Brief Overview of Forestry Scenario

Though Nagaland is a small State, it has been endowed with a wide variety of forest types on account of its unique geographic location and wide range of physiographic terrain. As per the Champion & Seth Classification of Forest Types (1968), the forests in Nagaland belong to seven Type Groups, which are further divided into 10 Forest Types. The forest area in Nagaland is limited and therefore the department has purchased land from private owners for Biodiversity Conservation and taking up plantations. The total land purchased by the department is approximately 192.47 sq km. Forests in Nagaland are largely under the community and private forests. The Forest Department owns only certain areas classified as Reserved Forests, Protected Forests, Wildlife Sanctuaries, National parks, Nurseries & Botanical Gardens. The State has started 'Joint Forest Management' program to elicit active participation of villagers in creation, management and protection of plantations. Intensification of Forest Management was carried out in the State by creating adequate infrastructure and controlling the incidences of forest fire.

Recorded Forest Area (RFA) in the State is 8,623 sq km of which 234 sq km is Reserved Forest and 8,389 sq km is Unclassed Forests. In Nagaland, during the period 1st January 2015 to 5th February 2019, no forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

One National Park, three Wildlife Sanctuaries and 57 Community Reserves constitute the Protected Area network of the State covering 5.19% of its geographical area.

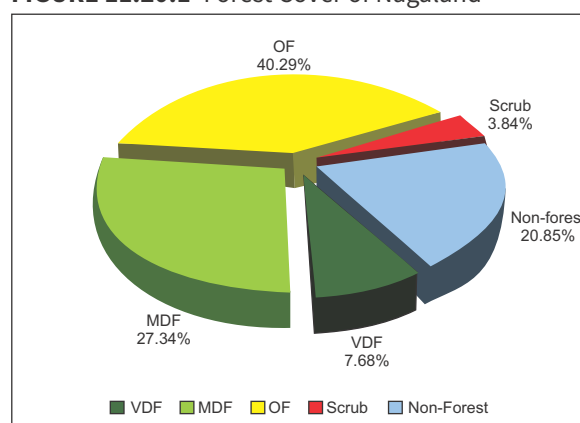
11.20.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to February 2018, the Forest Cover in the State is 12,486.40 sq km which is 75.31 % of the State's geographical area. In terms of forest canopy density classes, the State has 1,273.19 sq km under Very Dense Forest (VDF), 4,533.72 sq km under Moderately Dense Forest (MDF) and 6,679.49 sq km under Open Forest (OF). Forest Cover in the State has decreased by 2.60 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.20.2 Forest Cover of Nagaland
(in sq. km)

Class	Area	% of GA
VDF	1,273.19	7.68
MDF	4,533.72	27.34
OF	6,679.49	40.29
Total	12,486.40	75.31
Scrub	635.49	3.84

FIGURE 11.20.1 Forest Cover of Nagaland



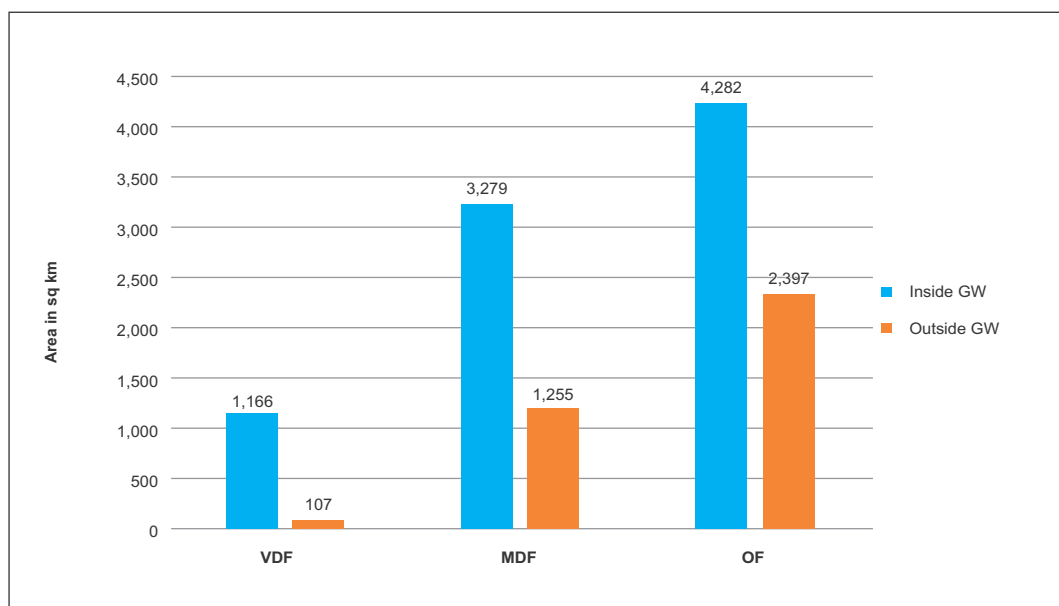
11.20.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 8,623 sq km which is 52.01% of its geographical area. The reserved and unclassified forests are 2.71% and 97.29% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 10,633.44 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.20.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Nagaland (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1,166	3,279	4,282	8,727	107	1,255	2,397	3,759
13.36%	37.57%	49.07%		2.85%	33.38%	63.77%	

*in case of Nagaland Green Wash boundaries have been used

FIGURE 11.20.2 Forest Cover inside and outside Green Wash in Nagaland**TABLE 11.20.4** District-wise Forest Cover in Nagaland

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Dimapur TH	927	24.00	161.71	406.38	592.09	63.87	3.09	9.23
Kiphire TH	1,130	151.72	277.80	405.06	834.58	73.86	-0.42	62.35
Kohima TH	1,463	131.70	377.68	673.28	1,182.66	80.84	-3.34	57.60
Longleng TH	562	0.00	125.45	246.95	372.40	66.26	-2.60	33.52
Mokokchung TH	1,615	1.89	501.89	823.83	1,327.61	82.20	5.61	22.08
Mon TH	1,786	32.00	431.32	739.50	1,202.82	67.35	-4.18	127.00
Peren TH	1,651	136.06	644.46	634.30	1,414.82	85.69	-23.18	76.66
Phek TH	2,026	272.61	637.83	705.37	1,615.81	79.75	-8.19	85.34
Tuensang TH	2,536	438.57	547.10	713.99	1,699.66	67.02	26.66	92.35
Wokha TH	1,628	1.00	465.13	839.68	1,305.81	80.21	-0.19	10.47
Zunheboto TH	1,255	83.64	363.35	491.15	938.14	74.75	4.14	58.89
Grand Total	16,579	1,273.19	4,533.72	6,679.49	12,486.40	75.31	-2.60	635.49

TABLE 11.20.5 Forest Cover Change Matrix for Nagaland

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1,273	0	0	0	6	1,279
Moderately Dense Forest	0	4,533	0	3	51	4,587
Open Forest	0	0	6,432	16	175	6,623
Scrub	0	1	81	416	5	503
Non Forest	0	0	166	200	3,221	3,587
Total ISFR 2019	1,273	4,534	6,679	635	3,458	16,579
Net Change	-6	-53	56	132	-129	

Main reasons for the decrease in forest cover in the State are shifting cultivation and development activities.

TABLE 11.20.6 Altitude-wise Forest Cover in Nagaland

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,910	0	1,005	1,964	2,969 (23.78%)	65
500-1000	5,051	9	1,286	2,367	3,662 (29.33%)	247
1000-2000	6,520	561	1,998	2,254	4,813 (38.55%)	315
2000-3000	1,075	689	238	92	1,019 (8.16%)	8
3000-4000	23	14	7	2	23 (0.18%)	0
Total	16,579	1,273	4,534	6,679	12,486	635

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.20.7 Forest Cover in different slope classes in Nagaland

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,704	23	336	649	1,008 (8.07%)	29
5-10	2,006	78	535	918	1,531 (12.26%)	66
10-15	2,804	154	751	1,234	2,139 (17.13%)	113
15-20	3,098	220	849	1,296	2,365 (18.94%)	136
20-25	2,809	247	792	1,114	2,153 (17.24%)	129
25-30	2,115	225	618	794	1,637 (13.11%)	94
>30	2,043	326	653	674	1,653 (13.25%)	68
Total	16,579	1,273	4,534	6,679	12,486	635

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.20.3 Forest Cover Map of Nagaland

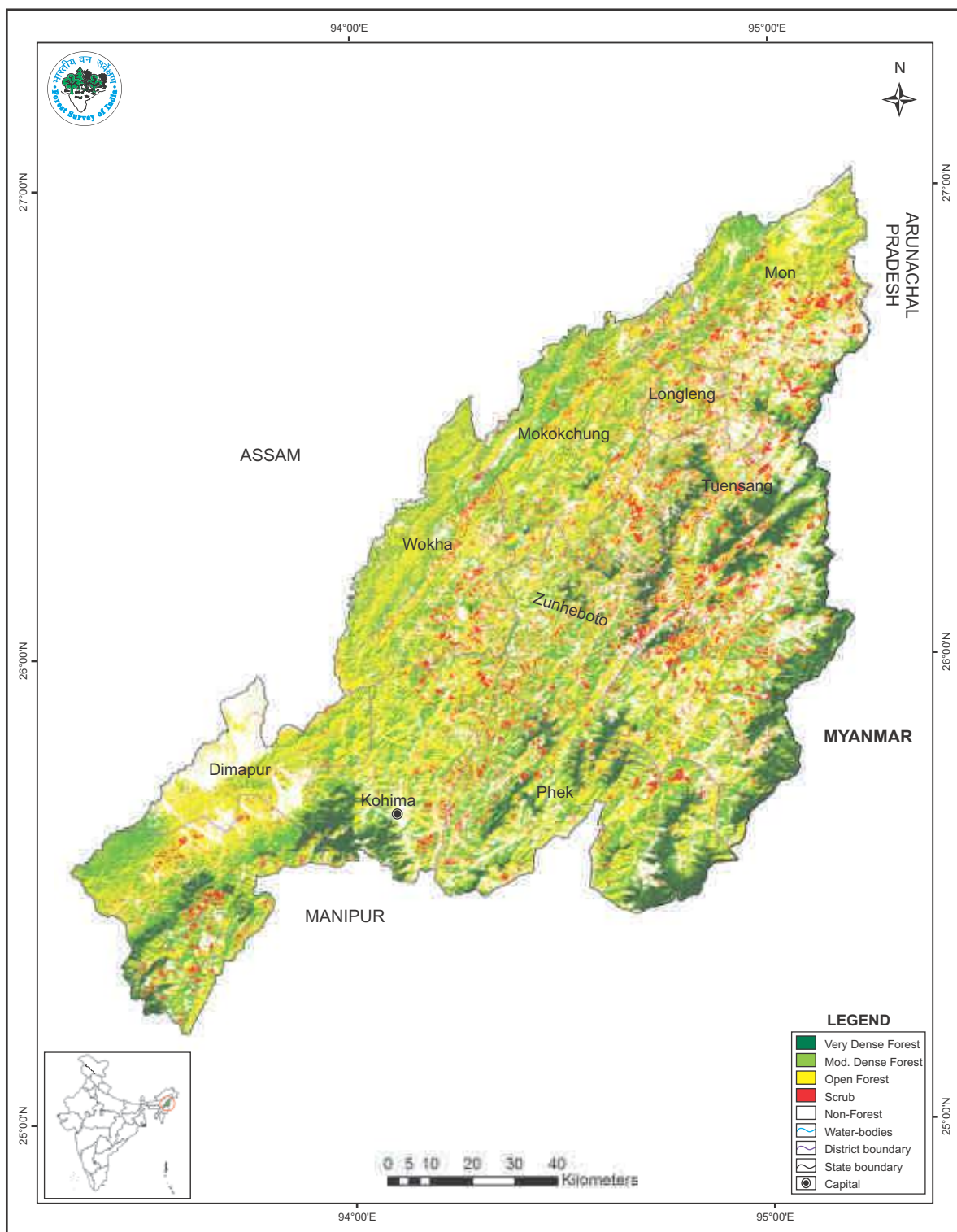


TABLE 11.20.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Nagaland (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	3
Ox-bow lake/Cut-off meander	2	6
Waterlogged	45	176
River/Stream	27	11,200
Sub - Total	75	11,385
Inland Wetlands - Man-made		
Reservoir/Barrage	1	11
Tank/Pond	2	7
Sub - Total	3	18
Wetlands (<2.25 ha)	119	119
Total	197	11,522
Total Recorded Forest (or Green Wash) Area (in ha)		10,63,344
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.08%

(analysis based on the National Wetland Atlas: India, 2011)

11.20.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Nagaland as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.20.9 Percentage area under different forest types of Nagaland

Sl.No.	Forest Type	% of Forest cover
1.	1B/C1 Assam Valley Tropical Wet Evergreen Forest (Dipterocarpus)	0.61
2.	1/2S1 Pioneer Euphorbiaceous Scrub	4.30
3.	2B/2S2 Eastern Alluvial Secondary Semi-Evergreen Forest	17.55
4.	2/2S1 Secondary Moist Bamboo Brakes	5.09
5.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	38.44
6.	8B/C2 Khasi Sub-Tropical Wet Hill Forest	16.09
7.	9/C2 Assam Sub-Tropical Pine Forest	5.84
8.	9/C2/DS1 Assam Subtropical Pine Savannah	0.17
9.	11B/C2 Naga Hill Wet Temperate Forest	11.32
10.	12/DS1 Montane Bamboo Brakes	0.07
11.	Plantation/TOF	0.52
	Total	100.00

11.20.3.1 Assessment of Biodiversity in Nagaland

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.20.10 and table 11.20.11 in respect of Nagaland.

TABLE 11.20.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	56
Shrub	137
Herb	113

TABLE 11.20.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Nagaland

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 1- Tropical Wet Evergreen Forests	*	3.09	2.81
2	Group 2- Tropical Semi-Evergreen Forests	2.15	2.97	2.35
3	Group 3- Tropical Moist Deciduous Forests	2.94	3.48	3.61
4	Group 8- Subtropical Broadleaved Hill Forests	2.62	3.40	2.92
5	Group 9- Subtropical Pine Forests	1.31	1.55	2.19
6	Group 11- Montane Wet Temperate Forests	1.04	1.17	1.90
7	Group 12- Himalayan Moist Temperate Forests	*	1.16	*

* adequate number of sample plots were not available

11.20.4 Fire Prone Forest Areas

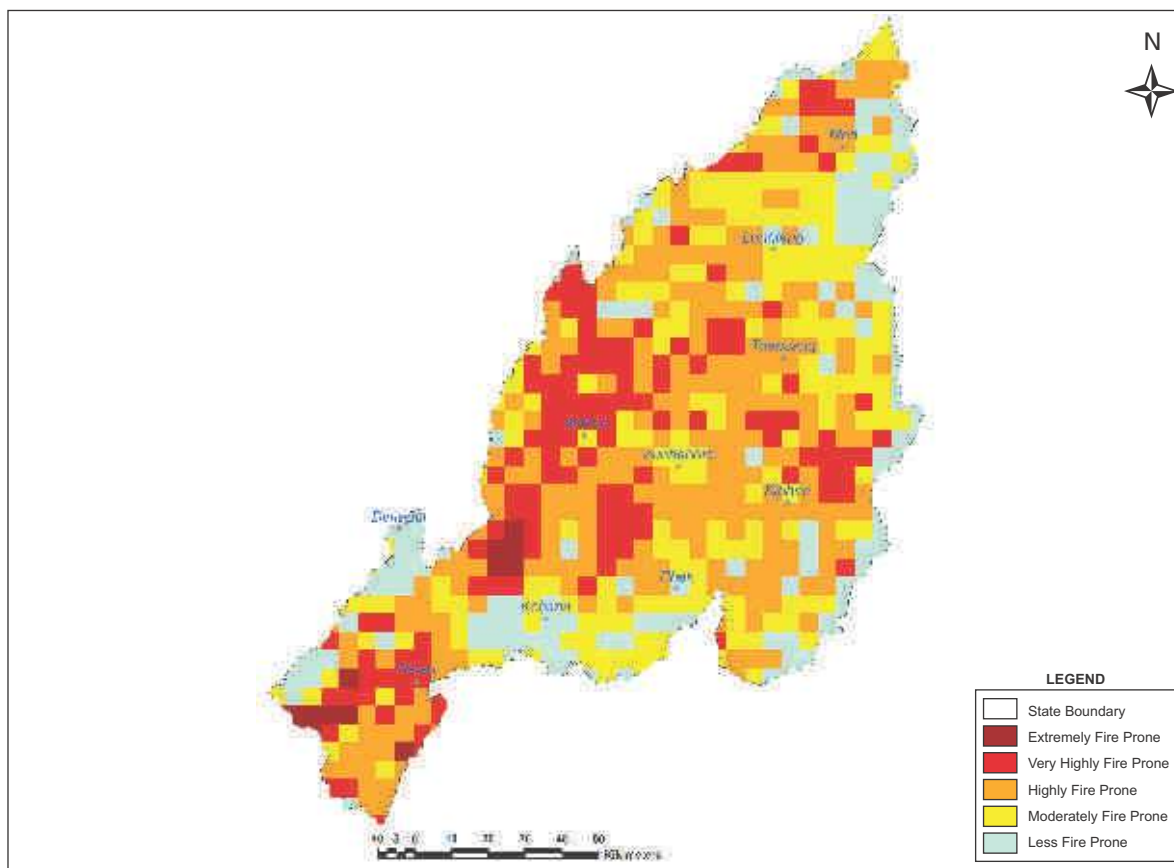
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.20.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	482.53	3.05
2.	Very highly fire prone	2,931.97	18.48
3.	Highly fire prone	6,121.94	38.05
4.	Moderately fire prone	4,485.63	25.65
5.	Less fire prone	2,556.46	14.77
	Total	16,578.53	100.00



FIGURE. 11.20.4 Fire prone forest areas under different fire prone classes



11.20.5 Tree Cover

Forest cover presented in the section 11.20.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Nagaland has been estimated as given in table 11.20.13.

TABLE 11.20.13 Tree Cover in Nagaland (in sq km)

Tree Cover	Area
	362

Tree cover of Nagaland has decreased by 17 sq km as compared to the previous assessment reported in ISFR2017.

11.20.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.20.14 Extent of TOF in Nagaland (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
3,759	362	4,121

11.20.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Nagaland is given in the table 11.20.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.20.16

TABLE 11.20.15 Growing Stock in Nagaland (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	29.52	0.69
Growing Stock in TOF	13.72	0.84

TABLE 11.20.16 Diameter class distribution of top five species inside RFA in Nagaland (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Ficus species</i>	7,225	0	657
2.	<i>Schima wallichii</i>	8,084	1,971	0
3.	<i>Endospermum melaccense</i>	12,202	0	0
4.	<i>Albizia species</i>	12,025	0	0
5.	<i>Sterculia villosa</i>	7,806	0	0

11.20.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 135.53 million tonnes (496.94 million tonnes of CO₂ equivalent) which is 1.90% of total forest carbon of the country. Pool wise forest carbon in Nagaland is given in the following table.

TABLE 11.20.17 Forest Carbon in Nagaland in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
35,850	9,612	522	2,897	86,646	1,35,527

11.20.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.20.18

TABLE 11.20.18 Growing Stock of Bamboo in Nagaland

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	4,284	2.68
Total number of culms (in millions)	2,544	6.45
Total equivalent green weight (in '000' tonnes)	20,547	7.40

11.20.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Nagaland in Rural and Urban areas are given in the table 11.20.19 and table 11.20.20 respectively

TABLE 11.20.19 Top five tree species in TOF (Rural) in Nagaland

Sl. No.	Species	Relative Abundance (%)
1.	<i>Alnusne palensis</i>	8.80
2.	<i>Schima wallichii</i>	7.51
3.	<i>Terminalia myriocarpa</i>	3.60
4.	<i>Duabanga grandiflora</i>	3.00
5.	<i>Mallotus albus</i>	2.87

TABLE 11.20.20 Top five tree species in TOF (Urban) in Nagaland

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	11.39
2.	<i>Areca catechu</i>	7.74
3.	<i>Tectona grandis</i>	5.88
4.	<i>Artocarpus integrifolia</i>	3.96
5.	<i>Gmelina arborea</i>	3.61

11.20.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.20.21 and table 11.20.22 respectively.

TABLE 11.20.21 Major NTFP species in the state of Nagaland

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Rhus Semialata</i>	Tree	37.50
2.	<i>Oroxylum Indicum</i>	Tree	25.00
3.	<i>Embilica officinalis</i>	Tree	25.00
4.	<i>Litsea citara</i>	Tree	12.50

TABLE 11.20.22 Major invasive species in the State inside the RFA/Green Wash in Nagaland (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	93
2.	<i>Mikania micrantha</i>	86
3.	<i>Ageratum conyzoides</i>	7
4.	<i>Parthenium hysteropharus</i>	2

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.20.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Nagaland

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Nagaland is given in the table 11.20.23

TABLE 11.20.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Nagaland

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
2,77,670	4,87,566	1,088	12,225

11.21

ODISHA

11.21.1 Introduction

Situated on the east coast of the country, Odisha covers an area of 1,55,707 sq km which is 4.74% of the geographical area of the country. The State lies between 17°47'N to 22°34'N latitude and 81°22'E to 87°29'E longitude and shares border with West Bengal, Jharkhand in the north, Chhattisgarh in the west, Andhra Pradesh in the south and Bay of Bengal in the east. Physiographically, the State can be divided into four regions, viz, Northern Plateau, Eastern Ghats, Central Tableland and Coastal Plains. The annual rainfall ranges between 1,200 mm to 1,600 mm and the annual temperature varies from 25°C to 28°C. The State is drained by a number of important rivers, which includes Mahanadi, Brahmani and Baitarni. The State has 30 districts, among which 12 are tribal districts. The State does not have any hill districts. As per the 2011 census, Odisha has a population of 41.97 million which is 3.47% of India's population. The rural and urban population constitute 83.32%, and 16.68% respectively. The tribal population is a sizeable 22.85%. The population density of the State is 270 per sq km, which is lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 20.73 million in the State.

TABLE 11.21.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	15,571	
Reporting area for land utilization	15,518	100.00
Forests	5,814	37.46
Not available for land cultivation	2,396	15.44
Permanent pastures and other grazing lands	524	3.38
Land under misc. tree crops and groves	211	1.36
Culturable wasteland	550	3.54
Fallow land other than current fallows	631	4.07
Current fallows	918	5.92
Net area sown	4,474	28.83

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.21.1.1 A Brief Overview of Forestry Scenario

Odisha's forests are well stocked, diverse, multi-storied and dense. The State is also very rich in mineral resources. As per the Champion & Seth Classification of Forest Types (1968), the forests in Odisha belong to four Forest Type Groups which are further divided into 19 Forest Types. In realizing the need for community participation in forest protection, the Government of Odisha is one of the pioneer State in implementing Joint Forest Management Programme.

Recorded Forest Area (RFA) in the State is 61,204 sq km of which 36,049 sq km is Reserved Forest, 25,133 sq km is Protected Forest and 22 sq km is Unclassed Forests. In Odisha, during the period 1st January 2015 to 5th February 2019, a total of 4,968.48 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the State during the last two years, 6,30,896 ha of plantations were raised.

Two National Parks and 19 Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.19% of its geographical area.

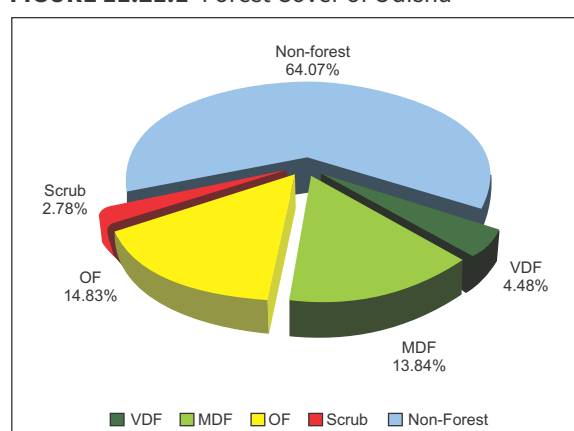
11.21.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018, the Forest Cover in the State is 51,618.51 sq km which is 33.15 % of the State's geographical area. In terms of forest canopy density classes, the State has 6,969.71 sq km under Very Dense Forest (VDF), 21,551.93 sq km under Moderately Dense Forest (MDF) and 23,096.87 sq km under Open Forest (OF). Forest Cover in the State has increased by 273.51 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.21.2 Forest Cover of Odisha
(in sq. km)

Class	Area	% of GA
VDF	6,969.71	4.48
MDF	21,551.93	13.84
OF	23,096.87	14.83
Total	51,618.51	33.15
Scrub	4,326.91	2.78

FIGURE 11.21.1 Forest Cover of Odisha



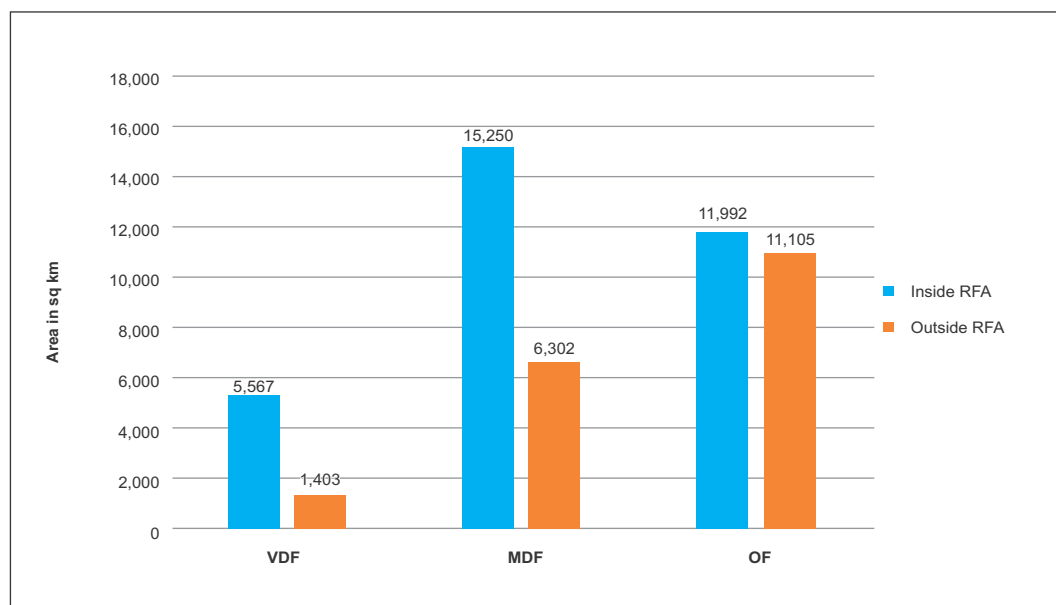
11.21.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 61,204 sq km which is 39.31% of its geographical area. The Reserved, Protected and Unclassed forests are 58.90%, 40.75% and 0.35% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 42,430.50 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.21.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Odisha (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
5,567	15,250	11,992	32,809	1,403	6,302	11,105	18,810
16.97%	46.48%	36.55%		7.46%	33.50%	59.04%	

*in case of Odisha RFA boundaries have been used.

FIGURE 11.21.2 Forest Cover inside and outside RFA in Odisha**TABLE 11.21.4** District-wise Forest Cover in Odisha

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Anugul	6,375	371.01	1,380.00	1,031.62	2,782.63	43.65	27.63	84.18
Balangir	6,575	70.00	224.00	841.26	1,135.26	36.64	4.26	143.16
Baleshwar ^T	3,806	23.00	133.38	226.18	382.56	5.82	2.56	46.59
Bargarh	5,837	175.01	374.14	501.31	1,050.46	27.60	19.46	40.57
Baudh	3,098	262.91	562.04	465.99	1,290.94	51.53	1.94	57.39
Bhadrak	2,505	0.00	8.70	69.30	78.00	1.34	3.00	0.00
Cuttack	3,932	53.00	226.00	525.38	804.38	20.46	8.38	67.80
Debagarh	2,940	191.00	667.41	618.75	1,477.16	50.23	5.16	14.08
Dhenkanal	4,452	173.99	420.38	851.24	1,445.61	32.47	28.61	83.88
Gajapati ^T	4,325	84.16	1,490.09	947.12	2,521.37	58.30	1.37	262.88
Ganjam	8,206	164.39	1,074.32	866.69	2,105.40	25.66	2.40	655.00
Jagatsinghapur	1,668	0.00	4.64	131.64	136.28	8.17	0.28	0.00
Jajapur	2,899	6.00	71.99	228.09	306.08	10.56	3.08	49.78
Jharsuguda	2,114	3.00	173.82	155.82	332.64	15.74	10.64	29.21
Kalahandi ^T	7,920	361.64	734.19	1,323.97	2,419.80	30.55	1.80	371.69
Kandhamal ^T	8,021	660.95	2,593.23	2,143.53	5,397.71	65.01	5.71	385.51
Kendrapara	2,644	83.40	88.54	139.36	311.30	3.88	6.30	1.99
Kendujhar ^T	8,303	288.78	1,420.07	1,513.31	3,222.16	121.87	10.16	53.24
Khordha	2,813	21.00	186.00	260.09	467.09	16.60	10.09	90.47
Koraput ^T	8,807	94.48	740.41	1,263.38	2,098.27	23.83	9.27	947.86
Malkangiri ^T	5,791	158.00	712.76	1,465.41	2,336.17	40.34	-5.83	45.90
Mayurbhanj ^T	10,418	1,334.95	1,717.24	1,041.98	4,094.17	39.30	14.17	37.57

Contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Nabarangapur ^T	5,291	172.63	447.04	527.08	1,146.75	29.48	43.75	48.62
Nayagarh	3,890	189.00	965.00	559.75	1,713.75	44.49	3.75	171.36
Nuapada	3,852	86.01	481.69	706.76	1,274.46	24.09	1.46	108.82
Puri	3,479	0.00	59.73	165.36	225.09	6.47	11.09	10.79
Rayagada ^T	7,073	419.54	853.42	1,873.55	3,146.51	44.49	20.51	359.91
Sambalpur ^T	6,624	498.99	1,696.32	1,096.98	3,292.29	49.70	12.29	40.55
Subarnapur	2,337	2.00	187.00	161.85	350.85	15.01	0.85	29.22
Sundargarh ^T	9,712	1,020.87	1,858.38	1,394.12	4,273.37	44.00	9.37	88.89
Grand Total	1,55,707	6,969.71	21,551.93	23,096.87	51,618.51	33.15	273.51	4,326.91

TABLE 11.21.5 Forest Cover Change Matrix for Odisha

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	6,957	5	1	0	4	6,967
Moderately Dense Forest	9	21,337	11	2	11	21,370
Open Forest	3	201	22,763	10	31	23,008
Scrub	1	5	24	4,267	9	4,306
Non Forest	0	4	298	48	99,706	1,00,056
Total ISFR 2019	6,970	21,552	23,097	4,327	99,761	1,55,707
Net Change	3	182	89	21	-295	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.21.6 Altitude-wise Forest Cover in Odisha

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	1,19,476	3,575	12,856	16,283	32,714 (63.38%)	2,513
500-1000	34,706	3,305	8,384	6,556	18,245 (35.34%)	1,531
1000-2000	1,525	90	312	258	660 (1.28%)	283
Total	1,55,707	6,970	21,552	23,097	51,619	4,327

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.21.7 Forest Cover in different slope classes in Odisha

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,09,048	1,653	6,429	10,557	18,639 (36.11%)	1,365
5-10	15,890	1,642	4,356	3,766	9,764 (18.92%)	753
10-15	10,209	1,427	3,747	2,890	8,064 (15.62%)	724
15-20	9,130	1,024	2,997	2,392	6,413 (12.42%)	644
20-25	6,609	646	2,120	1,783	4,549 (8.81%)	464
25-30	3,005	349	1,187	1,058	2,594 (5.03%)	251
>30	1,816	229	716	651	1,596 (3.09%)	126
Total	1,55,707	6,970	21,552	23,097	51,619	4,327

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.21.3 Forest Cover Map of Odisha

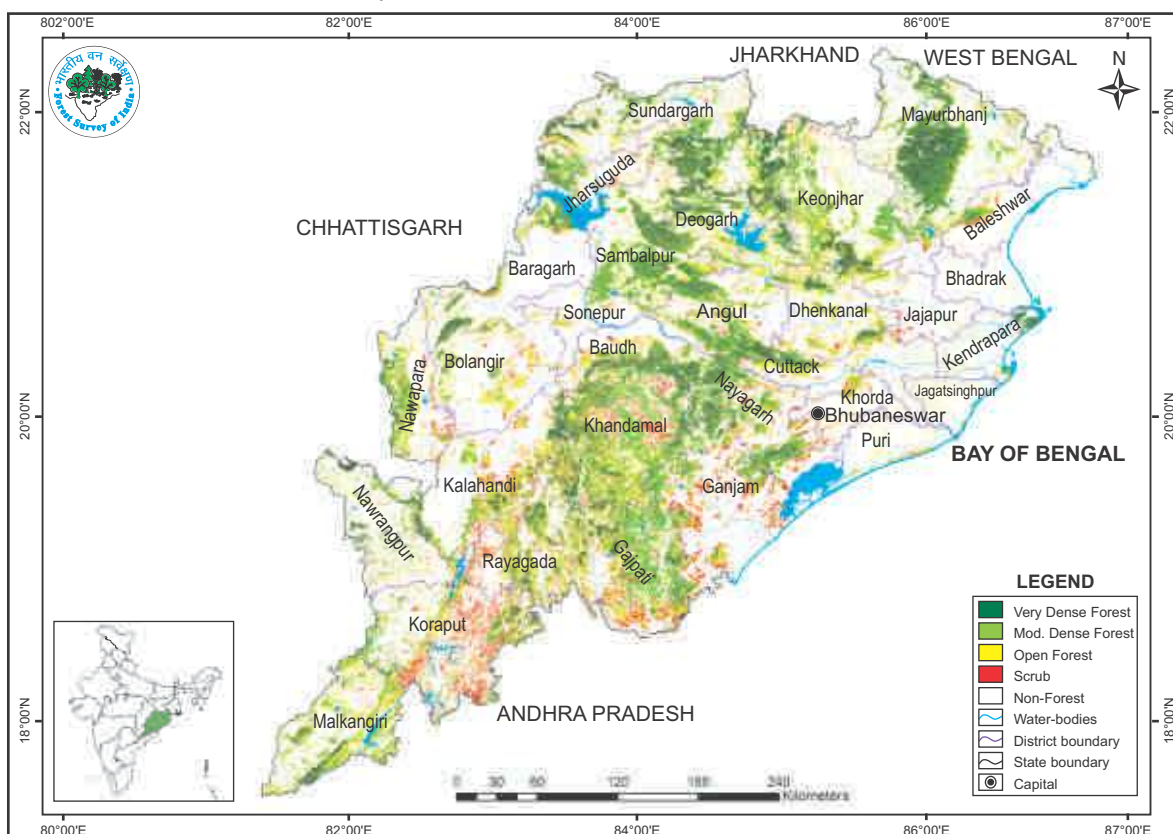


TABLE 11.21.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Odisha (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	9
Waterlogged	69	282
River/Stream	323	13,098
Sub - Total	393	13,389
Inland Wetlands - Man-made		
Reservoir/Barrage	340	38,889
Tank/Pond	451	1,327
Waterlogged	4	11
Sub - Total	795	40,227
Coastal Wetlands - Natural		
Lagoon	1	1
Sand/Beach	27	629
Intertidal mud flat	76	3,523
Mangrove	66	4,089
Sub -Total	170	8,242
Wetlands (<2.25 ha)	2,769	2,769
Total	4,127	64,627
Total Recorded Forest (or Green Wash) Area (in ha)		42,43,050
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.52%

(analysis based on the National Wetland Atlas: India, 2011)

11.21.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Odisha as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.21.9 Percentage area under different forest types of Odisha

Sl.No.	Forest Type	% of Forest cover
1	2B/C3 Orissa Semi-Evergreen Forest	0.14
2	2/2S1 Secondary Moist Bamboo Brakes	0.39
3	3B/C2 Southern Moist Mixed Deciduous Forest	2.26
4	3B/2S1 Southern Secondary Moist Mixed Deciduous Forest	0.75
5	3C/C1d Peninsular (Coastal) Sal Forest	0.01
6	3C/C2e (i) Moist Peninsular High Level Sal	4.47
7	3C/C2e (ii) Moist Peninsular Low Level Sal	22.06
8	3C/C2e (iii) Moist Peninsular Valley Sal	1.74
9	3C/2S1 Northern Secondary Moist Mixed Deciduous Forest	8.66
10	3C/DS1 Moist Sal Savannah	0.01
11	4A/L1 Littoral Forest	0.23
12	4B/TS2 Mangrove Forest	0.44
13	5A/C1b Dry Teak Forest	0.32
14	5A/C3 Southern Dry Mixed Deciduous Forest	10.51
15	5B/C1c Dry Peninsular Sal Forest	17.79
16	5B/C2 Northern Dry Mixed Deciduous Forest	21.29
17	5/DS1 Dry Deciduous Scrub	3.92
18	5/E9 Dry Bamboo Brake	1.63
19	5/E2 Boswellia Forest	0.06
20	Plantation/ TOF	3.32
	Total	100.00

11.21.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.21.10 and table 11.21.11 in respect of Odisha.

TABLE 11.21.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	192
Shrub	90
Herb	105



TABLE 11.21.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Odisha

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	2.05	2.51	2.78
2	Group 3- Tropical Moist Deciduous Forests	3.10	2.91	3.48
3	Group 4- Littoral and Swamp Forests	*	2.74	2.36
4	Group 5- Tropical Dry Deciduous Forests	3.33	3.26	3.61

*adequate number of sample plots were not available

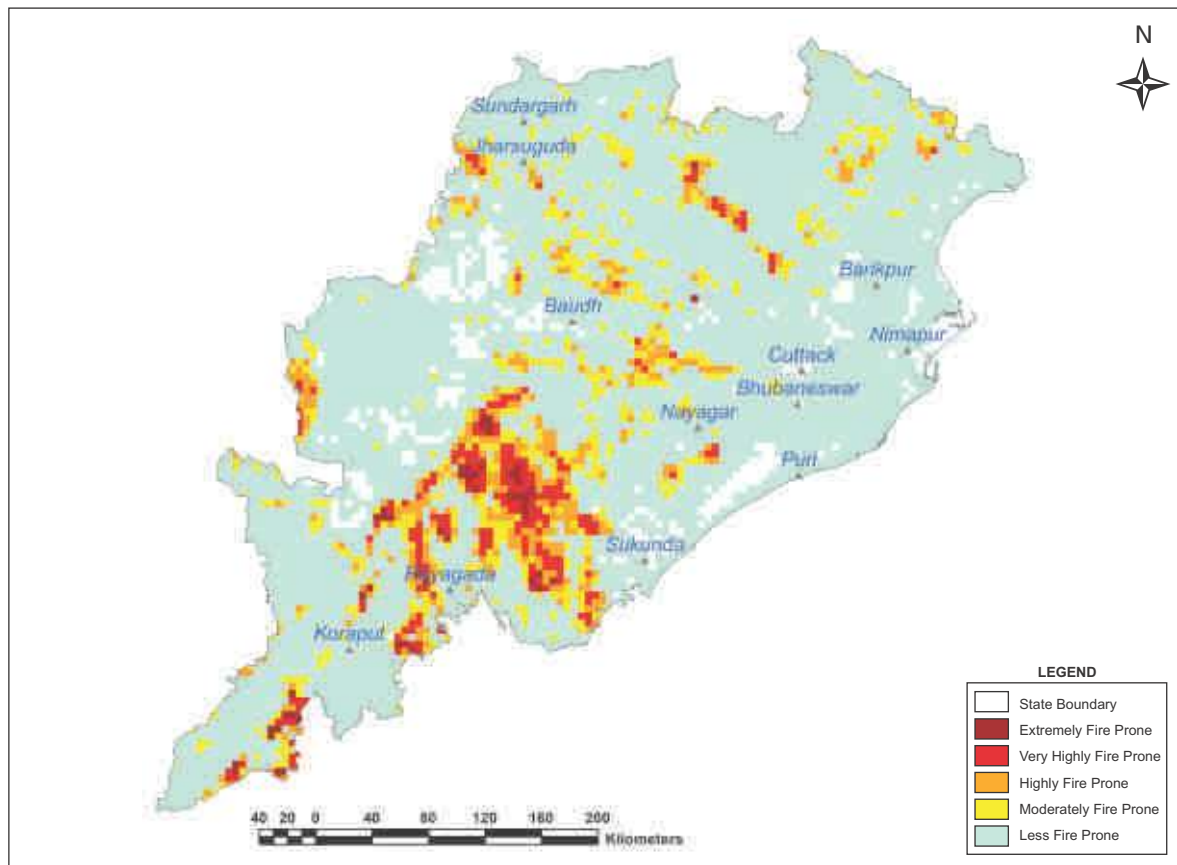
11.21.4 Fire Prone Forest Areas

Geographical area under different forest fire proneness are given in the following table:

TABLE 11.21.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	1,811.42	2.82
2.	Very highly fire prone	4,925.48	7.73
3.	Highly fire prone	8,857.86	13.32
4.	Moderately fire prone	15,159.88	19.96
5.	Less fire prone	1,16,976.77	56.17
	Total	1,47,731.41	100.00

FIGURE 11.21.4 Fire prone forest areas under different fire prone classes



11.21.5 Tree Cover

Forest cover presented in the section 11.21.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Odisha has been estimated as given in table 11.21.13.

TABLE 11.21.13 Tree Cover in Odisha (in sq km)

Tree Cover	Area
	4,648

Tree cover of Odisha has increased by 655 sq km as compared to the previous assessment reported in ISFR 2017.

11.21.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.21.14 Extent of TOF in Odisha (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
18,810	4,648	23,458

11.21.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Odisha is given in the table 11.21.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.21.16

TABLE 11.21.15 Growing Stock in Odisha (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	299.04	7.00
Growing Stock in TOF	95.02	5.79

TABLE 11.21.16 Diameter class distribution of top five species inside RFA in Odisha (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	2,02,258	38,248	3,671
2.	<i>Lannea grandis</i>	50,604	7,702	177
3.	<i>Buchanania latifolia</i>	50,910	1,274	0
4.	<i>Terminalia tomentosa</i>	53,964	9,791	530
5.	<i>Cleistanthus collinus</i>	55,394	1,564	0

11.21.8 Carbon Stock in Forest in Odisha

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 432.29 million tonnes (1,585.06 million tonnes of CO₂ equivalent) which is 6.07% of total forest carbon of the country. Pool wise forest carbon in Odisha is given in the following table

TABLE 11.21.17 Forest Carbon in Odisha in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,26,656	39,066	1,647	9,062	2,55,857	4,32,288

11.21.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.21.18

TABLE 11.21.18 Growing Stock of Bamboo in Odisha

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	11,827	7.39
Total number of culms (in millions)	2,291	5.81
Total equivalent green weight (in 000' tonnes)	16,131	5.81

11.21.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Odisha in Rural and Urban areas are given in the table 11.21.19 and table 11.21.20 respectively.

TABLE 11.21.19 Top five tree species in TOF (Rural) in Odisha

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	6.61
2.	<i>Shorea robusta</i>	6.43
3.	<i>Madhuca latifolia</i>	6.04
4.	<i>Azadirachta indica</i>	5.99
5.	<i>Anacardium occidentale</i>	5.69

TABLE 11.21.20 Top five tree species in TOF (Urban) in Odisha

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	9.79
2.	<i>Cocos nucifera</i>	7.71
3.	<i>Azadirachta indica</i>	6.81
4.	<i>Tectona grandis</i>	5.81
5.	<i>Moringa species</i>	5.50

11.21.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.21.21 and table 11.21.22 respectively.

TABLE 11.21.21 Major NTFP species in the State of Odisha

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Shorea robusta</i>	Tree	57.91
2.	<i>Madhuca indica</i>	Tree	17.11
3.	<i>Buchanania Lanza</i>	Tree	12.48
4.	<i>Schleichera oleosa</i>	Tree	3.02
5.	<i>Semecarpus anacardium</i>	Tree	2.98

TABLE 11.21.22 Major invasive species in the State inside the RFA/Green Wash in Odisha (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	668
2.	<i>Lantana camara</i>	236
3.	<i>Ageratum conyzoides</i>	212
4.	<i>Acacia farnesiana</i>	107
5.	<i>Dioscorea pentaphylla</i>	15

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.21.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Odisha

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Odisha is given in the table 11.21.23

TABLE 11.21.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Odisha

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
91,85,833	5,60,35,117	1,10,787	3,76,521



11.22

PUNJAB

11.22.1 Introduction

Situated in the north-western part of the country, the State of Punjab has an area of 50,362 sq km, which is 1.53% of the geographical area of the country. The State lies between 29°33'N to 32°32'N latitude and 73°53'E to 76°56' E longitude. On the western side, Punjab has international border with Pakistan. The State shares border with Jammu & Kashmir in the north, Himachal Pradesh in the east and Haryana & Rajasthan on the south. Major part of the State is comprised of fertile alluvial plains and along the north eastern part of the state bordering Himachal Pradesh runs the belt of low Shivalik hills. Climate of the State is tropical, semi arid, hot and subtropical monsoon type with cold winter and hot summer. The annual rainfall ranges between 480 mm to 960 mm and the annual temperature varies from 0°C to 47°C. The State is drained by two main rivers, Satluj and Beas. The State has 20 districts none of which are hill or tribal district. As per the 2011 census, Punjab has a population of 27.74 million accounting to 2.29% of India's population. The rural and urban population comprise 62.52% and 37.48% respectively. The average population density of the State is 551 per sq km which is higher than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 8.12 million.

TABLE 11.22.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	5,036	
Reporting area for land utilization	5,033	100.00
Forests	256	5.08
Not available for land cultivation	488	9.69
Permanent pastures and other grazing lands	5	0.10
Land under misc. tree crops and groves	8	0.16
Culturable wasteland	69	1.37
Fallow land other than current fallows	5	0.11
Current fallows	83	1.65
Net area sown	4,119	81.84

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.22.1.1 A Brief Overview of Forestry Scenario

Punjab is predominantly an agricultural State, with 83% of the total geographical area is under agriculture. As per the Champion & Seth Classification of Forest types (1968), the forests in Punjab belong to three Forest Type Groups i.e. Tropical Dry Deciduous Forests, Tropical Thorn Forests and Subtropical Pine Forests which are further divided into seven Forest Types. The Community reserves of 'Lalwan' in Hoshiarpur and 'Keshopur-Chamb' in Gurdaspur districts are the first notified community reserves in the country under the Wildlife Protection Act, 1972. These reserves enable conservation of biodiversity on the community lands with the support of State Forest Department.

With major portion of the land under agriculture, there is limited scope to increase the area under forests except by bringing the wastelands and degraded lands. The department encourages farmers to take up agroforestry on their farm lands by providing quality planting material and technical hand holding.

Recorded Forest Area (RFA) in the State is 3,084 sq km of which 44 sq km is Reserved Forest, 1,137 sq km is Protected Forest and 1,903 sq km is Unclassed Forests. In Punjab, during the period 1st January 2015 to 5th February 2019, a total of 1,525 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Thirteen Wildlife Sanctuaries, four Conservation Reserves and three Community Reserves constitute the Protected Area network of the State covering 0.76% of its geographical area.

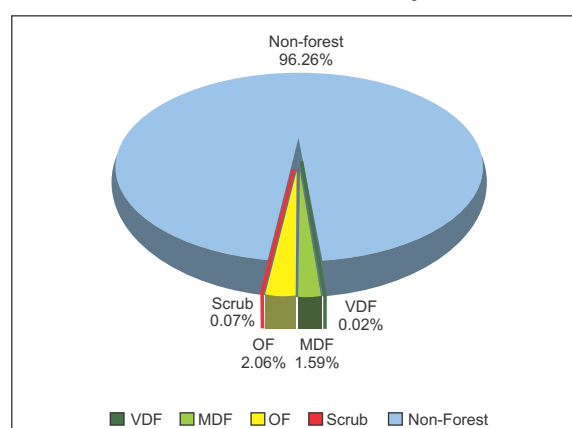
11.22.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017, the Forest Cover in the State is 1,848.63 sq km which is 3.67% of the State's geographical area. In terms of forest canopy density classes, the State has 8.00 sq km under Very Dense Forest (VDF), 800.97 sq km under Moderately Dense Forest (MDF) and 1,039.66 sq km under Open Forest (OF). Forest Cover in the State has increased by 11.63 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.22.2 Forest Cover of Punjab
(in sq. km)

Class	Area	% of GA
VDF	8.00	0.02
MDF	800.97	1.59
OF	1,039.66	2.06
Total	1,848.63	3.67
Scrub	32.94	0.07

FIGURE 11.22.1 Forest Cover of Punjab



11.22.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 3,084 sq km which is 6.12% of its geographical area. The reserved, protected and unclassified forests are 1.43%, 36.87% and 61.70% respectively of the recorded forest area in the State. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 924.03 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.22.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
7	451	326	784	1	350	714	1,065
0.89%	57.54%	41.57%		0.09%	32.87%	67.04%	

*in case of Punjab Green Wash boundaries have been used.

FIGURE 11.22.2 Forest Cover inside and outside Green Wash in Punjab

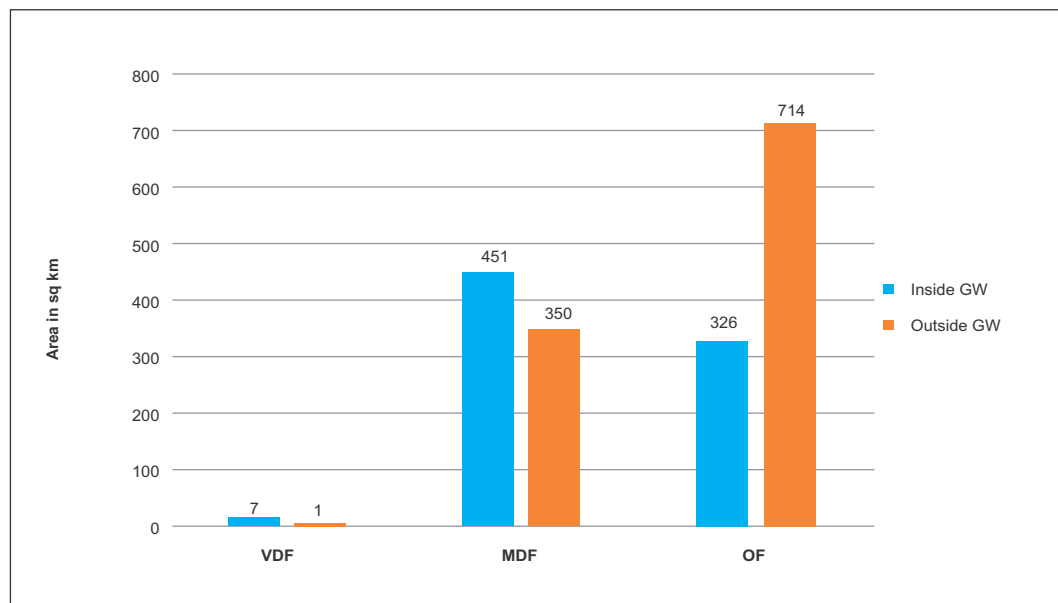


TABLE 11.22.4 District-wise Forest Cover in Punjab

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Amritsar	2,683	1.00	11.05	14.73	26.78	1.00	-0.22	1.22
Barnala	1,482	0.00	1.00	7.33	8.33	0.56	0.33	0.00
Bathinda	3,353	0.00	18.91	36.52	55.43	1.65	-0.57	9.00
Faridkot	1,458	0.00	3.97	14.51	18.48	1.27	-2.52	1.00
Fatehgarh Sahib	1,180	0.00	3.74	0.00	3.74	0.32	-0.26	0.00
Firozpur	5,305	0.00	6.00	27.66	33.66	0.63	-0.34	0.85
Gurdaspur	3,551	0.00	104.16	108.16	212.32	5.98	-0.68	1.00
Hoshiarpur	3,386	0.00	370.33	353.87	724.20	21.39	-0.80	7.00
Jalandhar	2,624	0.00	1.92	8.69	10.61	0.40	-0.39	1.00
Kapurthala	1,633	0.00	1.93	7.92	9.85	0.60	-0.15	1.00
Ludhiana	3,578	0.00	25.18	33.74	58.92	1.65	3.92	1.00
Mansa	2,198	0.00	0.98	9.00	9.98	0.45	-0.02	0.00
Moga	2,242	0.00	0.00	8.89	8.89	0.40	-0.11	0.00
Muksar	2,593	0.00	5.97	12.35	18.32	0.71	0.32	0.00
Patiala	3,325	7.00	28.69	39.12	74.81	2.25	-0.19	3.11
Rupnagar	1,356	0.00	105.82	155.64	261.46	19.28	1.46	3.00
Sahibzada Ajit Singh Nagar	1,094	0.00	74.50	66.23	140.73	12.86	-1.27	3.00
Sangrur	3,625	0.00	6.00	16.83	22.83	0.63	-0.17	0.00
Shahid Bhagat Singh Nagar	1,282	0.00	25.90	105.86	131.76	10.28	13.76	0.00
Tarn Taran	2,414	0.00	4.92	12.61	17.53	0.73	-0.47	0.76
Grand Total	50,362	8.00	800.97	1,039.66	1,848.63	3.67	11.63	32.94

TABLE 11.22.5 Forest Cover Change Matrix for Punjab

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	8	0	0	0	0	8
Moderately Dense Forest	0	801	0	0	5	806
Open Forest	0	0	1,010	1	12	1,023
Scrub	0	0	0	32	1	33
Non Forest	0	0	30	0	48,462	48,492
Total ISFR 2019	8	801	1,040	33	48,480	50,362
Net Change	0	-5	17	0	-12	

Main reasons for the increase in forest cover in the State are plantation and conservation activities

TABLE 11.22.6 Altitude-wise Forest Cover in Punjab

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	49,882	8	581	885	1,474 (79.72%)	33
500-1000	480	0	220	155	375 (20.28%)	0
Total	50,362	8	801	1,040	1,849	33

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.22.7 Forest Cover in different slope classes in Punjab

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	48,329	7	379	663	1,049 (56.73%)	32
5-10	1,582	1	229	220	450 (24.34%)	1
10-15	316	0	126	107	233 (12.60%)	0
15-20	99	0	48	37	85 (4.60%)	0
20-25	26	0	14	9	23 (1.24%)	0
25-30	7	0	4	3	7 (0.38%)	0
>30	3	0	1	1	2 (0.11%)	0
Total	50,362	8	801	1,040	1,849	33

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.22.3 Forest Cover Map of Punjab

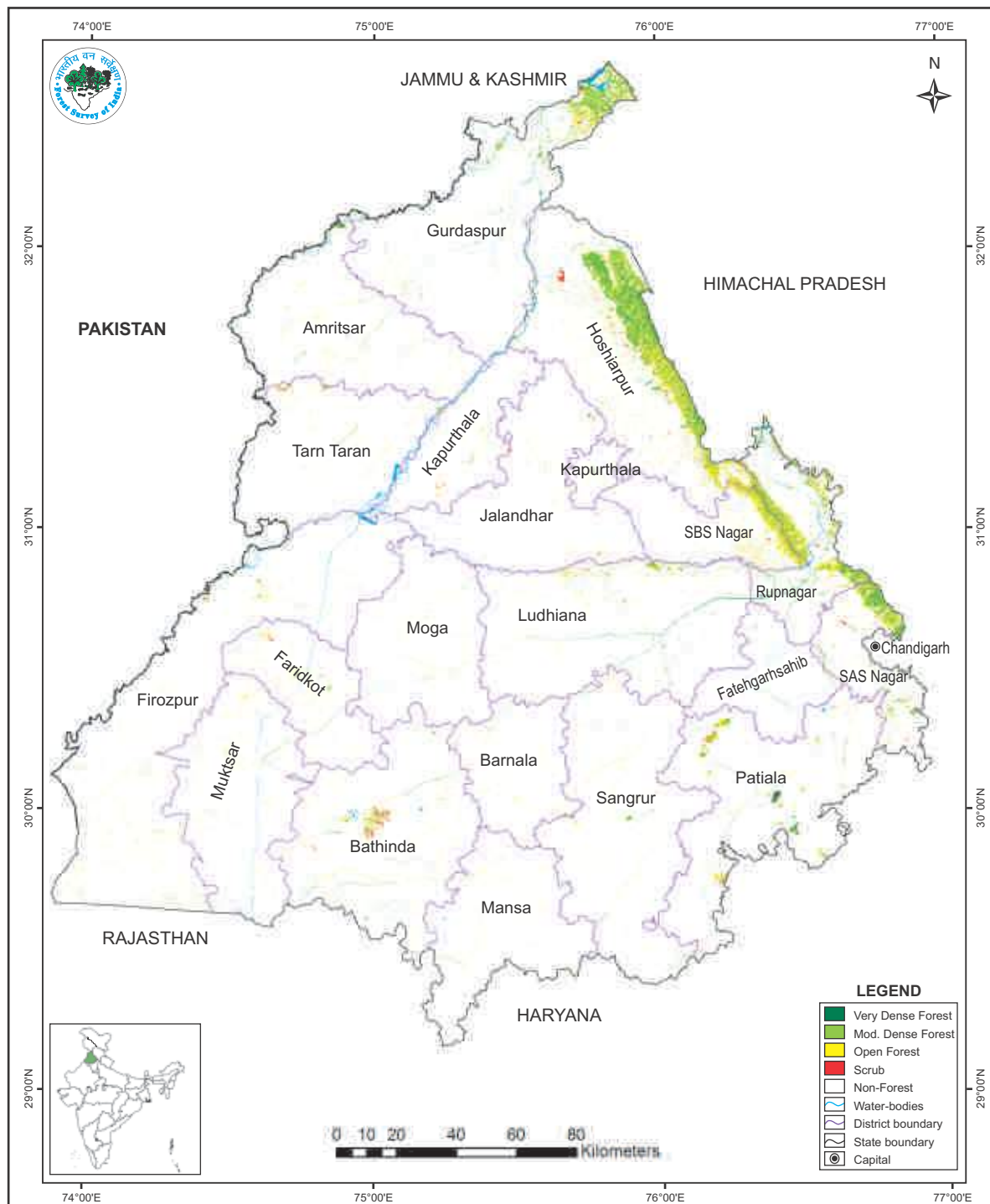


TABLE 11.22.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Punjab (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	5	15
Waterlogged	1	66
River/Stream	40	1,365
Sub - Total	46	1,446
Inland Wetlands -Man-made		
Reservoir/Barrage	26	1,570
Tank/Pond	11	16
Sub - Total	37	1,586
Coastal Wetlands - Natural		
Wetlands (<2.25 ha)	36	36
Total	119	3,068
Total Recorded Forest (or Green Wash) Area (in ha)		92,403
% of Wetland area inside Recorded Forest (or Green Wash) Area		3.32%

(analysis based on the National Wetland Atlas: India, 2011)

11.22.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Punjab as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.22.9 Percentage area under different forest types of Punjab

Sl. No.	Forest Type	% of Forest cover
1.	5B/C2 Northern Dry Mixed Deciduous Forest	67.29
2.	5/DS1 Dry Deciduous Scrub	1.36
3.	5/E9 Dry Bamboo Brakes	1.62
4.	5/1S2 Khair-Sissu Forest	0.23
5.	6B/C2 Ravine Thorn Forest	4.17
6.	6/1S1 Desert Dune Scrub	0.27
7.	9/C1a Siwalik Chir Pine Forest	1.49
8.	Plantation/TOF	23.57
	Total	100.00

11.22.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.22.10 and table 11.22.11 in respect of Punjab.

TABLE 11.22.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	50
Shrub	31
Herb	37

TABLE 11.22.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Punjab

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 5- Tropical Dry Deciduous Forests	3.06	2.07	1.65
2.	Group 6- Tropical Thorn Forests	1.78	2.38	2.28
3.	Group 9- Subtropical Pine Forests	*	1.94	2.36

*adequate number of sample plots were not available

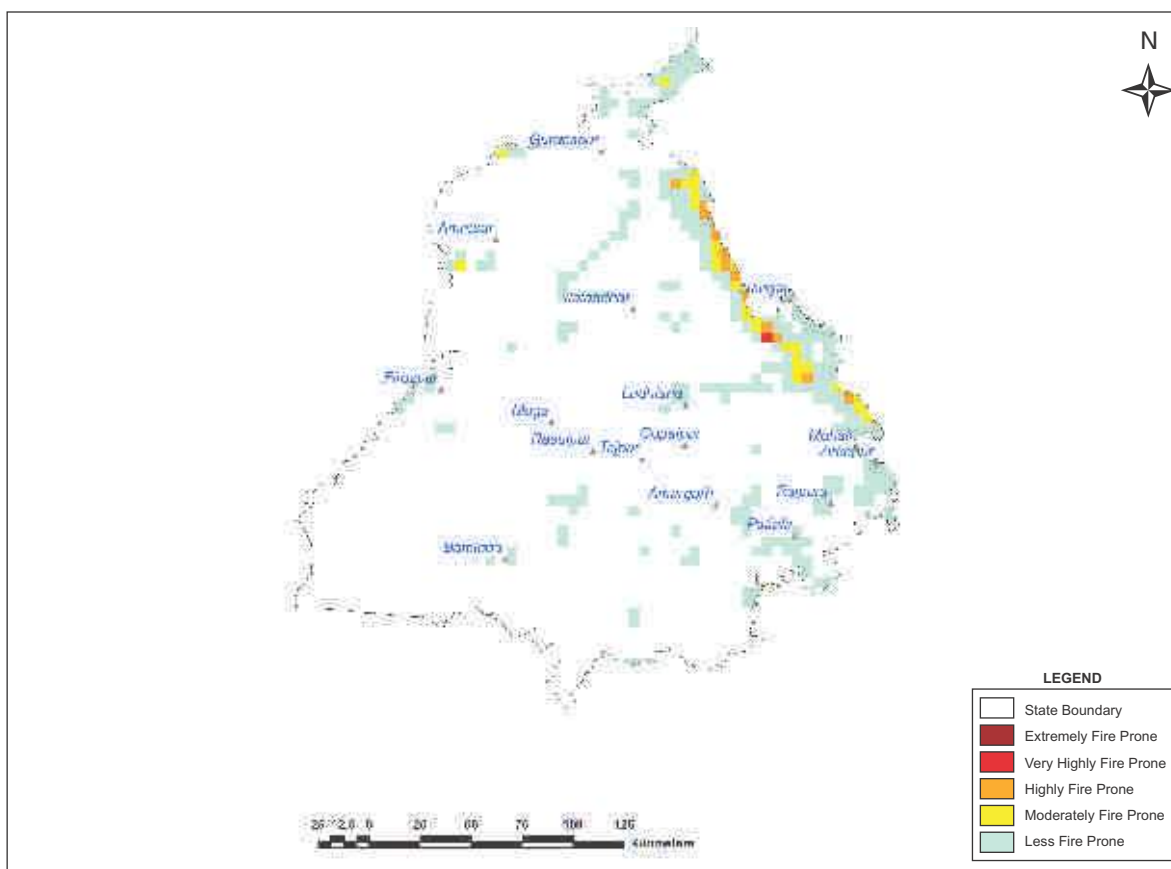
11.22.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.22.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	25.00	0.56
3.	Highly fire prone	282.16	17.09
4.	Moderately fire prone	638.00	29.24
5.	Less fire prone	5,618.68	53.11
	Total	6,563.84	100.00

FIGURE 11.22.4 Fire prone forest areas under different fire prone classes



11.22.5 Tree Cover

Forest cover presented in the section 11.22.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Punjab has been estimated as given in the table 11.22.13.

TABLE 11.22.13 Tree Cover in Punjab (in sq km)

Tree Cover	Area
	1,592

Tree cover of Punjab has decrease by 30 sq km as compared to the previous assessment reported in ISFR 2017.

11.22.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.22.14 Extent of TOF in Punjab (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
1,065	1,592	2,657

11.22.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Punjab is given in the table 11.22.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.22.16

TABLE 11.22.15 Growing Stock in Punjab (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	11.12	0.26
Growing Stock in TOF	18.56	1.13

TABLE 11.22.16 Diameter class distribution of top five species inside RFA in Punjab (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Prosopis juliflora</i>	16,782	1,001	0
2.	<i>Eucalyptus species</i>	2,943	1,307	0
3.	<i>Butea monosperma</i>	297	0	0
4.	<i>Acacia catechu</i>	8,658	185	0
5.	<i>Grewia oppositifolia</i>	1,636	0	0

11.22.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 13.34 million tonnes (48.91 million tonnes of CO₂ equivalent) which is 0.19% of total forest carbon of the country. Pool wise forest carbon in Punjab is given in the following table

TABLE 11.22.17 Forest Carbon in Punjab in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
3,529	1,367	25	125	8,298	13,344

11.22.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.22.18

TABLE 11.22.18 Growing Stock of Bamboo in Punjab

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	255	0.16
Total number of culms (in millions)	11	0.03
Total equivalent green weight (in 000' tonnes)	47	0.02

11.22.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Punjab in Rural and Urban areas are given in the table 11.22.19 and table 11.22.20 respectively

TABLE 11.22.19 Top five tree species in TOF (Rural) in Punjab

Sl. No.	Species	Relative Abundance (%)
1.	<i>Eucalyptus species</i>	24.67
2.	<i>Melia azadirachta</i>	18.76
3.	<i>Populus species</i>	12.44
4.	<i>Dalbergia sissoo</i>	9.39
5.	<i>Morus species</i>	5.43

TABLE 11.22.20 Top five tree species in TOF (Urban) in Punjab

Sl. No.	Species	Relative Abundance (%)
1.	<i>Melia azadirachta</i>	20.97
2.	<i>Eucalyptus species</i>	14.26
3.	<i>Morus species</i>	7.58
4.	<i>Azadirachta indica</i>	4.79
5.	<i>Dalbergia sissoo</i>	4.64

11.22.11 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.22.21.

TABLE 11.22.21 Major Invasive Species in the State within the RFA/Green Wash of Punjab (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	652
2.	<i>Ageratum houstonianum</i>	106
3.	<i>Leucanea leucocephala</i>	83
4.	<i>Senna occidentalis</i>	39
5.	<i>Imperata cylindrica</i>	39

Major invasive species are given in terms of their estimated extent.

11.22.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Punjab

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Punjab is given in the table 11.22.22

TABLE 11.22.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Punjab

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
4,56,167	42,69,224	94	18,758

11.23

RAJASTHAN

11.23.1 Introduction

Situated in the north-western part of the country, the largest state of the country, Rajasthan covers an area of 3,42,239 sq km, which is 10.40% of the geographical area of the country. The geographical extent of the State is bounded by 23°4'N to 30°11'N latitude and 69°29'E to 78°17' E longitude. The State has 4 distinct regions namely, Western Desert with Barren Hills, Level Rocky and Sandy Plains, the Aravalli Hills and South-Eastern Plateau. The climate of the State varies from semi-arid to arid. Western part of the State, including Thar Desert (also known as The Great Indian Desert), is relatively dry and infertile whereas in the south-western part, the land is wetter, hilly, and more fertile. The average annual temperature ranges between 0°C to 50°C and the average annual rainfall is in the range of 500 mm to about 750 mm. The State is drained by a number of rivers which include Banas, Chambal, Luni and Mahi. The State has 33 districts. As per the 2011 Census, Rajasthan has a population of 68.55 million accounting to 5.66 percent of India's population. The rural and urban population constitute 75.10% and 24.90% respectively. The population density is 200 per sq km which is much lower than the national average of 382 persons per sq km. The 19th Livestock census 2012 has reported a total livestock population of 57.73 million in the State.

TABLE 11.23.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	34,224	
Reporting area for land utilization	34,267	100.00
Forests	2,740	8.00
Not available for land cultivation	4,343	12.67
Permanent pastures and other grazing lands	1,674	4.88
Land under misc. tree crops and groves	26	0.08
Culturable wasteland	4,038	11.78
Fallow land other than current fallows	2,069	6.04
Current fallows	1,856	5.42
Net area sown	17,521	51.13

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.23.1.1 A Brief Overview of Forestry Scenario

Rajasthan, the largest State of India according to geographical area, ranks 15th in terms of the RFA, is a forest deficient State. As per the Champion & Seth Classification of Forest Types (1968), the forests in Rajasthan belong to two Type groups i.e. Tropical Dry Deciduous and Tropical Thorn Forests which are further divided into 20 Forest Types.

The State has the examples of some of the best afforestation practices along the Indira Gandhi Canal. Under Joint Forest Management, there are 6,377 VFMCs/EDC operational in the State.

Recorded Forest Area (RFA) in the State is 32,737 sq km of which 12,475 sq km is Reserved Forest, 18,217 sq km is Protected Forest and 2,045 sq km is Unclassed Forests. In Rajasthan, during the period 1st January 2015 to 5th February 2019, a total of 2,834 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the State during the last two years, a total of 42,633 ha of plantations were raised.

Five National Parks, 25 Wildlife Sanctuaries and 11 Conservation Reserves constitute the Protected Area network of the State covering 2.92% of its geographical area. There are 3 Project Tiger (Ranthambhore, Sariska and Mukundra Hills) and two Ramsar (Keoladeo Ghana sanctuary and Sambhar lake) sites.

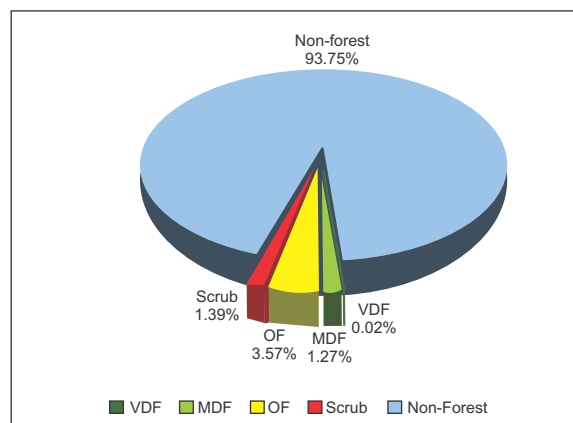
11.23.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct to Dec 2017, the Forest Cover in the State is 16,629.51 sq km which is 4.86 % of the State's geographical area. In terms of forest canopy density classes, the State has 77.81 sq km under Very Dense Forest (VDF), 4,341.90 sq km under Moderately Dense Forest (MDF) and 12,209.80 sq km under Open Forest (OF). Forest Cover in the State has increased by 57.51 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.23.2 Forest Cover of Rajasthan
(in sq km)

Class	Area	% of GA
VDF	77.81	0.02
MDF	4,341.90	1.27
OF	12,209.80	3.57
Total	16,629.51	4.86
Scrub	4,760.04	1.39

FIGURE 11.23.1 Forest Cover of Rajasthan



11.23.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 32,737 sq km which is 9.57% of its geographical area. The reserved, protected and unclassified forests are 38.11%, 55.64% and 6.25% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 33,072.12 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.23.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Rajasthan (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
72	3,931	8,279	12,282	6	411	3,931	4,348
0.59%	32.00%	67.41%		0.13%	9.45%	90.42%	

*in case of Rajasthan RFA boundaries have been used.

FIGURE 11.23.2 Forest Cover inside and outside RFA in Rajasthan

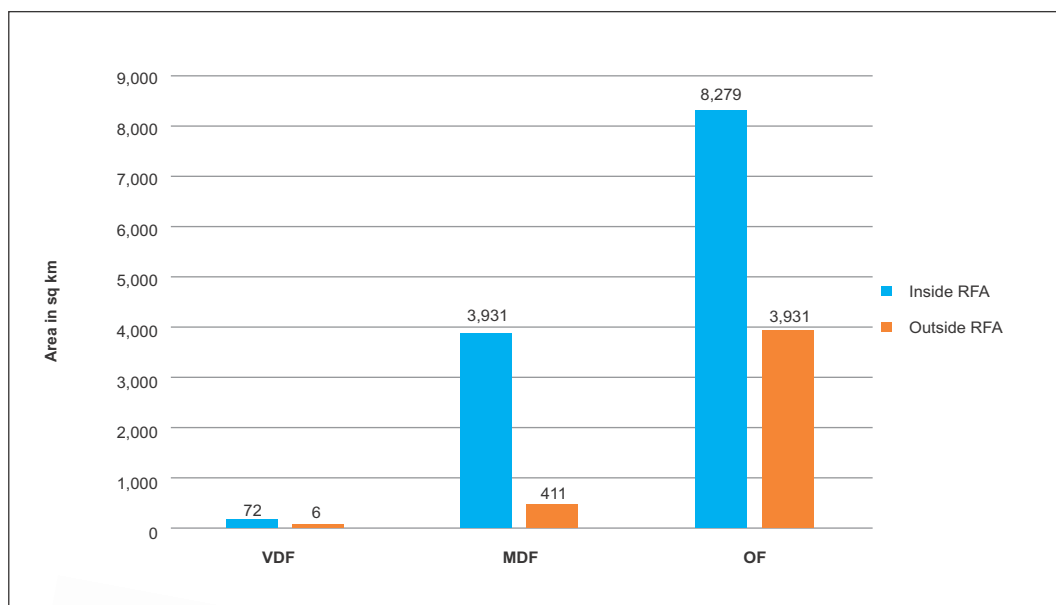


TABLE 11.23.4 District-wise Forest Cover in Rajasthan

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Ajmer	8,481	0.00	43.00	262.11	305.11	3.60	6.11	204.64
Alwar	8,380	59.00	334.96	802.70	1,196.66	14.28	-0.34	245.66
Banswara ^T	4,522	0.00	38.57	229.85	268.42	5.94	7.42	63.45
Baran	6,992	0.00	154.89	856.10	1,010.99	14.46	-2.01	106.56
Barmer	28,387	0.00	3.85	285.94	289.79	1.02	16.79	234.23
Bharatpur	5,066	0.00	22.00	208.27	230.27	4.55	1.27	77.93
Bhilwara	10,455	0.00	31.00	193.19	224.19	2.14	3.19	176.39
Bikaner	30,239	0.88	27.23	227.50	255.61	0.85	8.61	51.85
Bundi	5,776	1.00	137.93	418.25	557.18	9.65	-0.82	151.62
Chittaurgarh	7,822	0.00	220.55	768.25	988.80	12.64	-0.20	100.09
Churu	13,835	0.00	3.00	79.00	82.00	0.59	0.00	22.00
Dausa	3,432	0.00	12.00	105.00	117.00	3.41	0.00	99.00
Dhaulpur	3,033	0.00	80.00	339.00	419.00	13.81	0.00	75.40
Dungarpur ^T	3,770	0.00	42.71	259.59	302.30	8.02	11.30	75.35
Ganganagar	10,978	0.00	10.00	102.92	112.92	1.03	-0.08	13.00
Hanumangarh	9,656	1.00	7.00	81.96	89.96	0.93	-0.04	1.00
Jaipur	11,143	12.00	97.11	443.65	552.76	4.96	0.76	285.39
Jaisalmer	38,401	3.93	51.13	270.71	325.77	0.85	12.77	213.27
Jalor	10,640	0.00	18.91	249.16	268.07	2.52	-6.93	250.89
Jhalawar	6,219	0.00	83.02	352.56	435.58	7.00	-3.42	102.34
Jhunjhunun	5,928	0.00	21.00	179.77	200.77	3.39	4.77	186.72
Jodhpur	22,850	0.00	4.55	103.23	107.78	0.47	2.78	172.71
Karauli	5,524	0.00	95.00	775.00	870.00	15.75	0.00	273.00
Kota	5,217	0.00	153.62	393.11	546.73	10.48	-3.27	135.17
Nagaur	17,718	0.00	15.00	132.04	147.04	0.83	4.04	102.32
Pali	12,387	0.00	209.94	464.91	674.85	5.45	0.85	323.64
Pratapgarh ^T	4,449	0.00	562.54	475.37	1,037.91	23.33	-6.09	58.73
Rajsamand	4,655	0.00	134.91	386.88	521.79	11.21	10.79	124.23
Sawai Madhopur	4,498	0.00	153.92	308.77	462.69	10.29	-3.31	119.67
Sikar	7,732	0.00	31.00	162.06	193.06	2.50	1.06	202.34
Sirohi ^T	5,136	0.00	300.74	611.17	911.91	17.76	-2.09	229.36
Tonk	7,194	0.00	26.94	138.12	165.06	2.29	0.06	57.73
Udaipur ^T	11,724	0.00	1,213.88	1,543.66	2,757.54	23.51	-6.46	224.36
Grand Total	3,42,239	77.81	4,341.90	12,209.80	16,629.51	4.86	57.51	4,760.04

TABLE 11.23.5 Forest Cover Change Matrix for Rajasthan

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	78	0	0	0	0	78
Moderately Dense Forest	0	4,309	13	2	16	4,340
Open Forest	0	28	11,708	88	330	12,154
Scrub	0	0	107	4,143	329	4,579
Non Forest	0	5	382	527	3,20,174	3,21,088
Total ISFR 2019	78	4,342	12,210	4,760	3,20,849	3,42,239
Net Change	0	2	56	181	-239	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.23.6 Altitude-wise Forest Cover in Rajasthan

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,24,954	27	2,538	9,383	11,948 (71.84%)	4016
500-1000	17,070	51	1,690	2,777	4,518 (27.17%)	740
1000-2000	215	0	114	50	164 (0.99%)	4
Total	3,42,239	78	4,342	12,210	16,630	4,760

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.23.7 Forest Cover in different slope classes in Rajasthan

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	3,15,978	21	1,563	7,253	8,837 (53.13%)	3,410
5-10	15,796	15	846	1,912	2,773 (16.68%)	586
10-15	4,729	12	669	1,163	1,844 (11.09%)	295
15-20	2,656	11	537	814	1,362 (8.19%)	200
20-25	1,650	9	379	560	948 (5.70%)	140
25-30	901	6	215	321	542 (3.26%)	82
>30	529	4	133	187	324 (1.95%)	47
Total	3,42,239	78	4,342	12,210	16,630	4,760

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.23.3 Forest Cover Map of Rajasthan

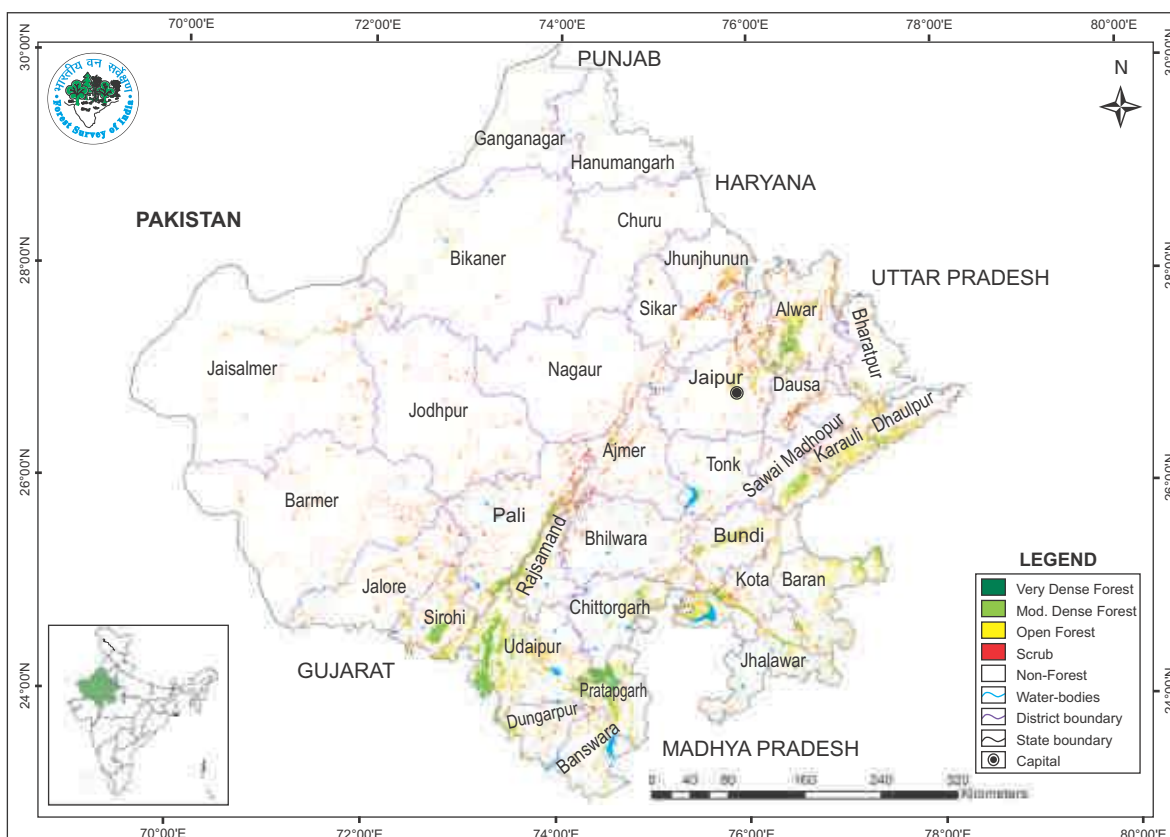


TABLE 11.23.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Rajasthan (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	20	1,177
Waterlogged	5	1,195
River/Stream	259	19,147
Sub - Total	284	21,519
Inland Wetlands -Man-made		
Reservoir/Barrage	219	16,401
Tank/Pond	1038	7,697
Waterlogged	16	3,037
Salt Pan	2	929
Sub - Total	1,275	28,064
Coastal Wetlands - Natural		
Intertidal mud flat	1	4,386
Salt Marsh	3	109
Sub -Total	4	4,495
Wetlands (<2.25 ha)	2,263	2,263
Total	3,826	56,341
Total Recorded Forest (or Green Wash) Area (in ha)		33,07,212
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.70%

(analysis based on the National Wetland Atlas: India, 2011)

11.23.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Rajasthan as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.23.9 Percentage area under different forest types of Rajasthan

Sl.No.	Forest Type	% of Forest cover
1.	5A/C1a Very Dry Teak Forest	5.63
2.	5A/C1b Dry Teak Forest	0.21
3.	5B/C2 Northern Dry Mixed Deciduous Forest	40.07
4.	5/E1/DS1 Dry Deciduous Scrub	10.96
5.	5/DS2 Dry savannah Forest	0.02
6.	5/E1 <i>Anogeissus pendula</i> Forest	15.21
7.	5/E1/DS1 <i>Anogeissus pendula</i> Scrub	2.94
8.	5/E2 <i>Boswellia</i> Forest	0.79
9.	5/E5 <i>Butea</i> Forest	0.30
10.	5/E6 <i>Aegle</i> Forest	0.01
11.	5/E8a <i>Phoenix</i> Savannah Forest	0.01
12.	5/1S1 Dry Tropical Riverain Forest	0.26
13.	5/1S2 <i>Khair-Sissu</i> Forest	1.52
14.	6B/C1 Desert Thorn Forest	6.17
15.	6B/C2 Ravine Thorn Forest	1.93
16.	6B/DS1 <i>Zizyphus</i> Scrub	0.94
17.	6B/DS2 Tropical <i>Euphorbia</i> Scrub	0.19
18.	6/E1 (<i>Euphorbia</i> scrub)	0.85
19.	6/E2 <i>Acacia senegal</i> Forest	0.23
20.	6/1S1 Desert Dune Scrub	6.62
21.	Plantation/TOF	5.14
	Total	100.00

11.23.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.23.10 and table 11.23.11 in respect of Rajasthan.

TABLE 11.23.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	65
Shrub	30
Herb	8



TABLE 11.23.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Rajasthan

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 5- Tropical Dry Deciduous Forests	2.59	2.63	2.01
2	Group 6- Tropical Thorn Forests	1.86	1.69	*

*adequate number of sample plots were not available

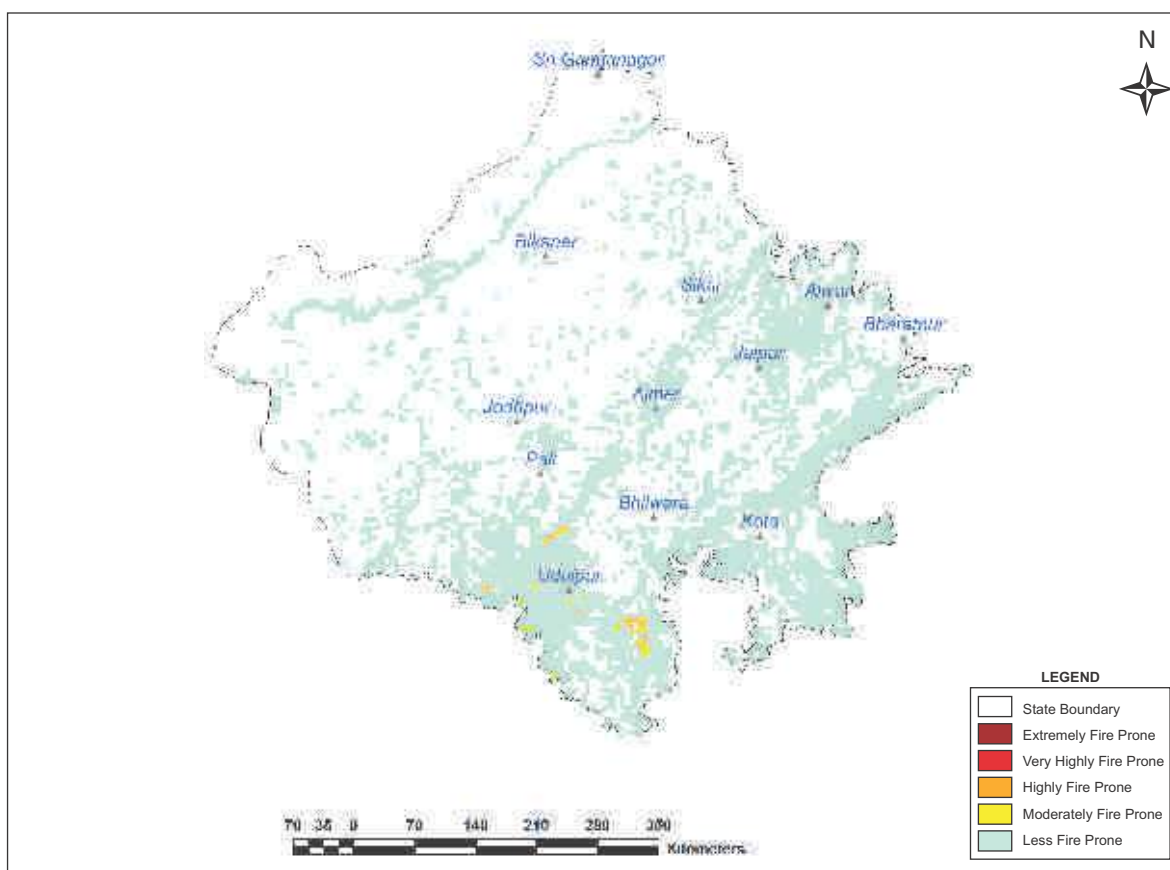
11.23.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.23.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	50.01	0.32
3.	Highly fire prone	450.08	2.48
4.	Moderately fire prone	803.51	3.62
5.	Less fire prone	1,20,580.88	93.58
	Total	1,21,884.48	100.00

FIGURE 11.23.4 Fire prone forest areas under different fire prone classes



11.23.5 Tree Cover

Forest cover presented in the section 11.23.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Rajasthan has been estimated as given in table 11.23.12.

TABLE 11.23.13 Tree Cover in Rajasthan (in sq km)

Tree Cover	Area
	8,112

Tree cover of Rajasthan has decreased by 154 sq km as compared to the previous assessment reported in ISFR2017.

11.23.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.23.14 Extent of TOF in Rajasthan (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
4,348	8,112	12,460

11.23.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Rajasthan is given in the table 11.23.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.23.16

TABLE 11.23.15 Growing Stock in Rajasthan (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	24.39	0.57
Growing Stock in TOF	89.07	5.42

TABLE 11.23.16 Diameter class distribution of top five species inside RFA in Rajasthan (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Butea monosperma</i>	19,371	1,795	120
2.	<i>Acacia catechu</i>	10,355	268	0
3.	<i>Boswellia serrata</i>	7,289	2,773	0
4.	<i>Anogeissus pendula</i>	55,799	780	60
5.	<i>Tectona grandis</i>	8,075	0	0

11.23.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 108.36 million tonnes (397.32 million tonnes of CO₂ equivalent) which is 1.52% of total forest carbon of the country. Pool wise forest carbon in Rajasthan is given in the following table

TABLE 11.23.17 Forest Carbon in Rajasthan in different pools

(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
26,155	10,865	191	928	70,224	1,08,363

11.23.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.23.18

TABLE 11.23.18 Growing Stock of Bamboo in Rajasthan

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,874	1.17
Total number of culms (in millions)	527	1.34
Total equivalent green weight (in 000' tonnes)	2,520	0.91

11.23.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Rajasthan in Rural and Urban areas are given in the table 11.23.19 and table 11.23.20 respectively

TABLE 11.23.19 Top five tree species in TOF (Rural) in Rajasthan

Sl. No.	Species	Relative Abundance (%)
1.	<i>Prosopis cineraria</i>	20.25
2.	<i>Acacia arabica</i>	8.87
3.	<i>Azadirachta indica</i>	8.12
4.	<i>Prosopis juliflora</i>	7.57
5.	<i>Zizyphus jujuba</i>	6.78

TABLE 11.23.20 Top five tree species in TOF (Urban) in Rajasthan

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	24.28
2.	<i>Prosopis juliflora</i>	15.83
3.	<i>Acacia arabica</i>	5.11
4.	<i>Acacia lenticularis</i>	4.23
5.	<i>Dalbergia sissoo</i>	3.66

11.23.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.23.21 and table 11.23.22 respectively.

TABLE 11.23.21 Major NTFP species in the state of Rajasthan

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Butea monosperma</i>	Tree	51.03
2.	<i>Boswellia serrata</i>	Tree	22.74
3.	<i>Diospyros melanoxylon</i>	Tree	12.27
4.	<i>Aegle marmelos</i>	Tree	6.33
5.	<i>Wrigahtia arborea</i>	Tree	3.75

TABLE 11.23.22 Major invasive species in the state inside the RFA/Green Wash in Rajasthan (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Cassia tora</i>	373
2.	<i>Lantana camara</i>	210
3.	<i>Senna occidentalis</i>	194
4.	<i>Prosopis juliflora</i>	162
5.	<i>Triumfetta rhomboidea</i>	55

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.23.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Rajasthan

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Rajasthan is given in the table 11.23.23

TABLE 11.23.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Rajasthan

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
85,59,582	11,27,07,814	3,698	82,433



11.24

SIKKIM

11.24.1 Introduction

Situated in the North Eastern part of the country, the State covers an area of 7,096 sq km, which is 0.22% of the geographical area of the country. The State lies between 27°04'N to 28°07'N latitude and 88°00'E to 88°55'E longitude and is shares international border with Nepal in the west, Bhutan in the east and China in the north. On the southern side lies the State of West Bengal. It is a mountainous State with wide variation in altitudes ranging from 300 m to 8,586 meters. Kangchenjunga, the highest Indian peak and third highest mountain in the world is located in the State. The climate of the State varies from sub-tropical to tundra. The annual rainfall ranges between 2,700 mm to 3,200 mm and the annual temperature varies from sub-zero during winter to 28°C during summer. The State is drained by a number of rivers which include Teesta, Ranjeet, Rangpo and Lachen. The State is divided into 4 districts all of which are tribal and hill districts. As per the 2011 Census, the population of the State is 0.61 million which is 0.05% of India's population. The rural and urban population constitutes 74.85% and 25.15% respectively. The Tribal population is 33.72%. The population density is 86 per sq km which is much lower than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 0.29 million in the State.

TABLE 11.24.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	710	
Reporting area for land utilization	442	100.00
Forests	336	76.02
Not available for land cultivation	10	2.26
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	4	0.91
Culturable wasteland	4	0.91
Fallow land other than current fallows	4	0.91
Current fallows	7	1.58
Net area sown	77	17.41

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.24.1.1 A Brief Overview of Forestry Scenario

Sikkim is a forest rich State and vegetation is marked by clear altitudinal zonation. As per the Champion & Seth Classification of Forest Type (1968), the forests in Sikkim belong to six Forest Type Groups which are further divided into 11 Forest Types. Being a predominantly tribal and hilly State, the lives of the rural people are largely dependent on forests.

The State of Sikkim with only 0.22% of the geographical area of the country harbors around one third of the flowering plants of India. More than 4,500 flowering plants with 550 species of orchids and 36 species of rhododendron are reported from the State.

The flagship 'State Green Mission' program started with avenue plantation for beautification and has transformed into a mass movement. Presently all vacant lands including lands belonging to the monasteries and community lands in the villages are being covered under the green mission.

Recorded Forest Area (RFA) in the State is 5,841 sq km of which 5,452 sq km is Reserved Forest and 389 sq km is Protected Forest. In Sikkim, during the period 1st January 2015 to 5th February 2019, a total of 24.30 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

One National Park, seven Wildlife Sanctuaries and a Conservation Reserve constitute the Protected Area network of the State covering 30.77% of its geographical area. The Khangchendzonga National Park, is a UNESCO World Heritage Site.

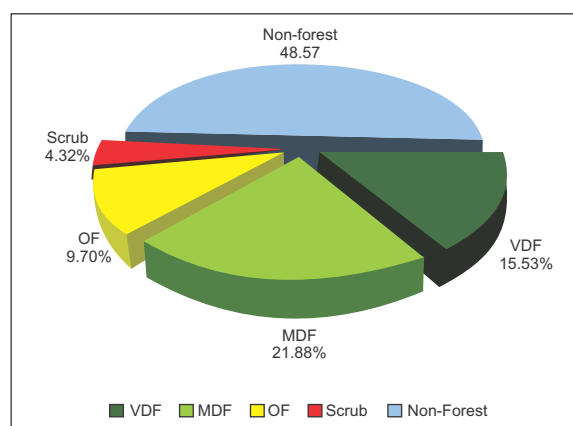
11.24.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017, the Forest Cover in the State is 3,342.49 sq km which is 47.11% of the State's geographical area. In terms of forest canopy density classes, the State has 1,101.96 sq km under Very Dense Forest (VDF), 1,552.31 sq km under Moderately Dense Forest (MDF) and 688.22 sq km under Open Forest (OF). Forest Cover in the State has decreased by 1.51 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.24.2 Forest Cover of Sikkim

(in sq km)		
Class	Area	% of GA
VDF	1,101.96	15.53
MDF	1,552.31	21.88
OF	688.22	9.70
Total	3,342.49	47.11
Scrub	306.65	4.32

FIGURE 11.24.1 Forest Cover of Sikkim



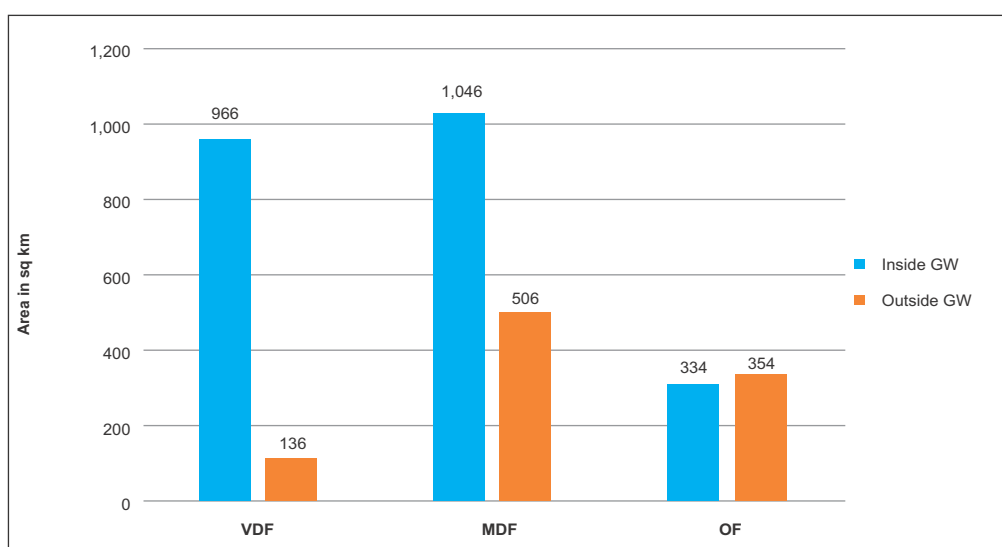
11.24.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 5,841 sq km which is 82.31% of its geographical area. The reserved and protected are 93.34% and 6.66% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 2,737.07 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.24.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Sikkim (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
966	1,046	334	2,346	136	506	354	996
41.16%	44.59%	14.25%		13.65%	50.81%	35.54%	

*in case of Sikkim Green Wash, boundaries have been used.

FIGURE 11.24.2 Forest Cover inside and outside Green Wash in Sikkim

TABLE 11.24.4 District-wise Forest Cover in Sikkim (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
East District TH	954	271.15	313.61	127.96	712.72	74.71	-0.28	54.73
North District TH	4,226	410.61	586.18	287.26	1,284.05	30.38	-0.95	206.21
South District TH	750	173.35	289.49	108.98	571.82	76.24	-0.18	3.71
West District TH	1,166	246.85	363.03	164.02	773.90	66.37	-0.10	42.00
Grand Total	7,096	1,101.96	1,552.31	688.22	3,342.49	47.11	-1.51	306.65

TABLE 11.24.5 Forest Cover Change Matrix for Sikkim (in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1,080	1	0	0	0	1,081
Moderately Dense Forest	22	1,551	1	0	1	1,575
Open Forest	0	0	687	0	1	688
Scrub	0	0	0	305	2	307
Non Forest	0	0	0	2	3,443	3,445
Total ISFR 2019	1,102	1,552	688	307	3,447	7,906
Net Change	21	-23	0	0	2	

Main reasons for the small loss in forest cover in the State are shifting cultivation practice on the community owned lands and mining activity in some parts of the State.

TABLE 11.24.6 Altitude-wise Forest Cover in Sikkim (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	50	0	20	16	36 (1.08%)	1
500-1000	375	12	155	95	262 (7.84%)	13
1000-2000	1,306	277	571	245	1,093 (32.75%)	15
2000-3000	1,155	577	404	91	1,072 (32.07%)	7
3000-4000	1,103	230	368	172	770 (23.00%)	106
>4000	3,107	6	34	69	109 (3.26%)	165
Total	7,096	1,102	1,552	688	3,342	307

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.24.7 Forest Cover in different slope classes in Sikkim (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	351	13	16	7	36 (1.08 %)	8
5-10	554	48	57	25	130 (3.89 %)	18
10-15	767	109	130	54	293 (8.77 %)	31
15-20	969	168	212	89	469 (14.03 %)	42
20-25	1,062	199	266	111	576 (17.24 %)	47
25-30	1,034	198	275	116	589 (17.62 %)	48
>30	2,359	367	596	286	1,249 (37.37 %)	113
Total	7,096	1,102	1,552	688	3,342	307

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.24.3 Forest Cover Map of Sikkim

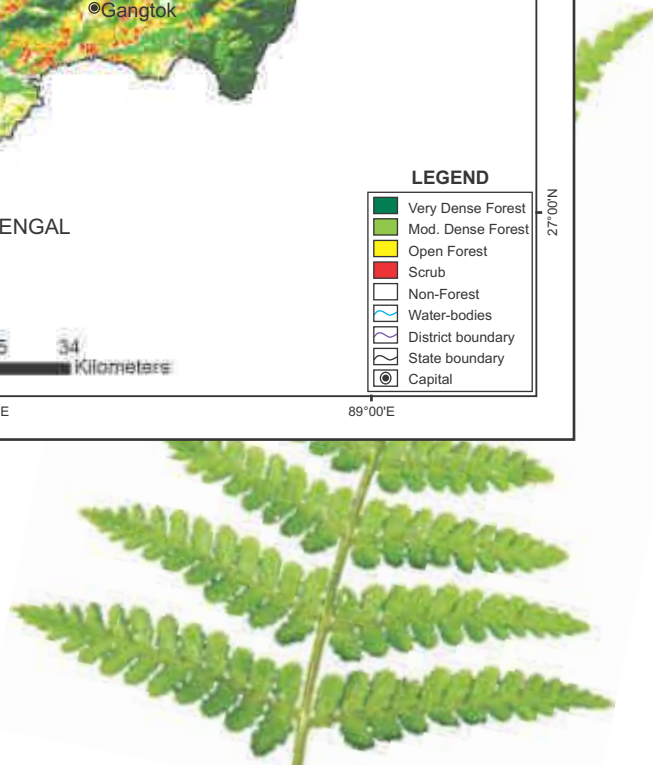
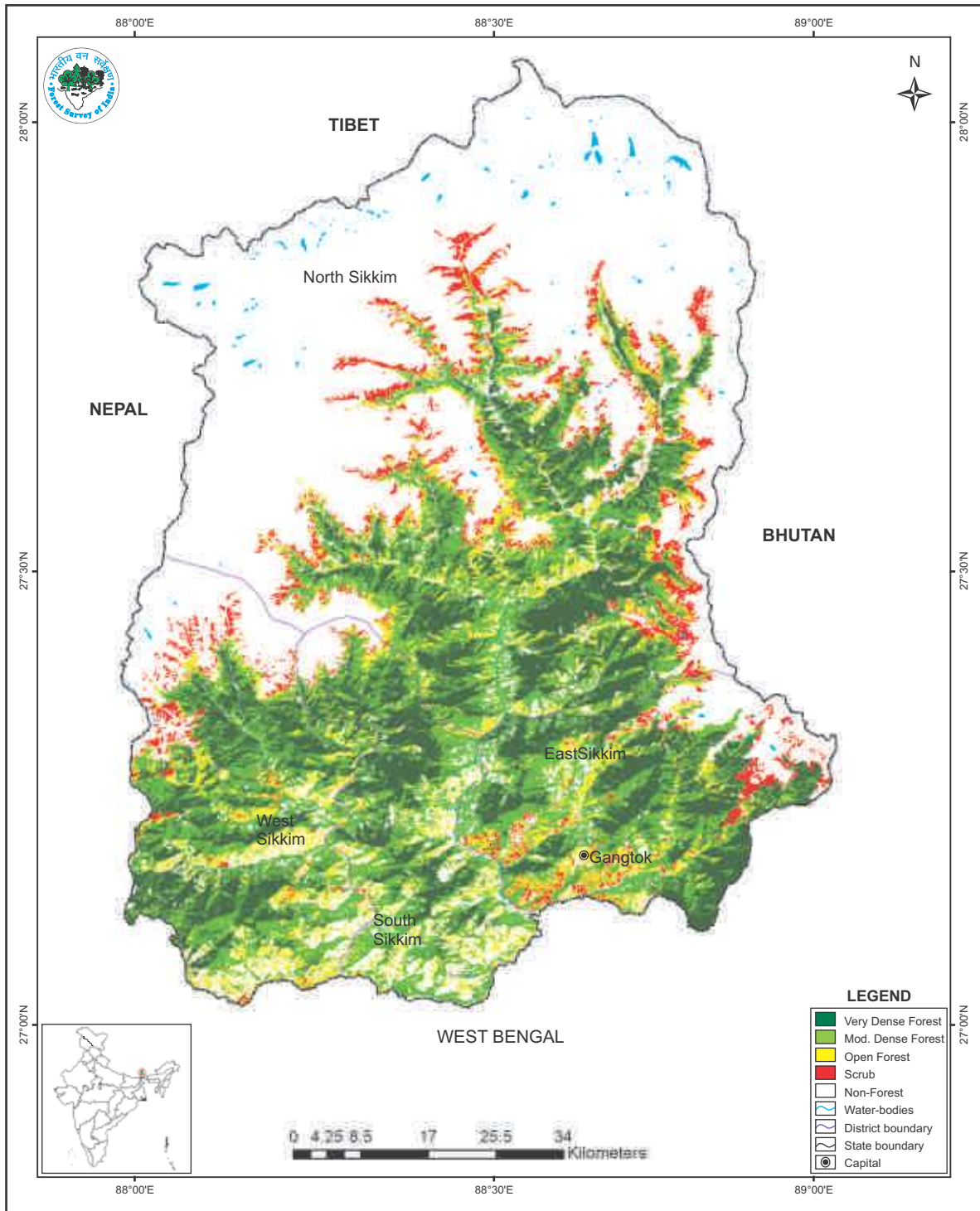


TABLE 11.24.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Sikkim (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
High altitude Wetland	25	154
River/Stream	11	2,417
Sub - Total	36	2,571
Wetlands (<2.25 ha)	38	38
Total	74	2,609
Total Recorded Forest (or Green Wash) Area (in ha)		2,73,707
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.95%

(analysis based on the National Wetland Atlas: India, 2011)

11.24.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Sikkim as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.24.9 Percentage area under different forest types of Sikkim

Sl.No.	Forest Type	% of Forest cover
1.	3C/C1a(I) East Himalayan sal	1.85
2.	3C/C3b East Himalayan Moist Mixed deciduous forest	5.19
3.	8B/C1 East Himalayan Sub-tropical wet hill forest	23.89
4.	11B/C1b <i>Buk</i> Oak Forest	23.04
5.	12/C3a East Himalayan Mixed Coniferous forest	5.90
6.	12/DS1 Montane bamboo Brakes	0.19
7.	14/C2 East Himalayan Sub-alpine birch/fir forest	24.01
8.	15/C1 Birch/ <i>Rhododendron</i> scrub	3.36
9.	15/C3 (Alpine pastures)	3.91
10.	15/E1 Dwarf <i>Rhododendron</i> Scrub	0.30
11.	15/E2 (Dwarf Juniper scrub)	4.96
12.	Plantation/TOF	3.40
	Total	100.00

11.24.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.24.10 and table 11.24.11 in respect of Sikkim.

TABLE 11.24.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	59
Shrub	35
Herb	29

TABLE 11.24.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Sikkim.

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 3- Tropical Moist Deciduous Forests	1.08	1.95	2.35
2	Group 8- Subtropical Broadleaved Hill Forests	2.75	2.62	2.19
3	Group 11- Montane Wet Temperate Forests	2.53	2.41	1.90
4	Group 12- Himalayan Moist Temperate Forests	*	2.57	1.66
5	Group 14- Sub Alpine Forests	2.09	1.87	0.83
6	Group 15- Moist Alpine Scrub	*	0.64	0.69

*adequate number of sample plots were not available

11.24.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.24.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	0.00	0.00
2	Very highly fire prone	0.00	0.00
3	Highly fire prone	0.00	0.00
4	Moderately fire prone	0.00	0.00
5	Less fire prone	5,195.21	100.00
	Total	5,195.21	100.00

11.24.5 Tree Cover

Forest cover presented in the section 11.24.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Sikkim has been estimated as given in table 11.24.13.

TABLE 11.24.13 Tree Cover in Sikkim (in sq km)

Tree Cover	Area
	36

Tree cover of Sikkim has increased by 1 sq km as compared to the previous assessment reported in ISFR 2017.

11.24.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.24.14 Extent of TOF in Sikkim (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
996	36	1,032

11.24.7 Growing Stock in Sikkim

Growing stock in the recorded forest areas (RFA) in Sikkim is given in the table 11.24.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.24.16

TABLE 11.24.15 Growing Stock in Sikkim (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	35.32	0.83
Growing Stock in TOF	1.94	0.12

TABLE 11.24.16 Diameter class distribution of top five species inside RFA in Sikkim (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Castanopsis species</i>	4,959	3,463	1,354
2.	<i>Smylocos theaefolia</i>	11,806	333	0
3.	<i>Viburnum species</i>	6,568	83	0
4.	<i>Shorea robusta</i>	4,534	1,155	83
5.	<i>Eurya japonica</i>	3,492	333	83

11.24.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 57.18 million tonnes (209.66 million tonnes of CO₂ equivalent) which is 0.80% of total forest carbon of the country. Pool wise forest carbon in Sikkim is given in the following table.

TABLE 11.24.17 Forest Carbon in Sikkim in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
17,645	5,372	505	664	32,994	57,180

11.24.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.24.18

TABLE 11.24.18 Growing Stock of Bamboo in Sikkim

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,176	0.73
Total number of culms (in millions)	218	0.55
Total equivalent green weight (in 000' tonnes)	429	0.15

11.24.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Sikkim in Rural and Urban areas are given in the table 11.24.19 and table 11.24.20 respectively

TABLE 11.24.19 Top five tree species in TOF (Rural) in Sikkim

Sl. No.	Species	Relative Abundance (%)
1.	<i>Schima wallichii</i>	16.55
2.	<i>Alnus species</i>	12.67
3.	<i>Ficus species</i>	6.84
4.	<i>Macaranga species</i>	5.88
5.	<i>Castanopsis species</i>	5.83

TABLE 11.24.20 Top five tree species in TOF (Urban) in Sikkim

Sl. No.	Species	Relative Abundance (%)
1.	<i>Alnus species</i>	15.35
2.	<i>Michelia species</i>	11.40
3.	<i>Prunus padus</i>	10.97
4.	<i>Crypomeria japonica</i>	7.02
5.	<i>Spondias axillaris</i>	6.58

11.24.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.24.21 and table 11.24.22 respectively.

TABLE 11.24.21 Major NTFP species in the State of Sikkim

Sl. No.	Species	Plant Type	Relative Abundance (%)
1	<i>Calamus flagellum</i>	Shrub	99.94
2	<i>Spondias axillaris</i>	Tree	0.06

TABLE 11.24.22 Major invasive species in the State inside the RFA/Green wash in Sikkim (in sq km)

Sl. No.	Species	Estimated Extent
1	<i>Glinsoga parviflora</i>	21
2	<i>Parthenium hysterophorus</i>	4
3	<i>Solanum viarum</i>	3
4	<i>Lantana camara</i>	1
5	<i>Ageratum conyzoides</i>	1

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.24.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Sikkim

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Sikkim is given in the table 11.24.23

TABLE 11.24.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Sikkim

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
82,134	4,39,756	66	1,320

11.25

TAMIL NADU

11.25.1 Introduction

Tamil Nadu, the Southernmost State of the country has a geographical area of 1,30,060 sq km which is 3.96% of the total geographical area of India. The State lies between 8°05'N to 13°35'N latitude and 76°15'E to 80°20'E longitude and is borders with Kerala in the west, Karnataka in the northwest, Andhra Pradesh in the north, Bay of Bengal in the east and the Indian Ocean in the south. Physiographically, the State can be divided into four major regions viz Coastal Plains, Eastern Ghats, Central Plateau and Western Ghats. The main rivers of the State are Cauvery, Bhavani, Palar, Vaigai etc. which drain into the Bay of Bengal. Tamil Nadu has a Humid Tropical Climate and the annual rainfall ranges between 900 mm to 1,200 mm and the annual temperature varies from 19°C to 37°C. The State has 32 districts out of which five are hill districts and six are tribal districts. As per the 2011 Census, Tamil Nadu has a population of 72.15 million which is 5.96% of India's population. The rural and urban population constitute 37.23 million and 34.92 million respectively. The Tribal population is 1.10%. The population density of the State is 555 per sq km which is higher than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 22.72 million which is about 4.43% of the total livestock population of the country.

TABLE 11.25.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	13,006	
Reporting area for land utilization	13,033	100.00
Forests	2,125	16.31
Not available for land cultivation	2,688	20.62
Permanent pastures and other grazing lands	108	0.83
Land under misc. tree crops and groves	236	1.80
Culturable wasteland	325	2.50
Fallow land other than current fallows	1,734	13.30
Current fallows	998	7.66
Net area sown	4,819	36.98

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.25.1.1 A Brief Overview of Forestry Scenario

The State is endowed with rich biodiversity, from marine coastal systems in the Gulf of Munnar to the terrestrial evergreen forests in the Western Ghats and temperate forests in the hilly regions. As per the Champion & Seth Classification of Forest Types (1968), the forests in Tamil Nadu belong to nine Forest Type Groups, which are further divided into 39 Forest Types. The Nilgiri Biosphere Reserve represents a unique and threatened ecosystem in the tropics inside the Western Ghats Mountain system and is one of the biodiversity hotspots. Tamil Nadu has been a pioneer State in the biodiversity conservation, particularly in Protected Area management, including conservation of marine fauna. Tamil Nadu is famous for its Teak and Sandalwood forests. Plantations of Sandalwood, conservation and management of mangroves and wetlands are a priority area of the SFD.

Recorded Forest Area (RFA) in the State is 22,877 sq km of which 20,293 sq km is Reserved Forest, 1,782 sq km is Protected Forest and 802 sq km is Unclassed Forests. In Tamil Nadu, during the period 1st January 2015 to 5th February 2019, a total of 542.40 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the State during the last two years, 74,030 ha of plantations were raised in the State.

Five National Parks, 29 Wildlife Sanctuaries and two Conservation Reserves constitute the Protected Area network of the State covering 4.97% of its geographical area. Mukurthi National Park, is famous for Nilgiri Thar.

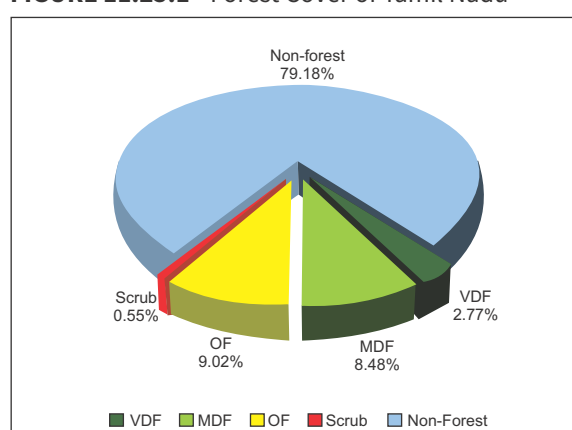
11.25.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Aug 2018, the Forest Cover in the State is 26,364.02 sq km which is 20.27 % of the State's geographical area. In terms of forest canopy density classes, the State has 3,605.49 sq km under Very Dense Forest (VDF), 11,029.55 sq km under Moderately Dense Forest (MDF) and 11,728.98 sq km under Open Forest (OF). Forest Cover in the State has increased by 83.02 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.25.2 Forest Cover of Tamil Nadu

(in sq km)		
Class	Area	% of GA
VDF	3,605.49	2.77
MDF	11,029.55	8.48
OF	11,728.98	9.02
Total	26,364.02	20.27
Scrub	714.72	0.55

FIGURE 11.25.1 Forest Cover of Tamil Nadu



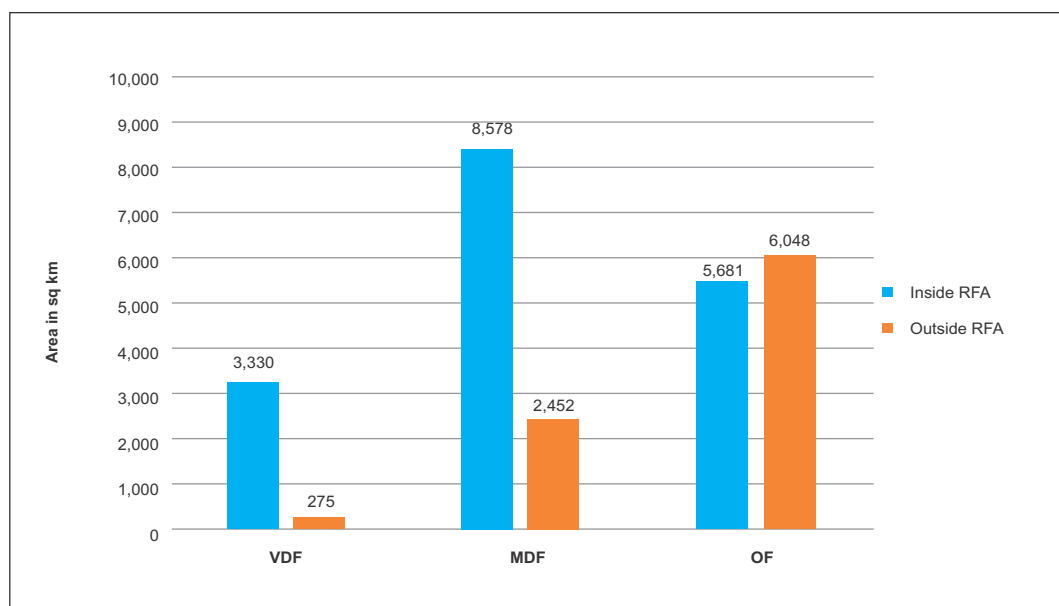
11.25.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 22,877 sq km which is 17.59% of its geographical area. The reserved, protected and unclassified forests are 88.70%, 7.79% and 3.51% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 21,653.95 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.25.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Tamil Nadu (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
3,330	8,578	5,681	17,589	275	2,452	6,048	8,775
18.93%	48.77%	32.30%		3.14%	27.94%	68.92%	

*in case of Tamil Nadu RFA boundaries have been used.

FIGURE 11.25.2 Forest Cover inside and outside RFA in Tamil Nadu**TABLE 11.25.4** District-wise Forest Cover in Tamil Nadu (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Ariyalur	1,940	0.00	40.45	352.69	393.14	20.26	13.14	3.96
Chennai	175	0.00	6.34	6.50	12.84	7.34	-1.16	0.00
Coimbatore ^H	4,732	360.80	680.01	943.83	1,984.64	41.94	9.64	7.01
Cuddalore	3,703	0.00	47.86	343.10	390.96	10.56	8.96	17.71
Dharmapuri ^T	4,497	261.85	835.79	603.50	1,701.14	37.83	3.14	14.31
Dindigul	6,036	253.19	779.85	841.36	1,874.40	31.05	-1.60	30.83
Erode	5,760	402.17	1,128.56	763.73	2,294.46	39.83	-12.54	36.73
Kancheepuram	4,483	0.00	69.95	237.83	307.78	6.87	-2.22	35.75
Kanniyakumari ^H	1,684	137.18	572.65	293.71	1,003.54	59.59	9.54	0.58
Karur	2,904	2.24	43.01	73.21	118.46	4.08	-9.54	7.02
Krishnagiri	5,129	94.87	827.67	694.87	1,617.41	31.53	68.41	31.38
Madurai ^H	3,710	39.51	232.20	283.41	555.12	14.96	-5.88	31.91
Nagapattinam	2,569	0.00	23.53	135.66	159.19	6.20	14.19	0.00
Namakkal ^T	3,420	83.75	283.58	211.72	579.05	16.93	-0.95	20.08

contd.

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Perambalur ^T	1,756	10.03	64.81	66.42	141.26	8.04	-2.74	18.35
Pudukkottai	4,644	0.91	96.04	267.84	364.79	7.86	2.79	7.30
Ramanathapuram	4,104	0.00	23.84	233.11	256.95	6.26	-7.05	0.88
Salem ^T	5,237	198.62	756.76	514.46	1,469.84	28.07	-13.16	33.64
Sivaganga	4,233	0.00	42.32	287.34	329.66	7.79	-14.34	5.34
Thanjavur	3,411	0.00	265.06	81.13	346.19	10.15	-9.81	0.33
The Nilgiris ^H	2,565	466.72	629.85	634.44	1,731.01	67.49	12.01	6.85
Theni	2,868	183.06	470.23	522.00	1,175.29	40.98	-1.71	29.36
Thiruvallur	3,394	11.00	45.87	228.80	285.67	8.42	-1.33	49.43
Thiruvavur	2,274	0.46	35.94	31.07	67.47	2.97	-17.53	0.00
Thoothukkudi	4,745	0.00	26.08	230.60	256.68	5.41	-15.32	68.65
Tiruchirappalli ^T	4,509	53.53	228.35	189.48	471.36	10.45	-11.64	30.33
Tirunelveli ^H	6,693	442.45	567.02	290.77	1,300.24	19.43	0.24	24.31
Tiruppur	5,187	48.28	237.68	558.47	844.43	16.28	39.43	8.78
Tiruvannamalai ^T	6,188	233.79	595.83	478.74	1,308.36	21.14	-3.64	67.06
Vellore	6,075	202.86	937.68	678.05	1,818.59	29.94	5.59	72.80
Viluppuram	7,194	79.48	301.56	476.52	857.56	11.92	11.56	46.44
Virudhunagar	4,241	38.74	133.18	174.62	346.54	8.17	16.54	7.60
Grand Total	1,30,060	3,605.49	11,029.55	11,728.98	26,364.02	20.27	83.02	714.72

TABLE 11.25.5 Forest Cover Change Matrix for Tamil Nadu

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	3,552	101	4	0	15	3,672
Moderately Dense Forest	35	10,661	159	3	121	10,979
Open Forest	2	127	10,567	17	917	11,630
Scrub	0	0	14	611	32	657
Non Forest	16	141	985	84	1,01,896	1,03,122
Total ISFR 2019	3,605	11,030	11,729	715	1,02,981	1,30,060
Net Change	-67	51	99	58	-141	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.25.6 Altitude-wise Forest Cover in Tamil Nadu

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	1,11,060	376	5,121	8,586	14,083 (53.42%)	564
500-100	13,688	1,810	4,398	2,411	8,619 (32.69%)	17
1000-2000	4,437	1,087	1,394	697	3,178 (12.05%)	4
2000-3000	875	332	117	35	484 (1.84%)	130
Total	1,30,060	3,605	11,030	11,729	26,364	715

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.25.7 Forest Cover in different slope classes in Tamil Nadu

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,09,583	335	3438	7407	11,180 (42.41%)	432
5-10	5,911	527	1750	1,270	3,547 (13.45%)	71
10-15	3,943	584	1504	875	2,963 (11.24%)	53
15-20	3,364	586	1375	717	2,678 (10.16%)	48
20-25	2,856	557	1,218	601	2,376 (9.01%)	44
25-30	2,208	484	929	460	1,873 (7.10%)	36
>30	2,195	532	816	399	1,747 (6.63%)	31
Total	1,30,060	3,605	11,030	11,729	26,364	715

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.25.3 Forest Cover Map of Tamil Nadu

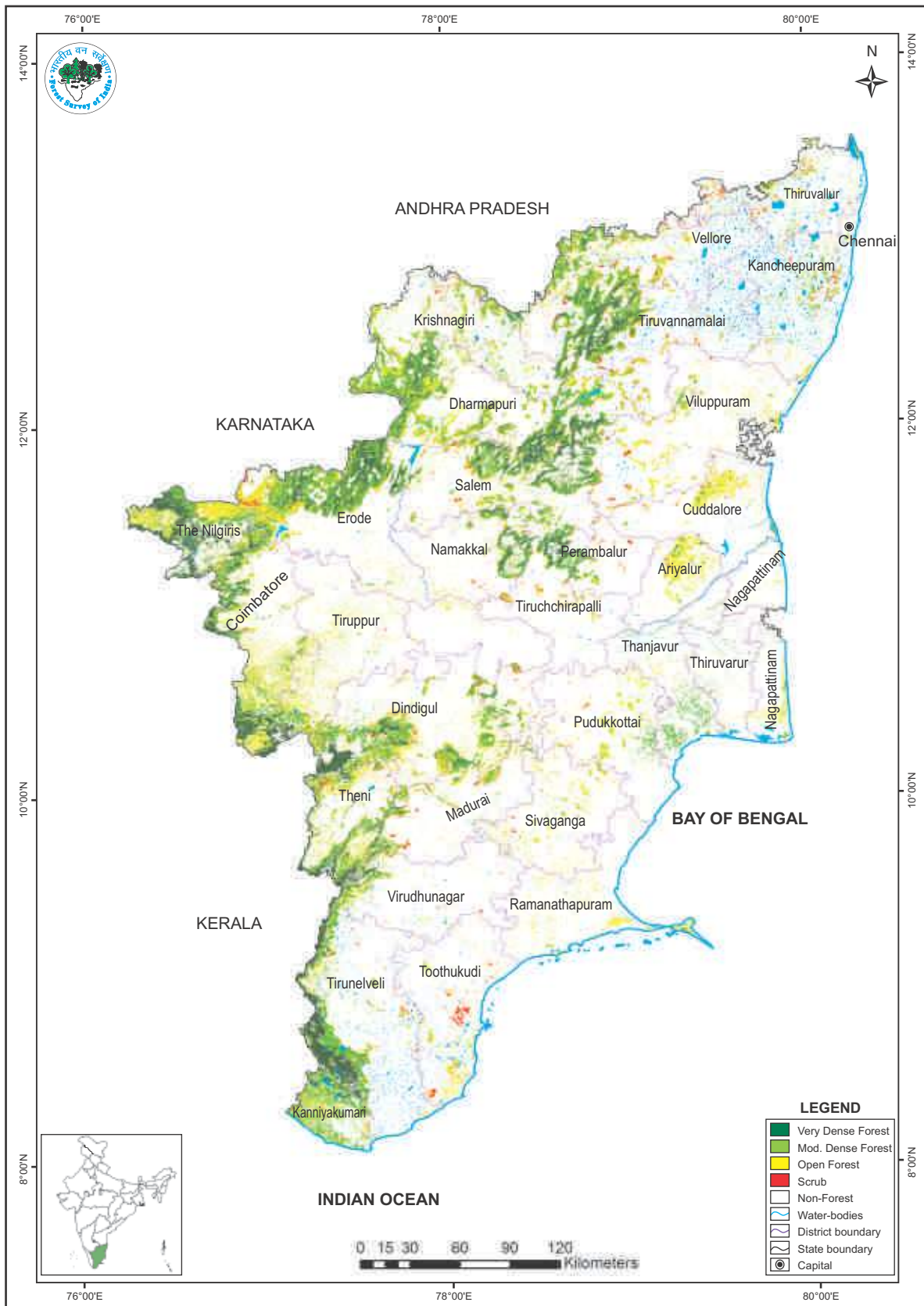


TABLE 11.25.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Tamil Nadu (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	198	2,907
Waterlogged	2	16
River/Stream	48	5,571
Sub - Total	248	8,494
Inland Wetlands -Man-made		
Reservoir/Barrage	35	13,900
Tank/Pond	703	3,824
Waterlogged	5	1,708
Sub - Total	743	19,432
Coastal Wetlands – Natural		
Lagoon	4	8,377
Creek	2	393
Sand/Beach	19	572
Intertidal mud flat	20	2,338
Salt Marsh	17	514
Mangrove	27	4,074
Coral Reef	15	597
Sub -Total	104	16,865
Wetlands (<2.25 ha)	428	428
Total	1,523	45,219
Total Recorded Forest (or Green Wash) Area (in ha)		21,65,395
% of Wetland area inside Recorded Forest (or Green Wash) Area		2.09%

(analysis based on the National Wetland Atlas: India, 2011)

11.25.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Tamil Nadu as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.25.9 Percentage area under different forest types of Tamil Nadu

Sl.No.	Forest Type	% of Forest cover
1.	1A/C3 Southern Hilltop Tropical Evergreen Forest	0.39
2.	1A/C4 West Coast Tropical Evergreen Forest	2.48
3.	2A/C2 West Coast Semi-Evergreen Forest	1.31
4.	2A/C3 Tirunelveli Semi-Evergreen Forest	0.42
5.	2/E3 Moist Bamboo Brakes	1.17
6.	3B/C1a Very Moist Teak Forest	0.21
7.	3B/C1b Moist Teak Forest	0.62
8.	3B/C1c Slightly Moist Teak Forest	0.18
9.	3B/C2 Southern Moist Mixed Deciduous Forest	4.40
10.	3B/2S1 Southern Secondary Moist Mixed Deciduous Forest	0.89
11.	4A/L1 Littoral Forest	0.03

Contd.

Sl.No.	Forest Type	% of Forest cover
12.	4B/TS1 Mangrove Scrub	0.01
13.	4B/TS2 Mangrove Forest	0.21
14.	4C/FS2 Submontane Hill-Valley Swamp Forest	0.01
15.	4E/RS1 Riparian Fringing Forest	0.14
16.	5A/C1a Very Dry Teak Forest	0.00
17.	5A/C1b Dry Teak Forest	0.56
18.	5A/C2 Dry Red Sanders-Bearing Forest	0.04
19.	5A/C3 Southern Dry Mixed Deciduous Forest	22.43
20.	5/DS1 Dry Deciduous Scrub	3.40
21.	5/DS2 Dry Savannah Forest	1.41
22.	5/DS3 (Euphorbia Scrub)	0.01
23.	5/DS4 (Dry Grass Land)	1.17
24.	5/E4 Hardwickia Forest	1.57
25.	5/E9 Dry Bamboo Brake	0.56
26.	5/1S1 Dry Tropical Riverain Forest	0.41
27.	5/2S1 Secondary Dry Deciduous Forest	9.91
28.	6A/C1 Southern Thorn Forest	6.85
29.	6A/C2 Karnatak Umbrella Thorn Forest	5.38
30.	6A/DS1 Southern Thorn Scrub	1.75
31.	6A/DS2 Southern Euphorbia Scrub	0.16
32.	7/C1 Tropical Dry Evergreen Forest	1.14
33.	7/DS1 Tropical Dry Evergreen Scrub	0.27
34.	8A/C1 Nilgiri Sub Tropical Hill Forest	0.61
35.	8A/DS1 South Indian Sub-Tropical Hill Savannah (Woodland)	0.06
36.	8A/E1 Reed Brakes (Ochalandra)	0.02
37.	11A/C1 Southern Montane Wet Temperate Forest	0.64
38.	11A/DS1 Southern Montane Wet Scrub	0.01
39.	11A/DS2 Southern Montane Wet Grassland	0.77
40.	Plantation/TOF	28.40
	Total	100.00

11.25.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.25.10 and table 11.25.11 in respect of Tamil Nadu.

TABLE 11.25.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	252
Shrub	313
Herb	87

TABLE 11.25.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Tamil Nadu

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 1- Tropical Wet Evergreen Forests	3.25	3.23	2.03
2	Group 2- Tropical Semi-Evergreen Forests	2.77	2.82	2.30
3	Group 3- Tropical Moist Deciduous Forests	3.39	3.27	2.31
4	Group 4- Littoral and Swamp Forests	*	1.04	1.43
5	Group 5- Tropical Dry Deciduous Forests	3.92	3.91	2.26
6	Group 6- Tropical Thorn Forests	3.09	3.10	1.85
7	Group 7- Tropical Dry Evergreen Forests	2.81	2.82	1.77
8	Group 8- Subtropical Broadleaved Hill Forests	2.94	3.20	0.62
9	Group 11- Montane Wet Temperate Forests	2.18	2.68	2.36

*adequate number of sample plots were not available

11.25.4 Fire Prone Forest Areas

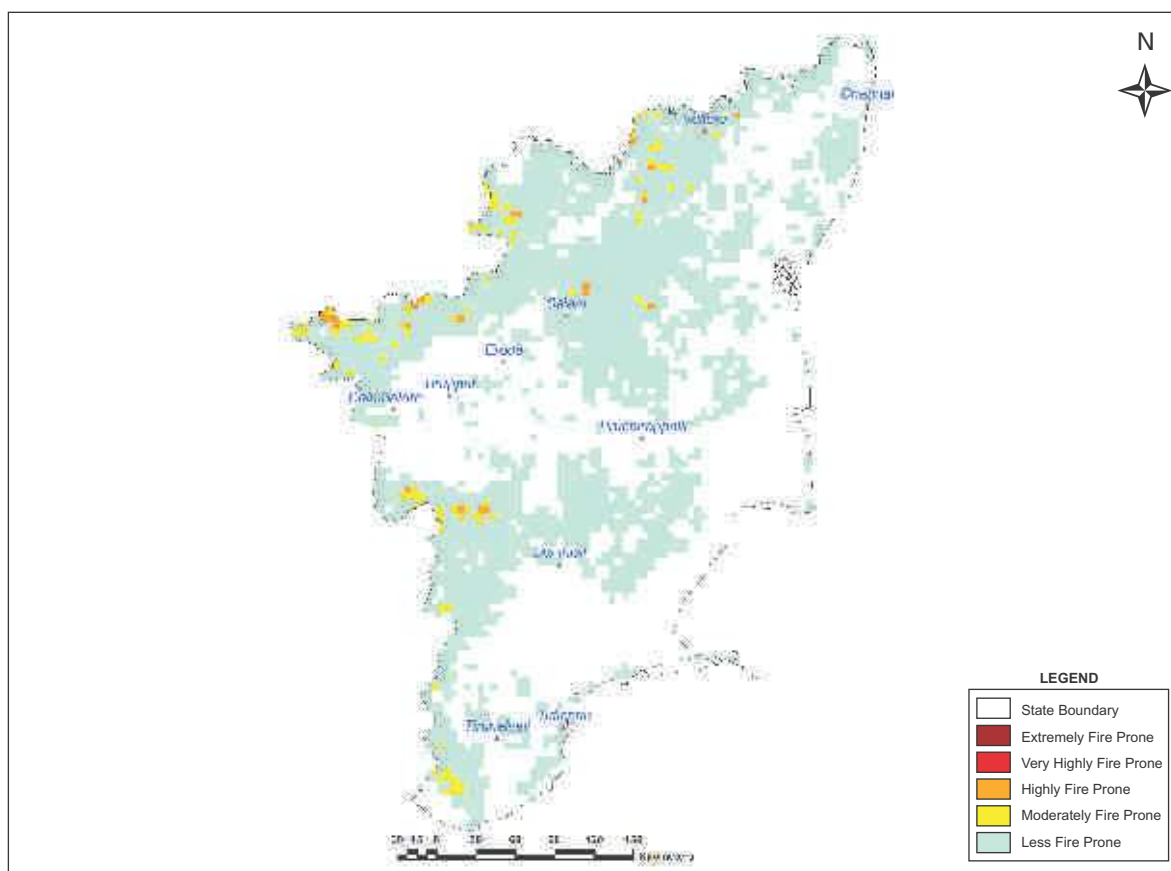
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.25.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	0.00	0.00
3.	Highly fire prone	561.97	2.19
4.	Moderately fire prone	2,306.92	7.92
5.	Less fire prone	60,434.72	89.89
	Total	63,303.61	100.00



FIGURE 11.25.4 Fire prone forest areas under different fire prone classes



11.25.5 Tree Cover

Forest cover presented in the section 11.25.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Tamil Nadu has been estimated as given table 11.25.13.

TABLE 11.25.13 Tree Cover in Tamil Nadu
(in sq km)

Tree Cover	Area
	4,830

Tree cover of Tamil Nadu has increased by 159 sq km as compared to the previous assessment reported in ISFR2017.

11.25.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.25.14 Extent of TOF in Tamil Nadu (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
8,775	4,830	13,605

11.25.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Tamil Nadu is given in the table 11.25.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.25.16

TABLE 11.25.15 Growing Stock in Tamil Nadu (in m cum)

Growing Stock (GS)	% of Country's GS	
Growing Stock in Recorded Forest Area	96.97	2.27
Growing Stock in TOF	76.30	4.65

TABLE 11.25.16 Diameter class distribution of top five species inside RFA in Tamil Nadu (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Albizzia amara</i>	68,756	2,218	61
2.	<i>Anogeissus latifolia</i>	31,396	2,787	0
3.	<i>Canthium decocum</i>	16,760	297	0
4.	<i>Commiphora ostdets</i>	15,118	792	61
5.	<i>Eucalyptus species</i>	17,978	991	0

11.25.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 216.78 million tonnes (794.86 million tonnes of CO₂ equivalent) which is 3.04% of total forest carbon of the country. Pool wise forest carbon in is given in the following table

TABLE 11.25.17 Forest Carbon in Tamil Nadu in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
62,092	21,433	776	4,107	1,28,374	2,16,782

11.25.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.25.18

TABLE 11.25.18 Growing Stock of Bamboo in Tamil Nadu

Growing Stock (GS)	% of Country's GS of Bamboo	
Bamboo bearing area inside RFA/Green Wash (in sq km)	4,357	2.72
Total number of culms (in millions)	946	2.40
Total equivalent green weight (in 000' tonnes)	7,779	2.80

11.25.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Tamil Nadu in Rural and Urban areas are given in the table 11.25.19 and table 11.25.20 respectively

TABLE 11.25.19 Top five tree species in TOF (Rural) in Tamil Nadu

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	27.80
2.	<i>Azadirachta indica</i>	12.24
3.	<i>Borassus flabelliformis</i>	11.05
4.	<i>Mangifera indica</i>	5.19
5.	<i>Tectona grandis</i>	4.35

TABLE 11.25.20 Top five tree species in TOF (Urban) in Tamil Nadu

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	33.82
2.	<i>Azadirachta indica</i>	12.37
3.	<i>Moringa pterygosperma</i>	5.02
4.	<i>Borassus flabelliformis</i>	4.27
5.	<i>Mangifera indica</i>	4.11

11.25.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.25.21 and table 11.25.22 respectively.

TABLE 11.25.21 Major NTFP Species in the State of Tamil Nadu

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Albizia amara</i>	Tree	56.60
2.	<i>Solanum nigrum</i>	Herb	26.15
3.	<i>Embilica officinalis</i>	Tree	5.20
4.	<i>Tamarindus indica</i>	Tree	2.15
5.	<i>Anacardium occidentale</i>	Tree	2.10

TABLE 11.25.22 Major invasive species in the State inside the RFA/Green Wash in Tamil Nadu (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	2,209
2.	<i>Chromolaena odorata</i>	420
3.	<i>Solanum elaeagnifolium</i>	126
4.	<i>Ageratum conyzoides</i>	83
5.	<i>Cuscuta spp.</i>	61

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent

11.25.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Tamil Nadu

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Tamil Nadu is given in the table 11.25.23

TABLE 11.25.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Tamil Nadu

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
17,52,370	2,01,22,937	2,350	1,02,566

11.26

TELANGANA

11.26.1 Introduction

Telangana, covers an area of 1,12,077 sq km, which is 3.41% of the geographical area of the country. The State lies between 15°50'N to 19°55'N latitudes and 77°14'E to 81°19'E longitude and is bordered by Maharashtra in the north & northwest, Karnataka in the west, Andhra Pradesh in the south & southeast and Chhattisgarh in the east. Being located in the Deccan Plateau in the central stretch, the State has sub-tropical climate. The annual rainfall ranges between 1,100 mm to 1,200 mm and the annual temperature varies from 15°C to 45°C. The State is drained by a number of rivers which include Godavari and Krishna. The State has 10 districts, of which 3 are tribal districts. As per the 2011 Census, Telangana has a population of 35.19 million, which is 2.91% of India's population. The rural and urban population constitute 61.12% and 38.88% respectively. The Tribal population is 9.35%. The population density is 306 per sq km, which is lower than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 56.10 million in the State.

TABLE 11.26.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	11,231	
Reporting area for land utilization	11,208	100.00
Forests	2,540	22.66
Not available for land cultivation	1,492	13.31
Permanent pastures and other grazing lands	298	2.66
Land under misc. tree crops and groves	112	1.00
Culturable wasteland	183	1.64
Fallow land other than current fallows	805	7.18
Current fallows	1,401	12.50
Net area sown	4,377	39.05

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.26.1.1 A Brief Overview of Forestry Scenario

The State of Telangana is endowed with rich diversity of Flora and Fauna. The State has dense Teak forests on the northern part along the banks of river Godavari. As per the Champion & Seth Classification of Forest Types (1968), the forests in Telangana belong to three Forest Type Groups, which are further divided into 12 Forest Types. The State Government has taken up a massive greening programme, 'Telangana Ku Harita Haram' in the State to plant and protect 230 crore seedlings over a period of 4 years. This initiative aims at achieving the twin objectives of increasing the forest cover and reduce pressure on the existing forest resources, through massive community participation by Vana Samrakshna Samithis (VSS) and Eco-Development Committees (EDCs) in Protected Areas and Watershed Development Committees in the Watershed areas.

Recorded Forest Area (RFA) in the State is 26,904 sq km of which 20,353 sq km is Reserved Forest, 5,939 sq km is Protected Forest and 612 sq km is Unclassed Forests. In Telangana, during the period 1st January 2015 to 5th February 2019, a total of 9,420 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the State during that last two years, 12,730 ha of plantations including avenue plantations in the State.

Three National Parks and nine Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.08% of its geographical area.

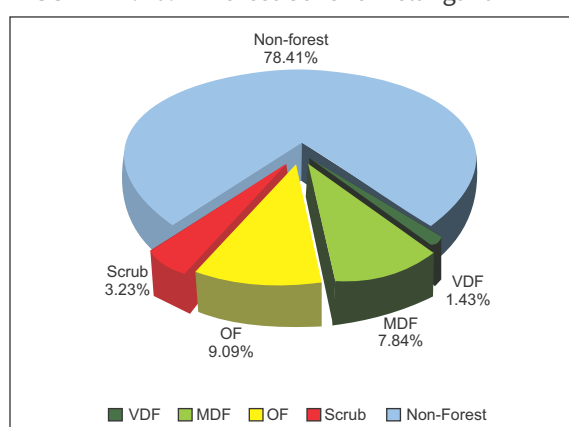
11.26.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Jan 2018, the Forest Cover in the State is 20,582.31 sq km which is 18.36 % of the State's geographical area. In terms of forest canopy density classes, the State has 1,608.24 sq km under Very Dense Forest (VDF), 8,787.13 sq km under Moderately Dense Forest (MDF) and 10,186.94 sq km under Open Forest (OF). Forest Cover in the State has increased by 163.31 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.26.2 Forest Cover of Telangana

(in sq km)		
Class	Area	% of GA
VDF	1,608.24	1.43
MDF	8,787.13	7.84
OF	10,186.94	9.09
Total	20,582.31	18.36
Scrub	3,615.04	3.23

FIGURE 11.26.1 Forest Cover of Telangana



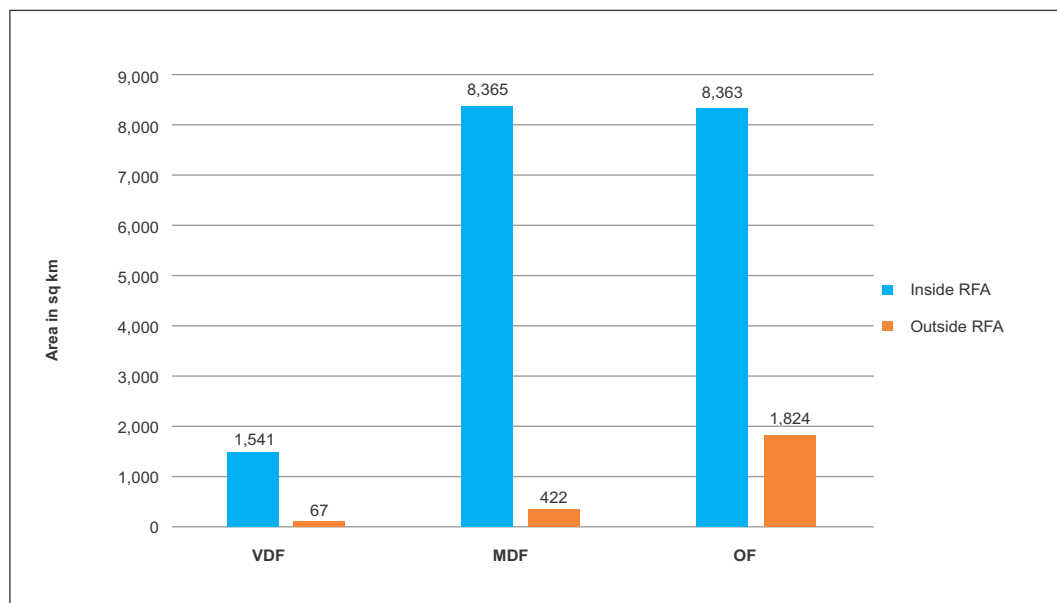
11.26.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 26,904 sq km which is 24.00% of its geographical area. The reserved, protected and unclassified forests are 75.65%, 22.07% and 2.28% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 26,989.00 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.26.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Telangana (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1,541	8,365	8,363	18,269	67	422	1,824	2,313
8.43%	45.79%	45.78%		2.90%	18.26%	78.84%	

*in case of Telangana RFA boundaries have been used.

FIGURE 11.26.2 Forest Cover inside and outside RFA in Telangana**TABLE 11.26.4** District- wise Forest Cover in Telangana (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Adilabad ^T	16,105	150.25	3,247.07	2,324.00	5,721.32	35.53	33.32	155.36
Hyderabad	217	0.00	5.00	13.68	18.68	8.61	1.68	2.42
Rangareddy	7,493	0.00	146.31	624.11	770.42	10.28	10.42	512.19
Karimnagar	11,823	71.00	769.25	1,147.96	1,988.21	16.82	26.21	520.34
Khammam ^T	13,266	721.30	2,245.62	1,512.22	4,479.14	33.76	46.14	61.27
Mahbubnagar	18,432	338.15	633.79	1,329.11	2,301.05	12.48	3.05	676.93
Medak	9,699	0.00	124.03	615.28	739.31	7.62	-6.69	362.36
Nalgonda	14,240	0.00	22.25	392.19	414.44	2.91	4.44	751.04
Nizamabad	7,956	0.00	253.27	943.02	1,196.29	15.04	9.29	320.68
Warangal ^T	12,846	327.54	1,340.54	1,285.37	2,953.45	22.99	35.45	252.45
Grand Total	1,12,077	1,608.24	8,787.13	10,186.94	20,582.31	18.36	163.31	3,615.04

TABLE 11.26.5 Forest Cover Change Matrix for Telangana

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1,596	0	0	0	0	1,596
Moderately Dense Forest	12	8,622	74	3	27	8,738
Open Forest	0	146	9,635	164	140	10,085
Scrub	0	0	93	3,110	35	3,238
Non Forest	0	19	385	338	87,678	88,420
Total ISFR 2019	1,608	8,787	10,187	3,615	87,880	1,12,077
Net Change	12	49	102	377	-540	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.26.6 Altitude-wise Forest Cover in Telangana

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	88,743	1,277	7,505	7,547	16,329 (79.33%)	2,596
500-1000	23,334	331	1,282	2,640	4,253 (20.67%)	1,019
Total	1,12,077	1,608	8,787	10,187	20,582	3,615

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.26.7 Forest Cover in different slope classes in Telangana

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,01,773	919	5,655	7,061	13,635 (66.25%)	2,768
5-10	5,542	284	1,374	1,524	3,182 (15.46%)	439
10-15	2,243	163	793	749	1,705 (8.28%)	188
15-20	1,260	107	490	424	1,021 (4.96%)	108
20-25	719	71	280	243	594 (2.89%)	65
25-30	357	41	132	122	295 (1.43%)	33
>30	183	23	63	64	150 (0.73%)	14
Total	1,12,077	1,608	8,787	10,187	20,582	3,615

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.26.3 Forest Cover Map of Telangana

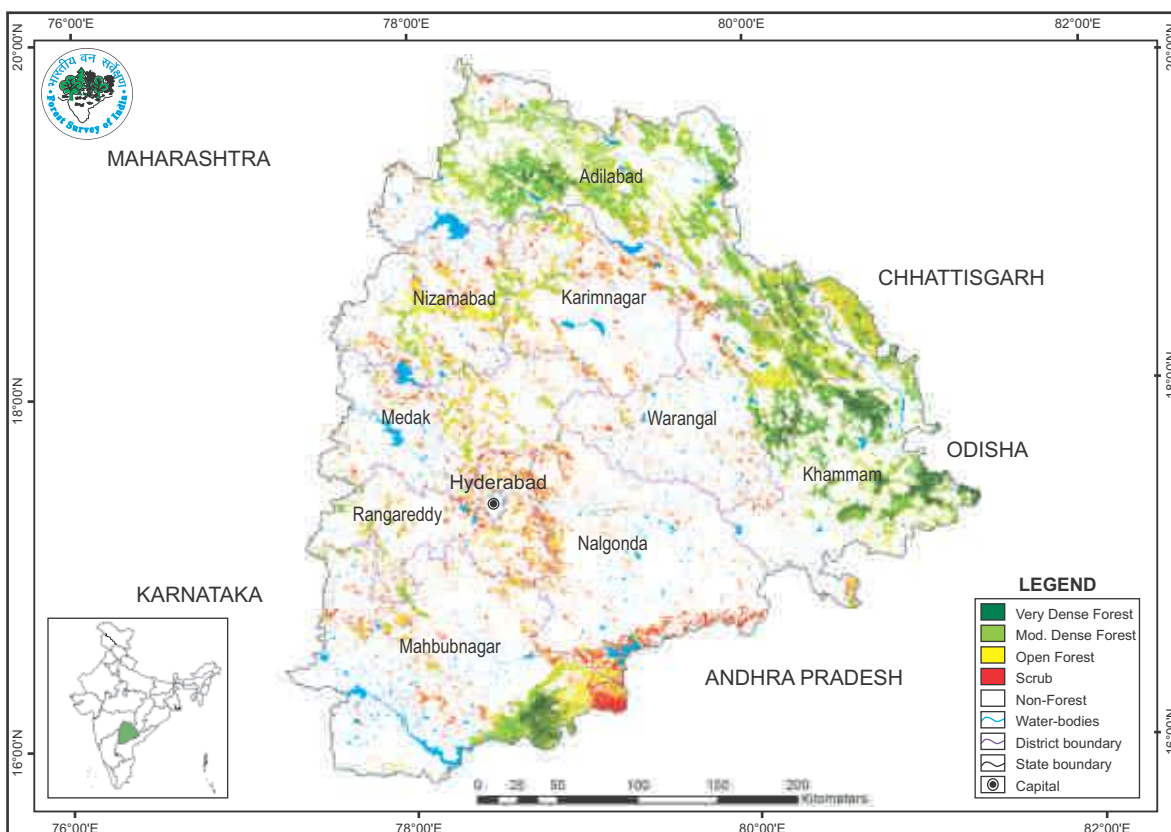


TABLE 11.26.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Telangana (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	2	1,1822
Waterlogged	2	12
River/Stream	55	11,252
Sub - Total	59	13,086
Inland Wetlands - Man-made		
Reservoir/Barrage	169	11,547
Tank/Pond	482	3,052
Waterlogged	3	197
Sub - Total	654	14,796
Wetlands (<2.25 ha)	357	357
Total	1,070	28,239
Total Recorded Forest (or Green Wash) Area (in ha)		26,98,900
% of Wetland area inside Recorded Forest (or Green Wash) Area		1.05%

(analysis based on the National Wetland Atlas: India, 2011)

11.26.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Telangana as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.26.9 Percentage area under different forest types of Telangana

Sl.No.	Forest Type	% of Forest cover
1.	3B/C2 Southern Moist Mixed Deciduous Forest	0.27
2.	5A/C3 Southern Dry Mixed Deciduous Forest	60.52
3.	5B/DS1 Dry Deciduous Scrub	19.21
4.	5A/C1b Dry Teak Forest	14.84
5.	5/2S1 Secondary Dry Deciduous Forest	0.89
6.	5/E9 Dry Bamboo Brake	0.07
7.	5/E4 <i>Hardwickia</i> Forest	0.00
8.	5/E2 <i>Boswellia</i> Forest	0.00
9.	5/DS2 Dry Savannah Forest	0.22
10.	5/DS4 (Dry Grass Land)	0.13
11.	6A/DS1 Southern Thorn Scrub	0.00
12.	6A/C1 Southern Thorn Forest	1.46
13.	Plantation/TOF	2.39
	Total	100.00

11.26.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in respect of Telangana.

TABLE 11.26.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	167
Shrub	67
Herb	33

TABLE 11.26.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Telangana

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	2.65	3.03	1.95
2.	Group 5- Tropical Dry Deciduous Forests	3.63	2.68	2.34
3.	Group 6- Tropical Thorn Forests	2.42	2.33	1.80

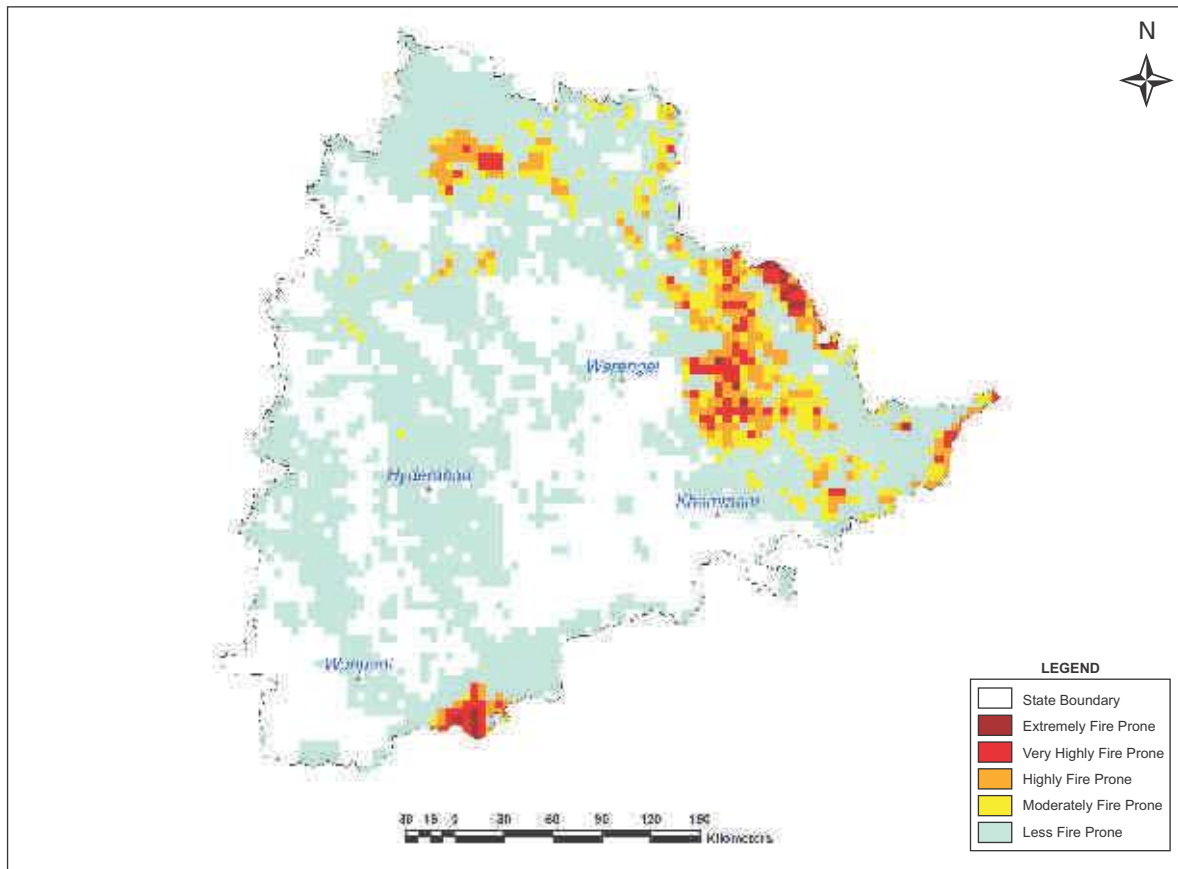
11.26.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.26.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	1,062.98	4.21
2.	Very highly fire prone	1,542.55	6.89
3.	Highly fire prone	4,586.50	17.59
4.	Moderately fire prone	6,145.56	18.60
5.	Less fire prone	54,018.12	52.71
	Total	67,355.71	100.00

FIGURE 11.26.4 Fire prone forest areas under different fire prone classes



11.26.5 Tree Cover

Forest cover presented in the section 11.26.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Telangana has been estimated as given in table 11.26.13.

TABLE 11.26.13 Tree Cover in Telangana
(in sq km)

Tree Cover	Area
	2,514

Tree cover of Telangana has decreased by 155 sq km as compared to the previous assessment reported in ISFR2017.

11.26.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.26.14 Extent of TOF in Telangana (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
2,313	2,514	4,827

11.26.7 Growing Stock in Telangana

Growing stock in the recorded forest areas (RFA) in Telangana is given in the table 11.26.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.26.16

TABLE 11.26.15 Growing Stock in Telangana (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	80.96	1.89
Growing Stock in TOF	41.45	2.52

TABLE 11.26.16 Diameter class distribution of top five species inside RFA in Telangana (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Tectona grandis</i>	56,011	5,435	282
2.	<i>Chloroxylon swietenia</i>	31,471	942	0
3.	<i>Xylia xylocarpa</i>	25,880	2,818	71
4.	<i>Anogeissus latifolia</i>	24,861	2,422	0
5.	<i>Lannea coromandelica</i>	19,562	4,776	141

11.26.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 151.84 million tonnes (556.75 million tonnes of CO₂ equivalent) which is 2.13% of total forest carbon of the country. Pool wise forest carbon in Telangana is given in the following table

TABLE 11.26.17 Forest Carbon in Telangana in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
41,389	17,227	333	2,031	90,862	1,51,842

11.26.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.26.18.

TABLE 11.26.18 Growing Stock of Bamboo in Telangana

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green wash (in sq km)	5,438	3.40
Total number of culms (in millions)	926	2.35
Total equivalent green weight (in 000' tonnes)	6,781	2.44

11.26.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Telangana in Rural and Urban areas are given in the table 11.26.19 and table 11.26.20 respectively

TABLE 11.26.19 Top five tree species in TOF (Rural) in Telangana

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	41.63
2.	<i>Azadirachta indica</i>	11.78
3.	<i>Butea frondosa</i>	5.21
4.	<i>Acacia Arabica</i>	4.38
5.	<i>Borassus flabelliformis</i>	3.56

TABLE 11.26.20 Top five tree species in TOF (Urban) in Telangana

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	18.94
2.	<i>Mangifera indica</i>	8.84
3.	<i>Leucaena leucocephala</i>	7.04
4.	<i>Tectona grandis</i>	6.72
5.	<i>Bongamia glabra</i>	6.49

11.26.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.26.21 and table 11.26.22 respectively.

TABLE 11.26.21 Major NTFP species in the State of Telangana

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Paris polyphyia</i>	Herb	23.16
2.	<i>Oscimum bassilicum</i>	Shrub	12.78
3.	<i>Calamus longietus</i>	Herb	12.14
4.	<i>Solanum nigrum</i>	Shrub	11.82
5.	<i>Desmodium gangeticum</i>	Shrub	7.19

TABLE 11.26.22 Major invasive species in the State inside the RFA/Green wash in Telangana (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	259
2.	<i>Chromolaena odorata</i>	247
3.	<i>Senna occidentalis</i>	153
4.	<i>Cassia tora</i>	52
5.	<i>Argemone mexicana</i>	50

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.26.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Telangana

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Telangana is given in the table 11.26.23

TABLE 11.26.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Telangana

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
19,68,863	1,59,57,527	6,861	1,541

11.27

TRIPURA

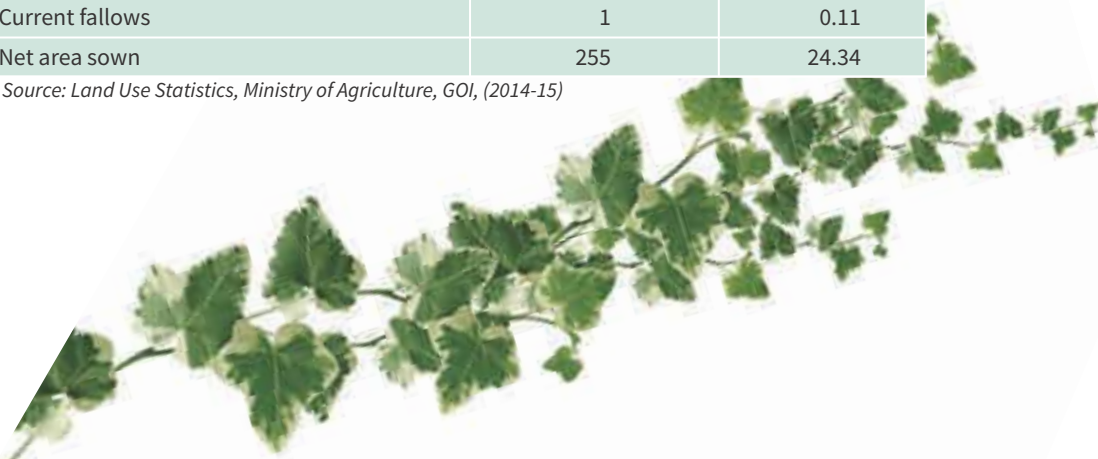
11.27.1 Introduction

Tripura is located in the North Eastern region of the country and has an area of 10,486 sq km which is 0.32% of the geographical area of the country. The State lies between 22°57' N to 24°32' N latitude and 91°10' E to 92°20' E longitude and is surrounded by Bangladesh on its north, south and west and shares borders with Assam and Mizoram on the east. Tripura has a Humid Climate and the annual rainfall ranges between 2,250 mm to 2,500 mm and the annual temperature varies from 7°C to 36°C. The State has four districts, all of which are hilly as well as tribal. The social composition of the population of Tripura is diverse. Around one-third of the population belongs to the Scheduled Tribes. The rural and urban population constitutes 73.83% and 26.17% respectively. The Tribal population is 31.76%. According to 2011 census, the State's population is 3.67 million which is 0.30% of the country's population. The average population density of the State is 350 persons per sq km, which is lower than the national average. The Livestock population of the State as per 19th Livestock Census 2012 is 1.94 million.

TABLE 11.27.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	1,049	
Reporting area for land utilization	1,049	100.00
Forests	629	59.99
Not available for land cultivation	146	13.93
Permanent pastures and other grazing lands	1	0.11
Land under misc. tree crops and groves	11	1.07
Culturable wasteland	3	0.29
Fallow land other than current fallows	2	0.16
Current fallows	1	0.11
Net area sown	255	24.34

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.27.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Tripura belong to two Forest Type Groups which are further divided into five Forest Types. The forests in the State are mainly tropical evergreen, semi evergreen, and moist deciduous. Sizeable area is covered with bamboo brakes which virtually form a sub climax resulting from shifting cultivation. Bamboo plays a very vital role in the economy of the State.

The State has taken special initiative in involvement of people in management of forests in territorial Divisions and Wildlife Sanctuaries through formation of 'Joint Forest Management' Committees (JFMCs) and Eco Development Committees (EDCs) respectively.

Recorded Forest Area (RFA) in the State is 6,249 sq km of which 4,175 sq km is Reserved Forest, 2 sq km is Protected Forest and 2,117 sq km is Unclassed Forests. In Tripura, during the period 1st January 2015 to 5th February 2019, a total of 83.98 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Two National Parks and four Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.76% of its geographical area.

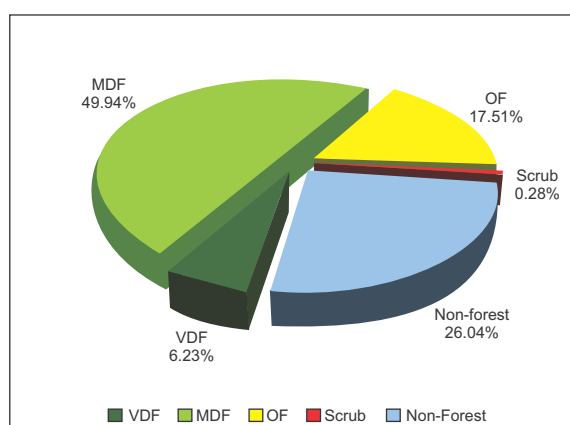
11.27.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Dec 2017, the Forest Cover in the State is 7,725.59 sq km which is 73.68 % of the State's geographical area. In terms of forest canopy density classes, the State has 653.51 sq km under Very Dense Forest (VDF), 5,236.19 sq km under Moderately Dense Forest (MDF) and 1,835.89 sq km under Open Forest (OF). Forest Cover in the State has decreased by 0.41 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.27.2 Forest Cover of Tripura
(in sq. km)

Class	Area	% of GA
VDF	653.51	6.23
MDF	5,236.19	49.94
OF	1,835.89	17.51
Total	7,725.59	73.68
Scrub	28.79	0.28

FIGURE 11.27.1 Forest Cover of Tripura



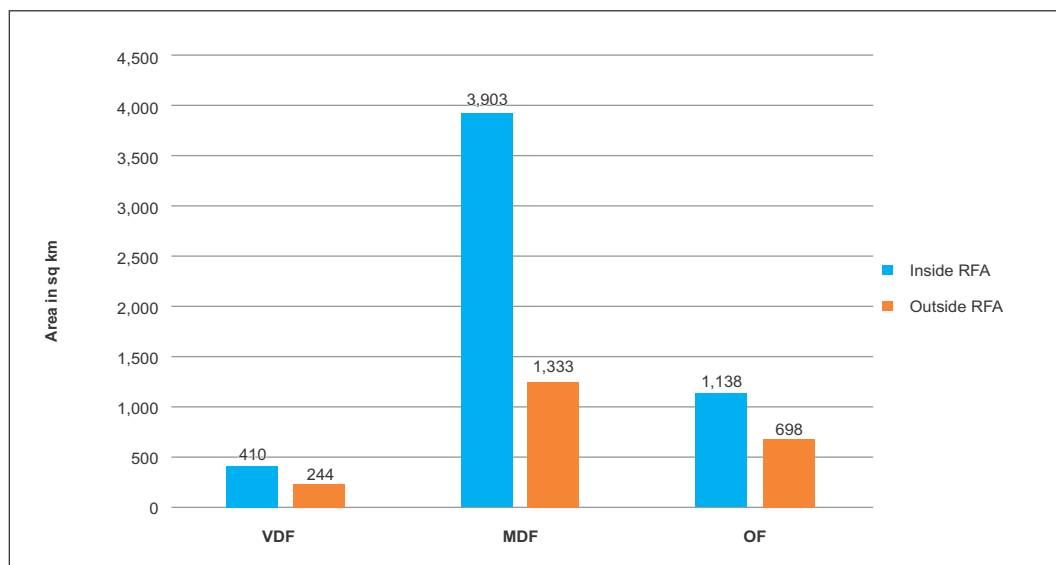
11.27.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 6,294 sq km which is 60.02% of its geographical area. The Reserved, Protected and Unclassed forests are 66.33%, 0.03% and 33.64% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 5,837.64 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.27.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Tripura (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
410	3,903	1,138	5,451	244	1,333	698	2,275
7.51%	71.62%	20.87%		10.71%	58.59%	30.70%	

*in case of Tripura RFA boundaries have been used.

FIGURE 11.27.2 Forest Cover inside and outside RFA in Tripura**TABLE 11.27.4** District-wise Forest Cover in Tripura (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Dhalai TH	2,400	115.94	1,465.81	401.95	1,983.70	82.65	3.70	1.90
North Tripura TH	2,036	49.98	1,053.25	376.96	1,480.19	72.70	2.19	17.66
South Tripura TH	3,057	239.41	1,578.03	454.76	2,272.20	74.32	-4.80	0.10
West Tripura TH	2,993	248.18	1,139.10	602.22	1,989.50	66.47	-1.50	9.13
Grand Total	10,486	653.51	5,236.19	1,835.89	7,725.59	73.68	-0.41	28.79

TABLE 11.27.5 Forest Cover Change Matrix for Tripura (in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	654	0	0	0	2	656
Moderately Dense Forest	0	5,235	0	0	11	5,246
Open Forest	0	0	1,812	0	12	1,824
Scrub	0	0	1	14	0	15
Non Forest	0	1	23	15	2,706	2,745
Total ISFR 2019	654	5,236	1,836	29	2,731	10,486
Net Change	-2	-10	12	14	-14	

Main reasons for the decrease in forest cover in the State are shifting cultivation and development activities.

TABLE 11.27.6 Altitude-wise Forest Cover in Tripura (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	10,420	654	5,190	1,819	7,663 (99.18%)	26
500-1000	66	0	46	17	63 (0.82%)	3
Total	10,486	654	5,236	1,836	7,726	29

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.27.7 Forest Cover in different slope classes in Tripura (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	6,067	432	2,436	927	3,795 (49.11%)	10
5-10	2,630	175	1,600	462	2,237 (28.96%)	3
10-15	1,059	35	722	235	992 (12.84%)	3
15-20	446	8	301	123	432 (5.59%)	4
20-25	179	2	114	56	172 (2.23%)	4
25-30	68	1	41	22	64 (0.83%)	3
>30	37	1	22	11	34 (0.44%)	2
Total	10,486	654	5,236	1,836	7,726	29

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.27.3 Forest Cover Map of Tripura

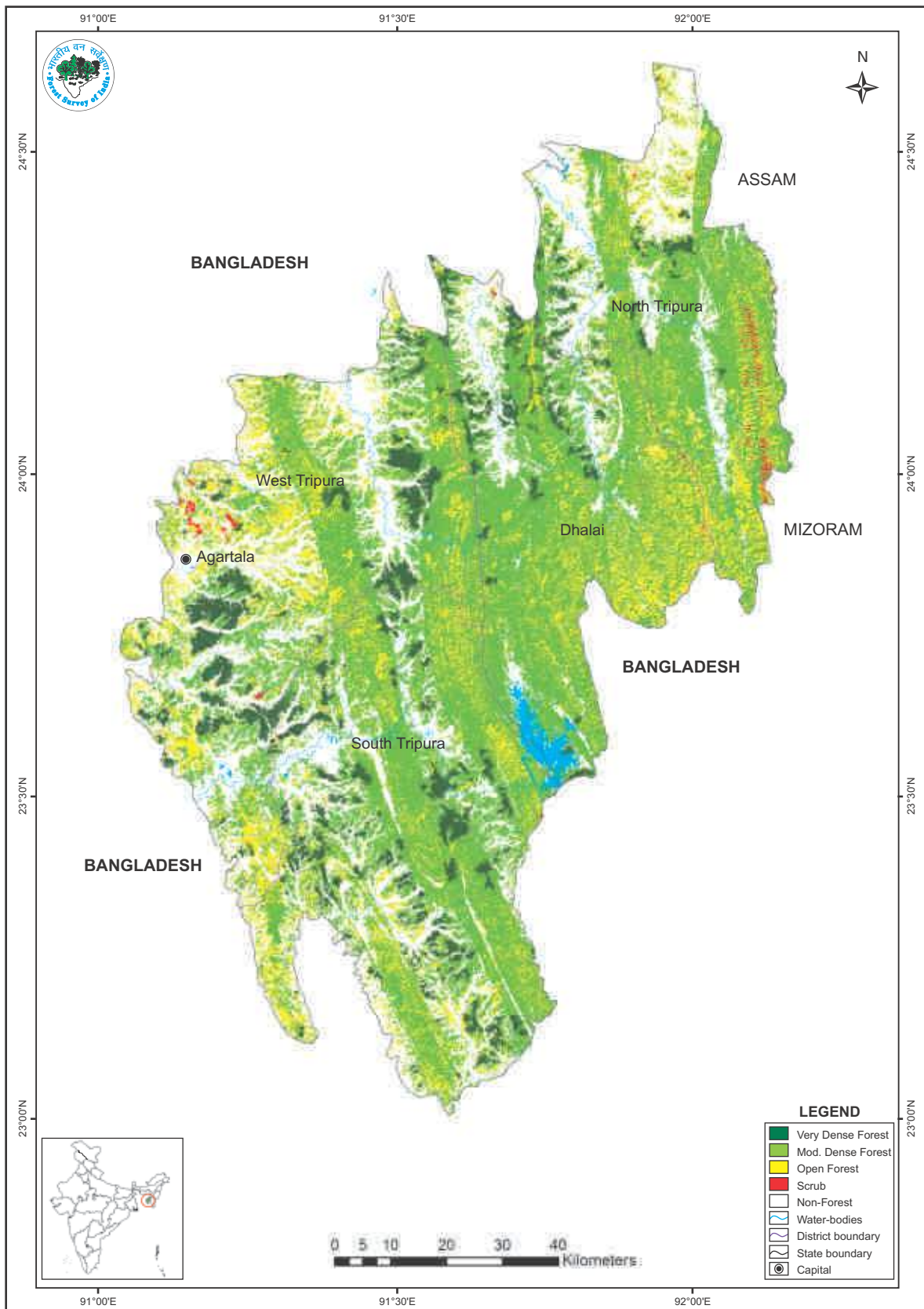


TABLE 11.27.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Tripura (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Ox-bow lake/Cut-off meander	23	55
Riverine wetland	17	25
Waterlogged	115	343
River/Stream	12	1,260
Sub - Total	167	1,683
Inland Wetlands - Man-made		
Reservoir/Barrage	8	1,661
Sub - Total	8	1,661
Wetlands (<2.25 ha)	535	535
Total	710	3,879
Total Recorded Forest (or Green wash) Area (in ha)		5,83,764
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.66%

(analysis based on the National Wetland Atlas: India, 2011)

11.27.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Tripura as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.27.9 Percentage Area under different forest types of Tripura

Sl. No.	Forest Type	% of Forest Cover
1.	2B/C2 Cachar Semi-Evergreen Forest	27.47
2.	2B/2S1 (Pioneer Euphorbiaceous Scrub)	0.01
3.	2/2S1 Secondary Moist Bamboo Brakes	7.55
4.	3C/C1b(ii) East Himalayan Lower Bhabar Sal	2.57
5.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	39.89
6.	Plantation/TOF	22.51
	Total	100.00

11.27.3.1 Assessment of Biodiversity

Findings of the rapid assessment of biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.27.10 and 11.27.11 in respect of Tripura.

TABLE 11.27.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	89
Shrub	37
Herb	22

TABLE 11.27.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Tripura

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	2.77	1.69	3.47
2	Group 3- Tropical Moist Deciduous Forests	3.14	2.95	2.97

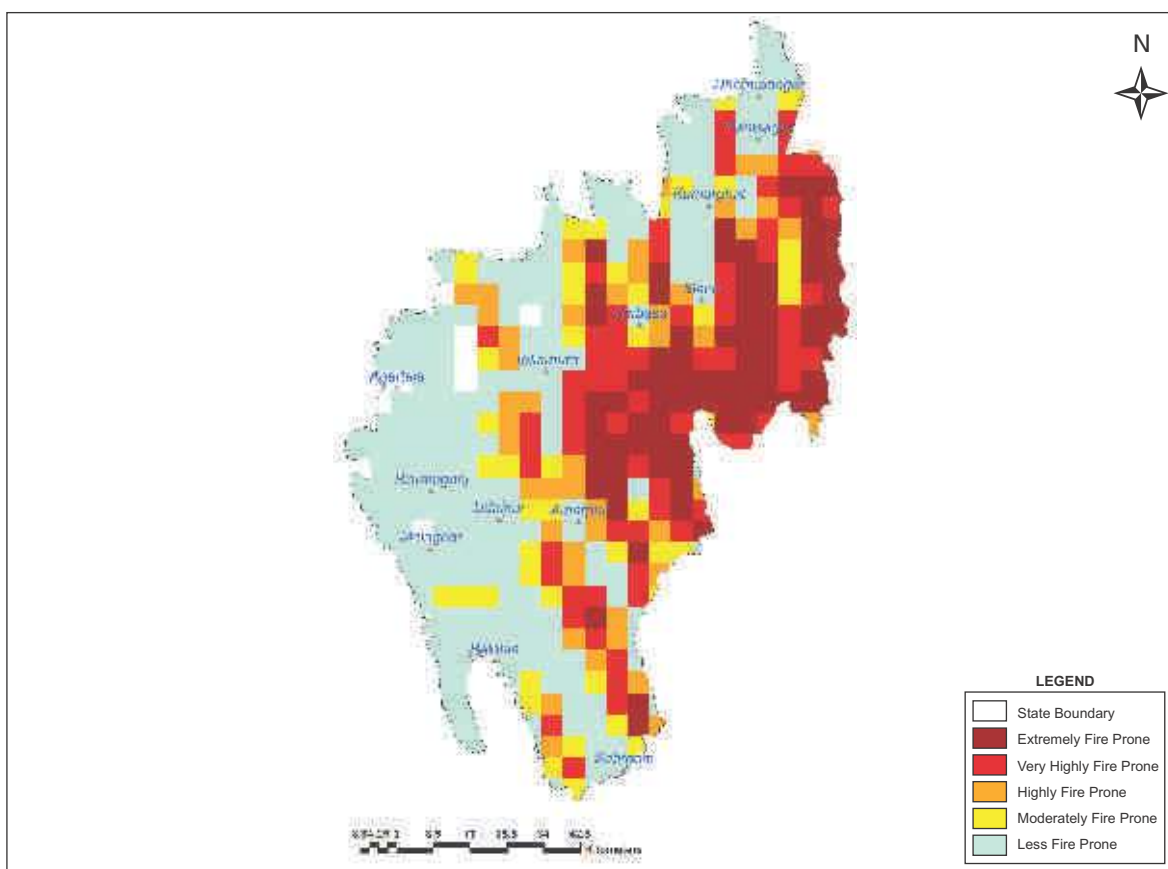
11.27.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.27.12 Forest Fire Prone Classes (in sq km)

Sl.No.	Forest Fire Prone Classes	Geographical Area	% of Total Forest Cover
1.	Extremely fire prone	1,943.69	26.95
2.	Very highly fire prone	1,644.32	21.90
3.	Highly fire prone	1,091.70	12.62
4.	Moderately fire prone	1,040.88	10.76
5.	Less fire prone	4,516.70	27.77
	Total	10,237.29	100.00

FIGURE 11.27.4 Fire prone forest areas under different fire prone classes



11.27.5 Tree Cover

Forest cover presented in the section 11.27.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Tripura has been estimated as given in table 11.27.13.

TABLE 11.27.13 Tree Cover in Tripura
(in sq km)

Tree Cover	Area
	231

Tree cover of Tripura has increased by 16 sq km as compared to the previous assessment reported in ISFR 2017.

11.27.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the Forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.27.14 Extent of TOF in Tripura
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
2,275	231	2,506

11.27.7 Growing Stock in Tripura

Growing stock in the recorded forest areas (RFA) in Tripura is given in the table 11.27.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.27.16.

TABLE 11.27.15 Growing Stock in Tripura
(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	19.74	0.46
Growing Stock in TOF	6.76	0.41

TABLE 11.27.16 Diameter class distribution of top five species inside RFA in Tripura
(in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Albizia species</i>	7,697	1,623	93
2.	<i>Tectona grandis</i>	6,337	1,002	0
3.	<i>Hevea brasiliensis</i>	26,081	1,415	0
4.	<i>Ficus carica</i>	4,709	31	0
5.	<i>Macaranga species</i>	6,100	121	0

11.27.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 76.06 million tonnes (278.89 million tonnes of CO₂ equivalent) which is 1.07% of total forest carbon of the country. Pool wise forest carbon in Tripura is given in the following table.

TABLE 11.27.17 Forest Carbon in Tripura in different pools

(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
25,061	5,513	297	2,169	43,017	76,057

11.27.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.27.18

TABLE 11.27.18 Growing Stock of Bamboo in Tripura

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green wash (in sq km)	3,783	2.36
Total number of culms (in millions)	1,110	2.81
Total equivalent green weight (in 000' tonnes)	6,295	2.27

11.27.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Tripura in Rural and Urban areas are given in the table 11.27.19 and table 11.27.20 respectively

TABLE 11.27.19 Top five tree species in TOF (Rural) in Tripura

Sl. No.	Species	Relative Abundance (%)
1.	<i>Hevea brasiliensis</i>	59.95
2.	<i>Tectona grandis</i>	8.20
3.	<i>Areca catechu</i>	6.33
4.	<i>Schima wallichii</i>	3.95
5.	<i>Dipterocarpus turbinatus</i>	3.15

TABLE 11.27.20 Top five tree species in TOF (Urban) in Tripura

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca catechu</i>	39.45
2.	<i>Mangifera indica</i>	9.28
3.	<i>Cocos nucifera</i>	7.98
4.	<i>Artocarpus integrifolia</i>	7.86
5.	<i>Hevea brasiliensis</i>	5.27

11.27.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.27.21 and table 11.27.22 respectively.

TABLE 11.27.21 Major NTFP species in the State of Tripura

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Clerodendrum serratum</i>	Shrub	53.62
2.	<i>Diplagium species</i>	Herb	32.50
3.	<i>Curcuma aromatic</i>	Herb	4.39
4.	<i>Curcuma caesia</i>	Herb	3.56
5.	<i>Thysanolaena maxima</i>	Herb	3.08

TABLE 11.27.22 Major invasive species in the State inside the RFA/Green wash in Tripura (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	214
2.	<i>Mikania micrantha</i>	90
3.	<i>Imperata cylindrica</i>	17
4.	<i>Saccharum spontanem</i>	8
5.	<i>Lantana camara</i>	3

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.27.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Tripura

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Tripura is given in the table 11.27.23.

TABLE 11.27.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Tripura

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
6,99,848	15,88,471	3,504	8,468



11.28

UTTAR PRADESH

11.28.1 Introduction

Situated in the northern part of the country, Uttar Pradesh covers an area of 2,40,928 sq km, which is 7.33% of the geographical area of the country. The State lies between 23°52'N to 31°28'N latitude and 77°30'E to 84°39' E longitude and is bordered by Uttarakhand in the north, Haryana, Delhi & Rajasthan in the west, Madhya Pradesh in the west and south west, Chhattisgarh in the south and Bihar in the East. It has international border with Nepal in the north. The State has three distinct regions namely, the Shiwalik region in the north, Gangetic plains in the central region and Vindhyan hills in the south. Uttar Pradesh has a humid subtropical climate with dry winters. The annual rainfall ranges between 1,000 mm to 1,200 mm and the annual temperature varies from 5°C to 46°C. The State is drained by a number of rivers, which include Ganga, Yamuna, Gomti, Ghagra, Betwa, Chambal and Gandak. There are 71 districts in the State, of which one is a tribal district and there are no hill districts. As per census 2011, Uttar Pradesh has a population of 199.81 million, which is 16.50% of India population. The urban and rural population constitute 22.27% and 77.73% respectively. The Tribal population is 0.57%. The average population density of the State is 829 per sq km, which is more than twice the national average. The 19th Livestock Census of 2012 has reported a total livestock population of 68.71 million.

TABLE 11.28.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	24,093	
Reporting area for land utilization	24,170	100.00
Forests	1,659	6.86
Not available for land cultivation	3,507	14.51
Permanent pastures and other grazing lands	65	0.27
Land under misc. tree crops and groves	305	1.26
Culturable wasteland	405	1.68
Fallow land other than current fallows	509	2.11
Current fallows	1,122	4.64
Net area sown	16,598	68.67

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.28.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Uttar Pradesh belong to five Forest Type Groups, which are further divided into 28 Forest Types. Major part of the State is agrarian. In recent years, massive plantation programmes have been taken up in the State to increase the forest & tree cover. Through the Nursery Management Scheme, the tall saplings of 8 to 12 feet height are also being raised for planting. During the plantation season of 2019 more than 22.5 crores saplings were planted across the State under the Vriksha Mahakhumbh Programme. To promote tree plantations outside the forest areas, improve livelihoods and enhance income of the farmers, the State Government has exempted most of the trees species from felling and transit rules.

Recorded Forest Area (RFA) in the State is 16,582 sq km of which 12,070 sq km is Reserved Forest, 1,157 sq km is Protected Forest and 3,355 sq km is Unclassed Forests. In Uttar Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 163.76 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

One National Park and 26 Wildlife Sanctuaries constitute the Protected Area network of the State covering 11.82% of its geographical area. Dudhwa National Park located in the State is known for successful translocation of one horned rhinoceros.

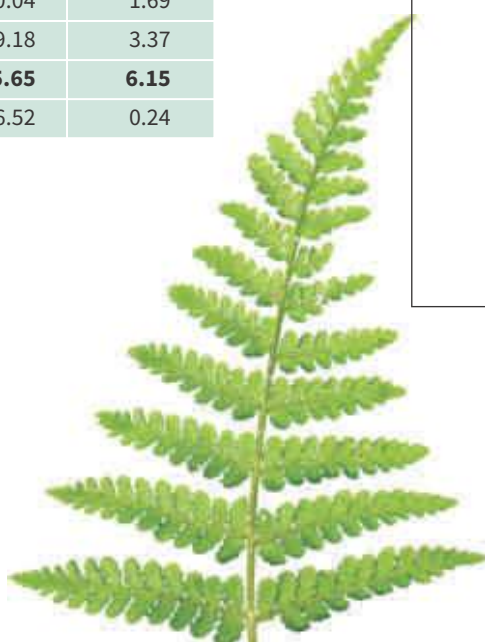
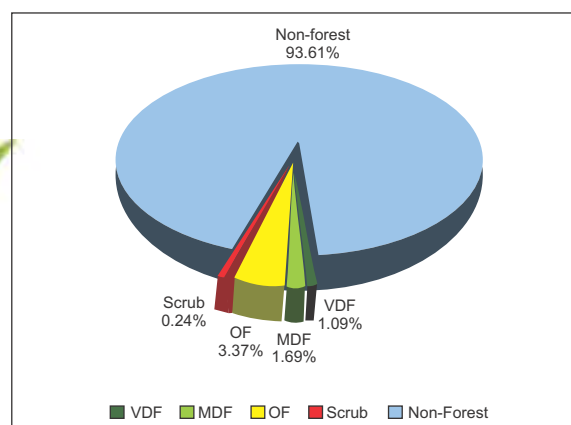
11.28.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Jan 2018, the Forest Cover in the State is 14,805.65 sq km which is 6.15 % of the State's geographical area. In terms of forest canopy density classes, the State has 2,616.43 sq km under Very Dense Forest (VDF), 4,080.04 sq km under Moderately Dense Forest (MDF) and 8,109.18 sq km under Open Forest (OF). Forest Cover in the State has increased by 126.65 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.28.2 Forest Cover of Uttar Pradesh

(in sq. km)		
Class	Area	% of GA
VDF	2,616.43	1.09
MDF	4,080.04	1.69
OF	8,109.18	3.37
Total	14,805.65	6.15
Scrub	586.52	0.24

FIGURE 11.28.1 Forest Cover of Uttar Pradesh



11.28.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 16,582 sq km which is 6.88% of its geographical area. The reserved, protected and unclassified forests are 72.79% and 6.98% and 20.23% of the recorded forest area in the State respectively. Due to non-availability of digitized boundary of recorded forest areas from the State, the updated Green Wash from Sol toposheets which is 13,433.75 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.28.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Uttar Pradesh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
2,455	3,039	3,701	9,195	162	1,041	4,408	5,611
26.70%	33.05%	40.25%		2.88%	18.55%	78.57%	

*in case of Uttar Pradesh Green Wash boundaries have been used.

FIGURE 11.28.2 Forest Cover inside and outside GW in Uttar Pradesh

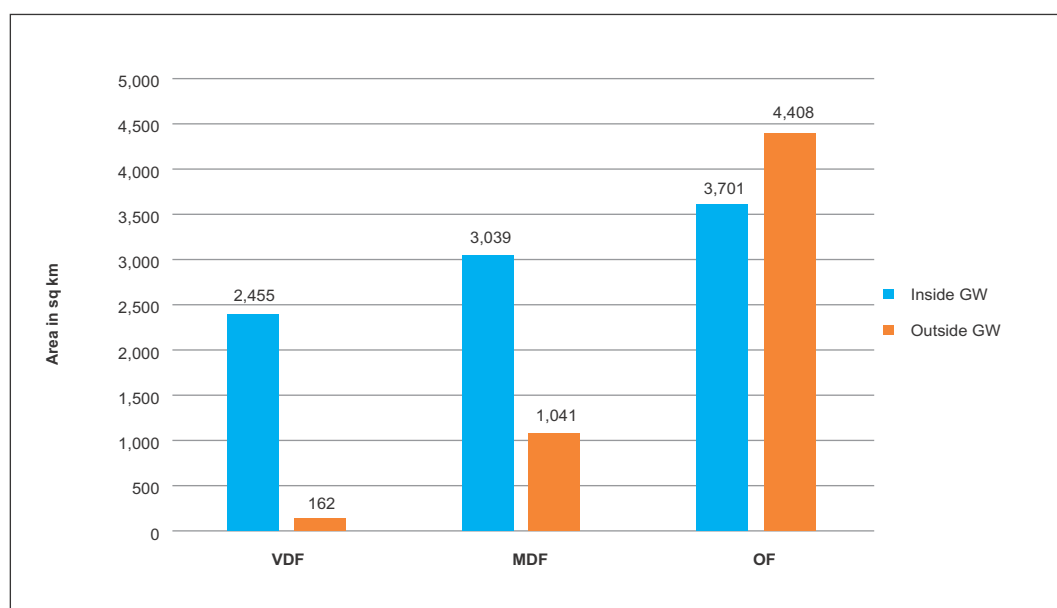


TABLE 11.28.4 District-wise Forest Cover in Uttar Pradesh

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Agra	4,041	0.00	62.68	199.94	262.62	6.50	-9.38	75.14
Aligarh	3,650	0.00	7.00	59.75	66.75	1.83	-0.25	1.00
Allahabad	5,482	6.00	26.00	97.21	129.21	2.36	2.21	36.26
Ambedkar Nagar	2,350	0.00	1.00	40.12	41.12	1.75	0.12	0.00
Auraiya	2,016	0.00	4.96	36.42	41.38	2.05	0.38	10.09
Azamgarh	4,054	0.00	1.00	49.00	50.00	1.23	0.00	0.00

Contd.

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Baghpat	1,321	0.00	5.00	12.06	17.06	1.29	0.06	0.00
Bahraich	5,237	240.00	156.11	153.99	550.10	10.50	1.10	9.00
Ballia	2,981	0.00	0.00	22.15	22.15	0.74	0.15	0.00
Balrampur	3,349	279.00	157.94	89.07	526.01	15.71	2.01	3.00
Banda	4,408	0.00	55.91	46.00	101.91	2.31	-0.09	4.00
Bara Banki	4,402	3.00	6.00	74.07	83.07	1.89	6.07	5.70
Bareilly	4,120	0.00	7.00	38.00	45.00	1.09	0.00	0.00
Basti	2,688	1.00	6.00	22.25	29.25	1.09	0.25	0.00
Bijnor	4,561	39.00	218.38	146.23	403.61	8.85	1.61	5.52
Budaun	5,168	0.00	8.13	23.91	32.04	0.62	-12.96	6.00
Bulandshahr	4,512	0.00	49.72	115.40	165.12	3.66	-0.88	0.00
Chandauli	2,541	7.00	192.00	366.26	565.26	22.25	0.26	10.00
Chitrakoot	3,216	81.00	319.00	186.40	586.40	18.23	0.40	40.51
Deoria	2,540	0.00	1.00	14.21	15.21	0.60	0.21	0.00
Etah	2,431	0.00	0.98	25.20	26.18	1.08	-4.82	-0.26
Etawah	2,311	0.00	62.75	188.63	251.38	10.88	9.38	45.05
Faizabad	2,341	6.00	10.00	73.30	89.30	3.81	3.30	0.96
Farrukhabad	2,181	0.00	14.00	33.45	47.45	2.18	0.45	2.00
Fatehpur	4,152	0.00	18.00	35.44	53.44	1.29	0.44	0.00
Firozabad	2,407	0.00	5.00	53.60	58.60	2.43	9.60	27.01
Gautam Buddha Nagar	1,282	0.00	5.00	15.00	20.00	1.56	0.00	0.00
Ghaziabad	1,179	0.00	8.67	16.55	25.22	2.14	-0.78	0.00
Ghazipur	3,377	0.00	1.00	28.00	29.00	0.86	0.00	0.00
Gonda	4,003	67.00	8.36	39.50	114.86	2.87	0.86	0.00
Gorakhpur	3,321	28.00	23.00	28.00	79.00	2.38	0.00	0.00
Hamirpur	4,021	0.00	80.00	147.00	227.00	5.65	0.00	14.00
Hardoi	5,986	0.00	16.98	126.87	143.85	2.40	-0.15	5.00
Jalaun	4,565	0.00	60.58	186.73	247.31	5.42	-1.69	37.97
Jaunpur	4,038	0.00	11.00	56.02	67.02	1.66	0.02	0.00
Jhansi	5,024	0.00	42.00	262.05	304.05	6.05	1.05	41.96
Jyotiba Phule Nagar	2,249	0.00	25.00	61.00	86.00	3.82	0.00	0.00
Kannauj	2,093	0.00	0.00	27.82	27.82	1.33	-0.18	0.00
Kanpur Dehat	3,021	0.00	3.00	38.00	41.00	1.36	0.00	9.00
Kanpur Nagar	3,155	0.00	7.00	59.00	66.00	2.09	0.00	3.00
Kanshiram Nagar	1,955	0.00	7.67	41.13	48.80	2.50	-19.20	0.00
Kaushambi	1,779	0.00	5.00	22.83	27.83	1.56	0.83	0.00
Kheri ¹	7,680	804.91	158.21	309.94	1,273.06	16.58	-0.94	4.49
Kushinagar	2,905	0.00	2.00	32.84	34.84	1.20	0.84	0.00
Lalitpur	5,039	0.00	128.89	452.40	581.29	11.54	-5.71	33.18
Lucknow	2,528	0.00	162.00	216.87	378.87	14.99	13.87	2.18
Mahamaya Nagar	1,840	0.00	1.00	22.00	23.00	1.25	0.00	0.00

Contd.

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Mahoba	3,144	0.00	21.00	149.00	170.00	5.41	0.00	62.00
Mahrajganj	2,952	259.00	101.00	69.07	429.07	14.53	0.07	0.34
Mainpuri	2,760	0.00	1.00	12.64	13.64	0.49	-0.36	0.00
Mathura	3,340	0.00	4.00	53.04	57.04	1.71	-2.96	3.52
Mau	1,713	0.00	0.00	11.00	11.00	0.64	0.00	0.00
Meerut	2,559	0.00	34.00	34.41	68.41	2.67	0.41	0.00
Mirzapur	4,405	8.00	289.58	506.15	803.73	18.25	-1.27	47.00
Moradabad	3,718	0.00	5.00	23.00	28.00	0.75	0.00	0.00
Muzaffarnagar	4,008	0.00	14.00	52.11	66.11	1.65	26.11	0.00
Pilibhit	3,686	471.00	86.73	129.38	687.11	18.64	-0.89	2.11
Pratapgarh	3,717	0.00	31.58	86.24	117.82	3.17	15.82	2.00
Rae Bareli	4,609	0.00	4.00	89.54	93.54	2.03	0.54	1.32
Rampur	2,367	4.00	26.00	45.00	75.00	3.17	0.00	0.00
Saharanpur	3,689	0.00	174.00	269.26	443.26	12.02	70.26	0.00
Sant Kabir Nagar	1,646	0.00	1.00	13.00	14.00	0.85	0.00	1.00
Sant Ravidas Nagar (Bhadohi)	1,015	0.00	0.00	3.12	3.12	0.31	0.12	0.00
Shahjahanpur	4,388	26.00	7.00	26.31	59.31	1.35	-1.69	1.17
Shrawasti	1,640	151.52	90.23	42.79	284.54	17.35	-0.46	0.00
Siddharthnagar	2,895	0.00	8.00	26.08	34.08	1.18	0.08	0.00
Sitapur	5,743	0.00	19.00	190.42	209.42	3.65	0.42	6.30
Sonbhadra	6,905	130.00	967.00	1,443.29	2,540.29	36.79	1.29	28.00
Sultanpur	4,436	5.00	15.00	190.03	210.03	4.73	6.03	0.00
Unnao	4,558	0.00	28.00	236.59	264.59	5.80	14.59	0.00
Varanasi	1,535	0.00	1.00	16.10	17.10	1.11	0.10	0.00
Grand Total	2,40,928	2,616.43	4,080.04	8,109.18	14,805.65	6.15	126.65	586.52

TABLE 11.28.5 Forest Cover Change Matrix for Uttar Pradesh

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	2,617	0	0	0	0	2,617
Moderately Dense Forest	0	4,052	9	0	8	4,069
Open Forest	0	25	7,899	16	53	7,993
Scrub	0	0	10	539	2	551
Non Forest	0	3	191	32	2,25,472	2,25,698
Total ISFR 2019	2,617	4,080	8,109	587	2,25,535	2,40,928
Net Change	0	11	116	36	-163	

Main reasons for the increase in forest cover in the State are plantation and conservation activities as well as improvement in interpretation.

TABLE 11.28.6 Altitude-wise Forest Cover in Uttar Pradesh (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	2,40,458	2,617	3,894	7,888	14,399 (97.25%)	585
500-1000	470	0	186	221	407 (2.75%)	2
Total	2,40,928	2,617	4,080	8,109	14,806	587

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.28.7 Forest Cover in different slope classes in Uttar Pradesh (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	2,35,259	2,394	3,142	7,074	12,610 (85.17%)	505
5-10	4,405	156	498	637	1,291 (8.72%)	57
10-15	730	39	220	207	466 (3.15%)	15
15-20	300	15	116	104	235 (1.59%)	6
20-25	143	8	62	52	122 (0.82%)	3
25-30	60	4	28	22	54 (0.36%)	1
>30	31	1	14	13	28 (0.19%)	0
Total	2,40,928	2,617	4,080	8,109	14,806	587

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.28.3 Forest Cover Map of Uttar Pradesh

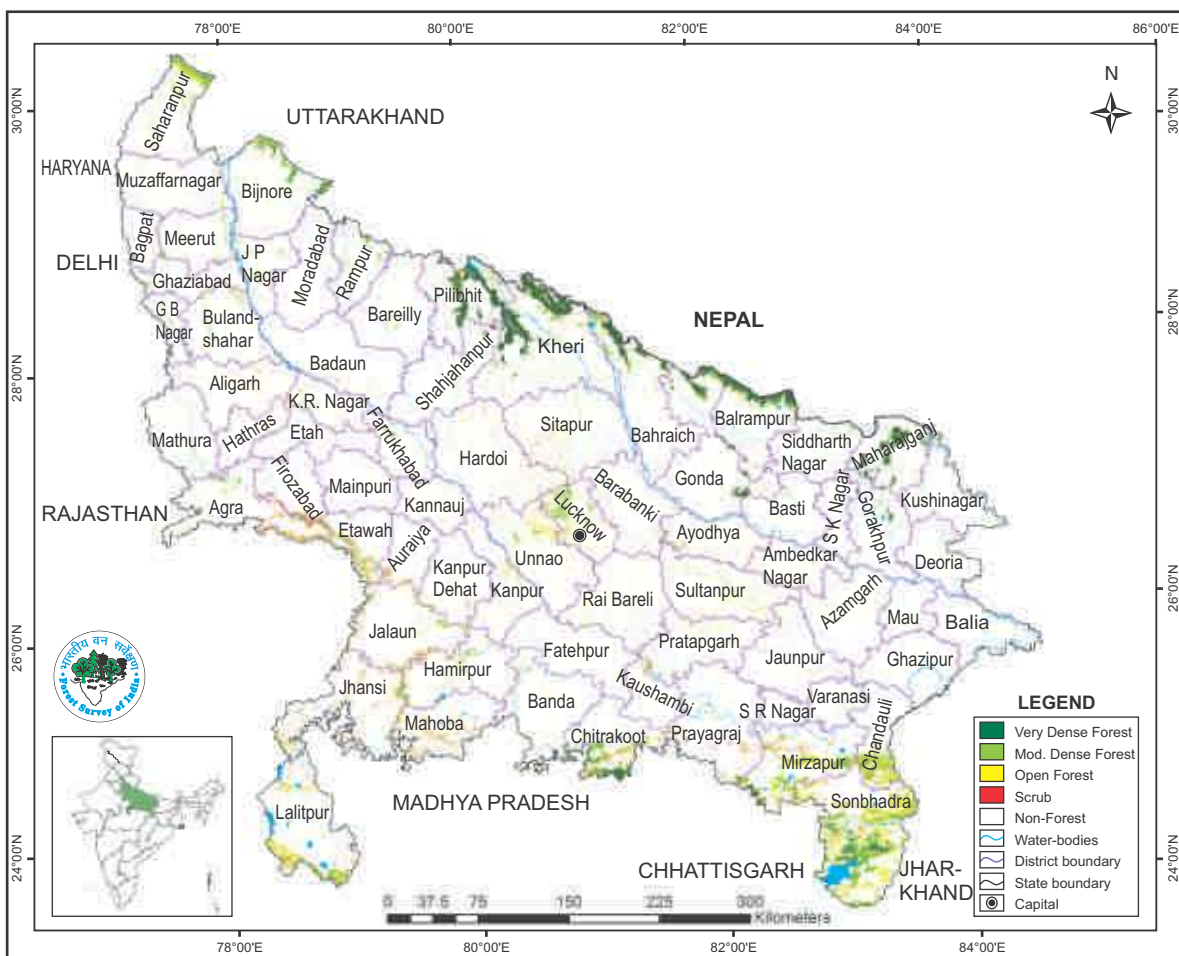


TABLE 11.28.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Uttar Pradesh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	92	924
Ox-bow lake/Cut-off meander	47	742
Riverine wetland	103	1,079
Waterlogged	240	3,035
River/Stream	310	26,048
Sub - Total	792	31,828
Inland Wetlands - Man-made		
Reservoir/Barrage	504	8,754
Tank/Pond	106	353
Waterlogged	50	390
Sub - Total	660	9,497
Wetlands (<2.25 ha)	899	899
Total	2,351	42,224
Total Recorded Forest (or Green Wash) Area (in ha)		13,43,375
% of Wetland area inside Recorded Forest (or Green Wash) Area		3.14%

(analysis based on the National Wetland Atlas: India, 2011)

11.28.3 Forest Types & Biodiversity

Forest Types Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Uttar Pradesh as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.28.9 Percentage area under different forest types of Uttar Pradesh

Sl.No.	Forest Type	% of Forest cover
1.	2/E1 (Cane Brakes)	0.14
2.	3C/1S1 Low Alluvial Savannah Woodland (<i>Salmania Albizzia</i>)	0.03
3.	3C/C2d (i) Western Light Alluvium Plains Sal	10.06
4.	3C/C2d (iii) Eastern Heavy Alluvium Plains Sal	4.11
5.	3C/C3a West Gangatic Moist Mixed Deciduous Forest	2.56
6.	3C/2S1 Northern Secondary Moist Mixed Deciduous Forest	2.25
7.	4D/SS2 <i>Barringtonia</i> Swamp Forest	0.01
8.	4D/2S2 Eastern Wet Alluvial Grassland	0.63
9.	4D/SS3 <i>Syzygium cumini</i> Swamp Low Forest	1.33
10.	5B/C2 Northern Dry Mixed Deciduous Forest	34.90
11.	5/E1 <i>Anogeissus Pendula</i> Forest	2.81
12.	5B/DS1 Dry Deciduous Scrub	2.75
13.	5B/C1c Dry Peninsular Sal Forest	2.39
14.	5E1/DS1 <i>Anogeissus Pendula</i> Scrub	1.08
15.	5/1S2 <i>Khair-Sissu</i> Forest	1.08
16.	5A/C1b Dry Teak Forest	0.91
17.	5/E2 <i>Boswellia</i> Forest	0.80
18.	5B/C1a Dry Siwalik Sal Forest	0.71

Contd.

Sl.No.	Forest Type	% of Forest cover
19.	5/E9 Dry Bamboo Brake	0.52
20.	5B/C1b Dry Plains Sal Forest	0.41
21.	5/E3 Babul Forest	0.25
22.	5/E8b Babul Savannah Forest	0.10
23.	5/E5 <i>Butea</i> Forest	0.05
24.	5/E8a Phoenix Savannah Forest	0.02
25.	5/DS2 Dry Savannah Forest	0.01
26.	5/DS3 (<i>Euphorbia</i> Scrub)	0.01
27.	5/1S1 Dry Tropical Riverain Forest	0.00
28.	6B/C2 Ravine Thorn Forest	5.11
29.	Plantation/ TOF	24.97
	Total	100.00

11.28.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.28.10 and table 11.28.11 in respect of Uttar Pradesh.

TABLE 11.28.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	84
Shrub	71
Herb	86

TABLE 11.28.11 Shannon-Wiener Index of Tree, Shrub and Herbs species in different Type Groups of Uttar Pradesh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	*	2.48	2.49
2	Group 3- Tropical Moist Deciduous Forests	2.31	2.41	2.26
3	Group 4- Littoral and Swamp Forests	1.98	2.29	2.63
4	Group 5- Tropical Dry Deciduous Forests	3.44	2.15	2.97
5	Group 6- Tropical Thorn Forests	1.42	2.07	*

*adequate number of sample plots were not available

11.28.4 Fire Prone Forest Areas

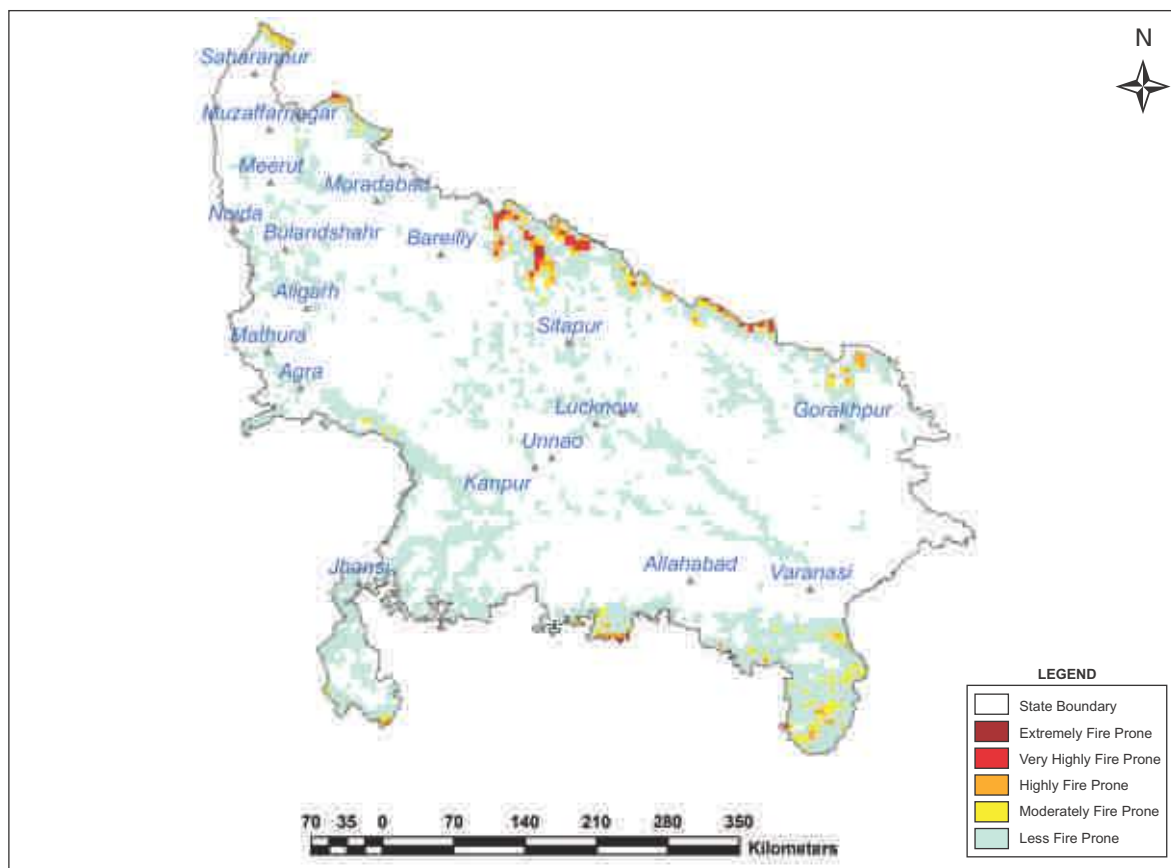
Geographical area under different classes of forest fire proneness are given in the following table

TABLE 11.28.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	124.70	0.92
2.	Very highly fire prone	976.65	7.10
3.	Highly fire prone	1,813.22	11.86
4.	Moderately fire prone	3,487.79	17.66
5.	Less fire prone	58,287.13	62.46
	Total	64,689.49	100.00



FIGURE 11.28.4 Fire prone forest areas under different fire prone classes



11.28.5 Tree Cover

Forest cover presented in the section 11.28.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Uttar Pradesh has been estimated as given in table 11.28.13.

TABLE 11.28.13 Tree Cover in Uttar Pradesh
(in sq km)

Tree Cover	Area
	7,342

Tree cover of Uttar Pradesh has decreased by 100 sq km as compared to the previous assessment reported in ISFR 2017.

11.28.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.28.14 Extent of TOF in Uttar Pradesh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
5,611	7,342	12,953

11.28.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Uttar Pradesh is given in the table 11.28.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.28.16

TABLE 11.28.15 Growing Stock in Uttar Pradesh (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	96.04	2.25
Growing Stock in TOF	97.62	5.94

TABLE 11.28.16 Diameter class distribution of top five species inside RFA in Uttar Pradesh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	12,454	19,709	1,988
2.	<i>Tectona grandis</i>	7,376	4,851	313
3.	<i>Butea monosperma</i>	8,439	1,575	66
4.	<i>Mallotus philippinensis</i>	9,659	707	0
5.	<i>Lannea coromandelica</i>	8,557	1,246	0

11.28.8 Carbon Stock in Forest

The total Carbon stock of forests in the State is 115.69 million tonnes (424.20 million tonnes of CO₂ equivalent) which is 1.62% of total forest carbon of the country. Pool wise forest carbon in Uttar Pradesh is given in the following table

TABLE 11.28.17 Forest Carbon in Uttar Pradesh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
32,498	10,374	372	1,893	70,553	1,15,690

11.28.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which includes culms of 1 year age and above are given in the table 11.28.18

TABLE 11.28.18 Growing Stock of Bamboo in Uttar Pradesh

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,235	0.77
Total number of culms (in millions)	236	0.60
Total equivalent green weight (in 000' tonnes)	974	0.35

11.28.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Uttar Pradesh in Rural and Urban areas are given in the table 11.28.19 and table 11.28.20 respectively.

TABLE 11.28.19 Top five tree species in TOF (Rural) in Uttar Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	31.54
2.	<i>Eucalyptus species</i>	15.86
3.	<i>Populus species</i>	9.60
4.	<i>Azadirachta indica</i>	5.71
5.	<i>Acacia arabica</i>	5.30

TABLE 11.28.20 Top five tree species in TOF (Urban) in Uttar Pradesh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Azadirachta indica</i>	15.90
2.	<i>Mangifera indica</i>	9.81
3.	<i>Eucalyptus species</i>	8.87
4.	<i>Psidium guyava</i>	3.90
5.	<i>Terminalia arjuna</i>	3.33

11.28.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.28.21 and table 11.28.22 respectively.

TABLE 11.28.21 Major NTFP species in the State of Uttar Pradesh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Calotropis gigantea</i>	Shrub	87.76
2.	<i>Acacia concina</i>	Shrub	11.04
3.	<i>Hedyotes scandens</i>	Shrub	1.20

TABLE 11.28.22 Major invasive species in the State inside the RFA/Green Wash in Uttar Pradesh (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	798
2.	<i>Cassia tora</i>	193
3.	<i>Saccharum spontanem</i>	126
4.	<i>Dioscorea pentaphylla</i>	72
5.	<i>Ichnocarpus frutescens</i>	59

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.28.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Uttar Pradesh

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Uttar Pradesh is given in the table 11.28.23.

TABLE 11.28.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Uttar Pradesh

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
51,40,777	5,93,35,092	1,09,512	1,59,587

11.29

UTTARAKHAND

11.29.1 Introduction

The predominantly mountainous State of Uttarakhand covers an area of 53,483 sq km, which is 1.63% of the geographical area of the country. The State lies between 28°43' N to 31°28' N latitude and 77°34' E to 81°03' E longitude and shares borders with Himachal Pradesh in north & Uttar Pradesh in south. It also shares International borders with Nepal and China. As the State lies in the Himalayan range, the climate and vegetation vary greatly with altitude, from glaciers at the highest elevations to subtropical forests at the lower elevations. Ice and bare rocks cover the higher elevations. The average annual rainfall is 1,500 mm and the annual temperature varies from 0°C to 43°C. Many major rivers including Ganga, Yamuna, Ramganga & Sharda drain the State along with their tributaries. The State has 13 districts; all of them are hill districts. The State does not have any tribal districts. As per the 2011 census, Uttarakhand has a population of 10.09 million, which is 0.83% of India's population. The rural and urban population of the State constitute 69.77% and 30.23% respectively. The Tribal population is 2.89%. The population density of the State is 189 per sq km, which is lower than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 4.79 million.

TABLE 11.29.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	5,348	
Reporting area for land utilization	5,993	100.00
Forests	3,800	63.41
Not available for land cultivation	452	7.54
Permanent pastures and other grazing lands	192	3.21
Land under misc. tree crops and groves	388	6.47
Culturable wasteland	317	5.29
Fallow land other than current fallows	87	1.44
Current fallows	57	0.96
Net area sown	700	11.68

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.29.1.1 A Brief Overview of Forestry Scenario

Uttarakhand is rich in forest resources. As per the Champion & Seth Classification of Forest Types (1968), the forests in Uttarakhand belong to nine Forest Type Groups, which are further divided into 43 Forest Types. Physiographically, the State can be divided into three zones namely, the Himalayas, the Shiwalik and the Terai region. The human and livestock population is largely dependent on forests due to agrarian economy and pastoralism.

Van Panchayats in Uttarakhand are unique institutions of community forest management which came into existence in 1921. At present there are 12,167 Van Panchayats in the State which manage an area of 7,32,688 hectares of forest. Occurrence of forest fires at regular intervals is a major problem in the State.

Recorded Forest Area (RFA) in the State is 38,000 sq km of which 26,547 sq km is Reserved Forest, 9,885 sq km is Protected Forest and 1,568 sq km is Unclassed Forests. In Uttarakhand, during the period 1st January 2015 to 5th February 2019, a total of 2,850.87 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019).

Six National Parks, seven Wildlife Sanctuaries and four Community Reserves constitute the Protected Area network of the State covering 3.24% of its geographical area. The Corbett National Park is located in the State.

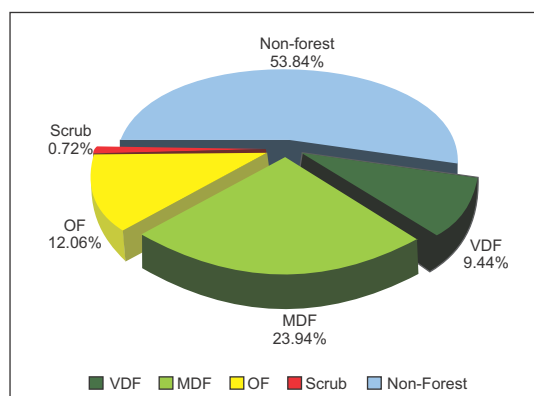
11.29.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017 to Oct 2018, the Forest Cover in the State is 24,303.04 sq km which is 45.44% of the State's geographical area. In terms of forest canopy density classes, the State has 5,046.76 sq km under Very Dense Forest (VDF), 12,805.24 sq km under Moderately Dense Forest (MDF) and 6,451.04 sq km under Open Forest (OF). Forest Cover in the State has increased by 8.04 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.29.2 Forest Cover of Uttarakhand

(in sq. km)		
Class	Area	% of GA
VDF	5,046.76	9.44
MDF	12,805.24	23.94
OF	6,451.04	12.06
Total	24,303.04	45.44
Scrub	383.17	0.72

FIGURE 11.29.1 Forest Cover of Uttarakhand



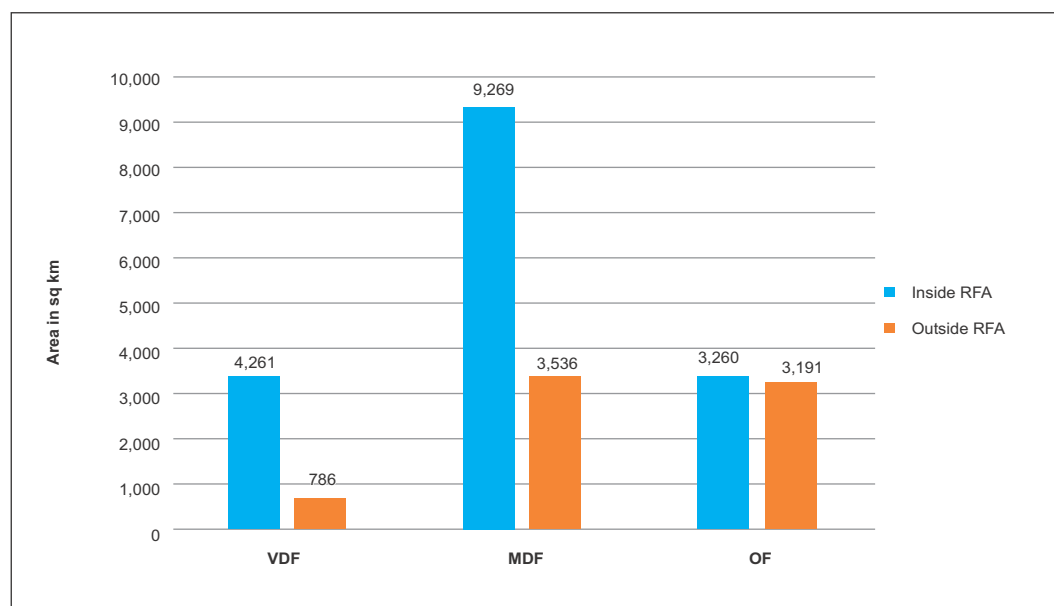
11.29.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 38,000 sq km which is 71.05% of its geographical area. The reserved, protected and unclassed forests are 69.86%, 26.01% and 4.13% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 25,494.46 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.29.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Uttarakhand (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
4,261	9,269	3,260	16,790	786	3,536	3,191	
25.38%	55.20%	19.42%		10.46%	47.07%	42.47%	

*in case of Uttarakhand RFA boundaries have been used

FIGURE 11.29.2 Forest Cover inside and outside RFA in Uttarakhand**TABLE 11.29.4** District-wise Forest Cover in Uttarakhand

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Almora ^H	3,144	199.00	837.00	683.14	1,719.14	54.68	1.14	6.00
Bageshwar ^H	2,241	162.39	761.61	338.69	1,262.69	56.34	1.69	1.00
Chamoli ^H	8,030	443.00	1,580.00	686.43	2,709.43	33.74	0.43	1.00
Champawat ^H	1,766	367.00	593.00	265.55	1,225.55	69.40	1.55	7.00
Dehradun ^H	3,088	659.77	601.56	347.36	1,608.69	52.09	3.69	86.28
Garhwal ^H	5,329	574.26	1,902.03	918.70	3,394.99	63.71	0.99	95.97
Haridwar ^H	2,360	74.74	276.42	234.09	585.25	24.80	-2.75	6.00
Nainital ^H	4,251	773.06	1,728.93	539.57	3,041.56	71.55	-6.44	9.63
Pithoragarh ^H	7,090	505.00	965.00	609.80	2,079.80	29.33	1.80	39.00
Rudraprayag ^H	1,984	252.00	580.00	310.17	1,142.17	57.57	1.17	9.00
Tehri Garhwal ^H	3,642	272.71	1,084.08	709.19	2,065.98	56.73	0.98	97.44
Udham Singh Nagar ^H	2,542	149.16	188.75	93.88	431.79	16.99	-4.21	3.85
Uttarkashi ^H	8,016	614.67	1,706.86	714.47	3,036.00	37.87	8.00	21.00
Grand Total	53,483	5,046.76	12,805.24	6,451.04	24,303.04	45.44	8.04	383.17

TABLE 11.29.5 Forest Cover Change Matrix for Uttarakhand

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	4,968	0	0	0	1	4,969
Moderately Dense Forest	79	12,787	6	0	12	12,884
Open Forest	0	18	6,406	2	16	6,442
Scrub	0	0	1	379	3	383
Non Forest	0	0	38	2	28,765	28,805
Total ISFR 2019	5,047	12,805	6,451	383	28,797	53,483
Net Change	78	-79	9	0	-8	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.29.6 Altitude-wise Forest Cover in Uttarakhand

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	7,937	628	1,636	620	2,884 (11.87%)	9
500-1000	5,703	1,196	1,865	898	3,959 (16.29%)	104
1000-2000	17,560	1,569	5,165	3,306	10,040 (41.31%)	238
2000-3000	7,248	1,548	3,099	1,128	5,775 (23.76%)	20
3000-4000	4,193	106	1,039	494	1,639 (6.74%)	11
>4000	10,842	0	1	5	6 (0.03%)	1
Total	53,483	5,047	12,805	6,451	24,303	383

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.29.7 Forest Cover in different slope classes in Uttarakhand

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	9,446	843	1,470	641	2,954 (12.16%)	26
5-10	4,069	486	976	346	1,808 (7.44%)	18
10-15	5,688	614	1,507	642	2,763 (11.37%)	37
15-20	7,028	728	1,933	921	3,582 (14.74%)	58
20-25	7,313	729	2,051	1,048	3,828 (15.75%)	69
25-30	6,683	649	1,874	1,021	3,544 (14.58%)	67
>30	13,256	998	2,994	1,832	5,824 (23.96%)	108
Total	53,483	5,047	12,805	6,451	24,303	383

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.29.3 Forest Cover Map of Uttarakhand

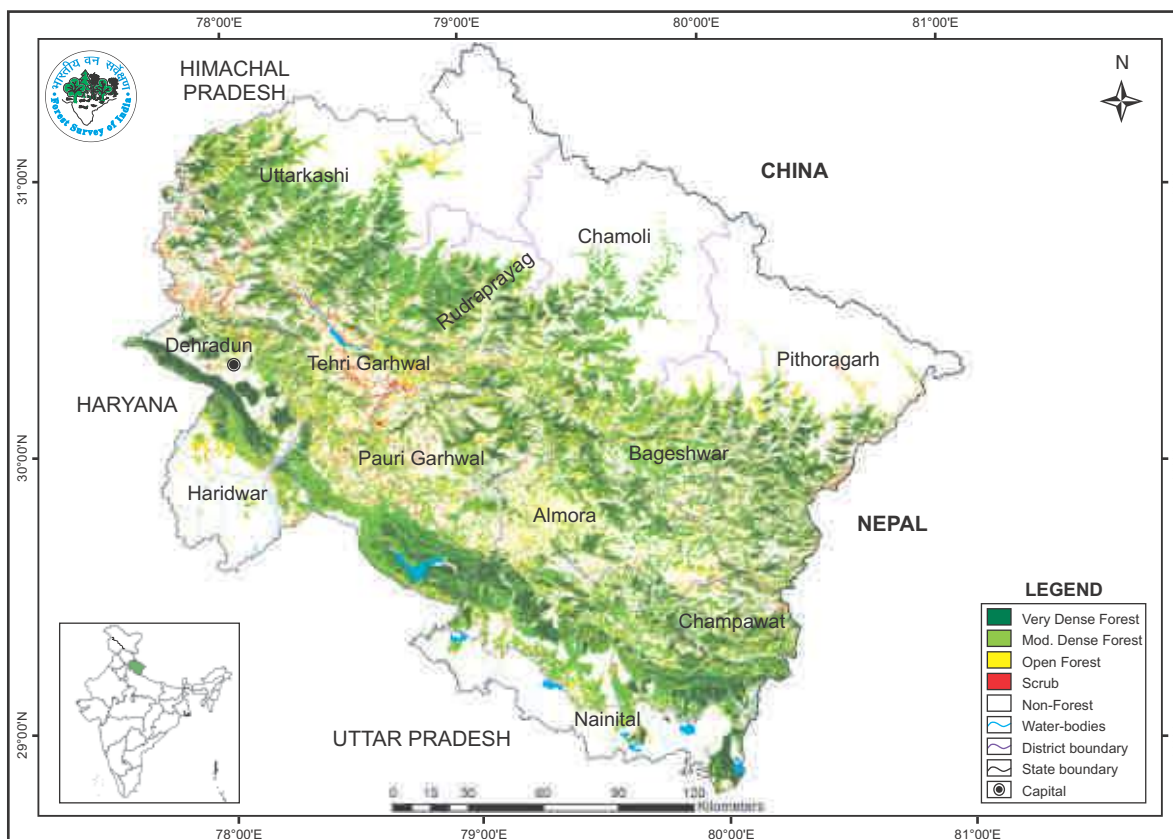


TABLE 11.29.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Uttarakhand (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	5	17
Ox-bow lake/Cut-off meander	5	14
High altitude Wetland	8	34
Riverine wetland	1	1
Waterlogged	1	9
River/Stream	75	38,932
Sub - Total	95	39,007
Inland Wetlands - Man-made		
Reservoir/Barrage	9	14,998
Tank/Pond	1	8
Sub - Total	10	15,006
Wetlands (<2.25 ha)	116	116
Total	221	54,129
Total Recorded Forest (or Green Wash) Area (in ha)		25,49,446
% of Wetland area inside Recorded Forest (or Green Wash) Area		2.12%

(analysis based on the National Wetland Atlas: India, 2011)

11.29.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Uttarakhand as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.29.9 Percentage area under different forest types of Uttarakhand

Sl.No.	Forest Type	% of Forest cover
1.	3C/C2a Moist Siwalik Sal Forest	14.05
2.	3C/C2c Moist Tarai Sal Forest	1.56
3.	3C/C2d (i) Western Light Alluvium Plains Sal Forest	0.62
4.	3C/DS1 Moist Sal Savannah	0.02
5.	3C/C3a West Gangatic Moist Mixed Deciduous Forest	4.04
6.	4C/FS2 Submontane Hill-Valley Swamp Forest	0.00
7.	5B/C1a Dry Siwalik Sal Forest	1.57
8.	5B/C1b Dry Plains Sal Forest	0.04
9.	5B/C2 Northern Dry Mixed Deciduous Forest	3.59
10.	5/DS1 Dry Deciduous Scrub	0.16
11.	5/1S2 Khair-Sissu Forest	0.97
12.	9/C1a Lower Or Siwalik Chir Pine Forest	0.18
13.	9/C1b Upper Or Himalayan Chir Pine Forest	27.97
14.	9/DS1 Himalayan Subtropical Scrub	1.61
15.	9/DS2 Subtropical Euphorbia Scrub	0.11
16.	12/C1a Ban Oak Forest (<i>Q.incana</i>)	13.86
17.	12/C1b Moru Oak Forest (<i>Q.dilatata</i>)	0.47
18.	12/C1c Moist Deodar Forest (<i>Cedrus</i>)	1.55
19.	12/C1d Western Mixed Coniferous Forest (Spruce, Blue Pine, Silver Fir)	5.01
20.	12/C1e Moist Temperate Deciduous Forest	0.79
21.	12/C1f Low-Level Blue Pine Forest (<i>P.wallichiana</i>)	0.09
22.	12/C1/DS1 Oak Scrub	0.14
23.	12/C1/DS2 Himalayan Temperate Secondary Scrub	0.06
24.	12/C2a Kharsu Oak Forest (<i>Q.semecarpifolia</i>)	3.08
25.	12/C2b West Himalayan Upper Oak/Fir Forest	5.49
26.	12/C2c (Moist Temperate Deciduous Forest)	0.79
27.	12/DS2 Himalayan Temperate Parkland	0.03
28.	12/DS3 Himalayan Temperate Pastures	0.16
29.	12/1S1 Alder Forest	0.03
30.	12/2S1 Low Level Blue Pine Forest	0.09
31.	13/C2b Dry Deodar Forest (<i>Cedrus</i>)	0.73
32.	13/C5 West Himalayan Dry Juniper Forest (<i>J.macropoda</i>)	0.02
33.	13/1S1 Hippophae / Myricaria Scrub	0.26
34.	14/C1a West Himalayan Sub-Alpine Birch/Fir Forest (<i>Betula/Abies</i>)	0.71
35.	14/C1b West Himalayan Sub-Alpine Fir Forest	2.06
36.	14/1S1 Hippophae / Myricaria Brakes	0.08
37.	14/1S2 Deciduous Sub-Alpine Scrub	0.16
38.	14/DS1 Sub-Alpine Pastures	0.82
39.	15/C1 Birch/Rhododendron Scrub Forest	0.45

Contd.

Sl.No.	Forest Type	% of Forest cover
40.	15/E1 Dwarf Rhododendron Scrub	0.06
41.	15/C3 (Alpine Pastures)	5.54
42.	16/C1 Dry Alpine Scrub	0.01
43.	16/E1 Dwarf Juniper Scrub	0.12
44.	Plantation/ TOF	0.85
	Total	100.00

11.29.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.29.10 and table 11.29.11 in respect of Uttarakhand.

TABLE 11.29.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Trees	112
Shrub	73
Herb	94

TABLE 11.29.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Uttarakhand

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	2.51	2.08	*
2.	Group 5- Tropical Dry Deciduous Forests	2.53	2.19	2.18
3.	Group 9- Subtropical Pine Forests	1.84	1.90	2.41
4.	Group 12- Himalayan Moist Temperate Forests	2.41	2.58	3.70
5.	Group 13- Himalayan Dry Temperate Forests	0.65	1.76	1.85
6.	Group 14- Sub Alpine Forests	*	2.49	2.82
7.	Group 15 - Moist Alpine Scrub	1.35	*	*
8.	Group 16- Dry Alpine Scrub	*	1.36	1.10

* adequate number of sample plots were not available

11.29.4 Fire Prone Forest Areas

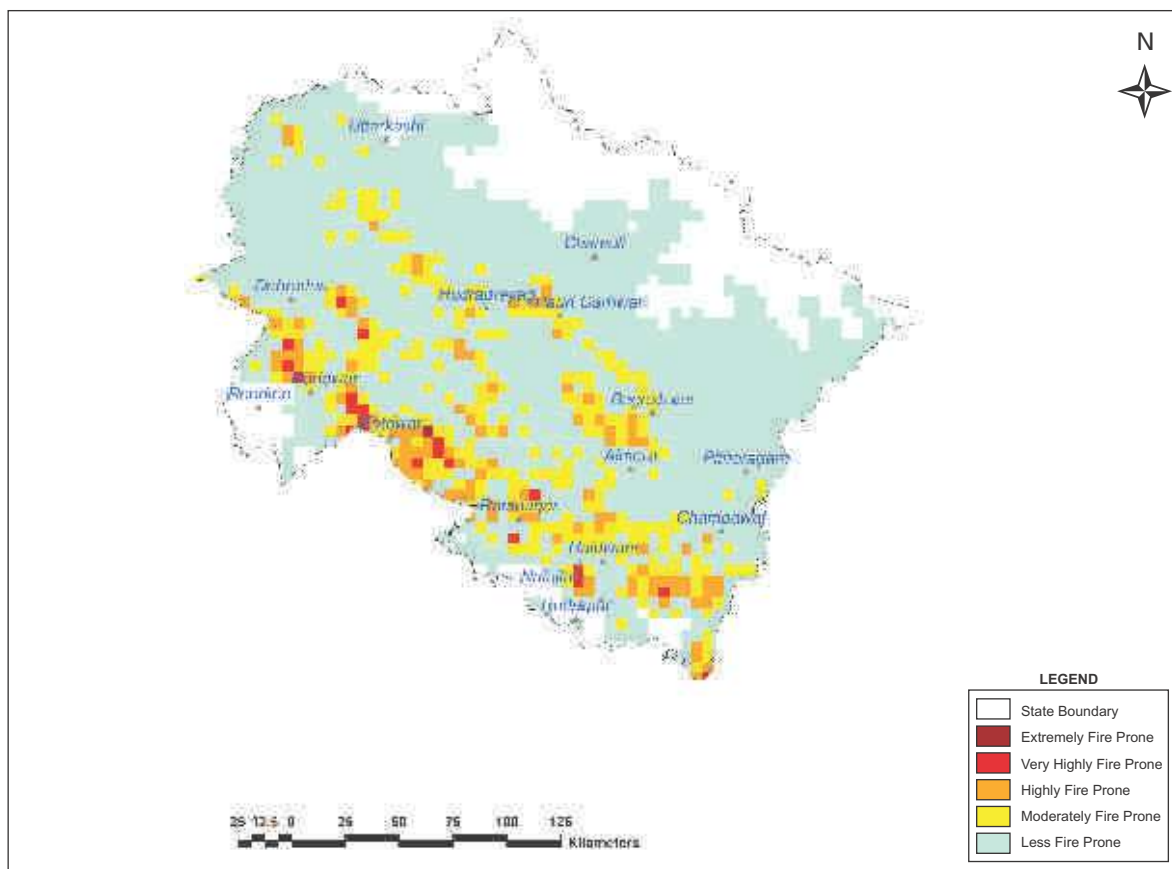
Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.29.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	45.56	0.17
2	Very highly fire prone	443.12	1.60
3	Highly fire prone	2,689.15	9.32
4	Moderately fire prone	7,316.58	21.66
5	Less fire prone	32,275.70	67.25
	Total	42,770.11	100.00



FIGURE 11.29.4 Fire prone forest areas under different fire prone classes



11.29.5 Tree Cover

Forest cover presented in the section 11.29.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Uttarakhand has been estimated as given in table 11.29.13.

TABLE 11.29.13 Tree Cover in Uttarakhand (in sq km)

Tree Cover	Area
	841

Tree cover of Uttarakhand has increased by 74 sq km as compared to the previous assessment reported in ISFR2017.

11.29.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.29.14 Extent of TOF in Uttarakhand (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
7,513	841	8,354

11.29.7 Growing Stock in Uttarakhand

Growing stock in the recorded forest areas (RFA) in Uttarakhand is given in the table 11.29.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.29.16.

TABLE 11.29.15 Growing Stock in Forest (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	406.08	9.50
Growing Stock in TOF	19.13	1.16

TABLE 11.29.16 Diameter class distribution of top five species inside RFA in Uttarakhand (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	43,087	28,380	4,250
2.	<i>Pinus roxburghii</i>	1,10,278	52,652	4,344
3.	<i>Quercus leucotrichophora</i>	1,19,542	21,968	3,082
4.	<i>Mallotus philippinensis</i>	54,823	1,161	0
5.	<i>Rhododendron arboreum</i>	76,339	14,212	651

11.29.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1 ha in size is 370.91 million tonnes (1,360.00 million tonnes of CO₂ equivalent) which is 5.21% of total forest carbon of the country. Pool wise forest carbon in Uttarakhand is given in the following table

TABLE 11.29.17 Forest Carbon in Uttarakhand in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
1,52,540	40,975	2,948	4,904	1,69,545	3,70,912

11.29.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash which include culms of 1 year age and above are given in the table 11.29.18

TABLE 11.29.18 Growing Stock of Bamboo in Uttarakhand

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,489	0.93
Total number of culms (in millions)	384	0.97
Total equivalent green weight (in '000' tonnes)	1,390	0.50

11.29.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Uttarakhand in Rural and Urban areas are given in the table 11.29.19 and table 11.29.20 respectively

TABLE 11.29.19 Top five tree species in TOF (Rural) in Uttarakhand

Sl. No.	Species	Relative Abundance (%)
1.	<i>Pinus roxburghii</i>	13.27
2.	<i>Grewia oppositifolia</i>	13.05
3.	<i>Mangifera indica</i>	12.61
4.	<i>Quercus leucotrichophora</i>	11.38
5.	<i>Ficus species</i>	6.03

TABLE 11.29.20 Top five tree species in TOF (Urban) in Uttarakhand

Sl. No.	Species	Relative Abundance (%)
1.	<i>Quercus leucotrichophora</i>	18.63
2.	<i>Mangifera indica</i>	14.33
3.	<i>Cedrus deodara</i>	7.36
4.	<i>Cupressus species</i>	5.63
5.	<i>Populus species</i>	4.58

11.29.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.29.21 and table 11.29.22 respectively.

TABLE 11.29.21 Major NTFP species in the State of Uttarakhand

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Rhododendron arborium</i>	Tree	71.98
2.	<i>Myrica esculenta</i>	Tree	16.65
3.	<i>Lannea coromandelica</i>	Tree	3.35
4.	<i>Ehretia laevis</i>	Tree	3.15
5.	<i>Taxus baccata</i>	Tree	1.52

TABLE 11.29.22 Major invasive species in the State with RFA/Green Wash in Uttarakhand (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	605
2.	<i>Ageratina adenophora</i>	271
3.	<i>Saccharum spontanem</i>	104
4.	<i>Cassia tora</i>	42
5.	<i>Acacia farnesiana</i>	30

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.29.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Uttarakhand

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Uttarakhand is given in the table 11.29.23

TABLE 11.29.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in Uttarakhand

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
40,75,981	3,21,18,736	2,427	38,801

11.30

WEST BENGAL

11.30.1 Introduction

The State of West Bengal, located in the eastern part of India has a geographical area of 88,752 sq km, which is 2.70% of the geographical area of the country. The State lies between 21°29'N to 27°13'N latitude and 85°50'E to 89°52' E longitude and shares international border with Bangladesh in the east, Nepal in the northwest and Bhutan in the northeast. The State is also bordered by Sikkim in the north, Assam in the east, Bihar & Jharkhand in the west and Odisha and the Bay of Bengal in the south. The State has two natural divisions viz the North Himalayan and the south Alluvial Gangetic Plains. The three main rivers of the State viz Teesta, Torsa and Jaldhaka are tributaries of river Brahmaputra. The rivers Ganga and Hooghly flowing through the central part of the State drain into the Bay of Bengal forming the famous Sunderbans. Climate varies from moist tropical in the southeast to dry tropical in the southwest and from subtropical to temperate in the mountains of north. The annual rainfall ranges between 900 mm in Southwest to 5,000 mm in parts of the north. The annual temperature varies from sub-zero in the hills during the winter to about 46°C in southern parts during the summer. As per the 2011 census, the population of West Bengal is 91.28 million, which is 7.54% of India's population. The rural and urban population constitute 68.13% and 31.87% respectively. The Tribal population is 5.80%. The population density of State is 1,028 per sq km, which is much higher than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 30.35 million.

TABLE 11.30.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	8,875	
Reporting area for land utilization	8,683	100.00
Forests	1,173	13.50
Not available for land cultivation	1,853	21.34
Permanent pastures and other grazing lands	2	0.03
Land under misc. tree crops and groves	50	0.57
Culturable wasteland	17	0.20
Fallow land other than current fallows	11	0.13
Current fallows	339	3.90
Net area sown	5,238	60.33

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.30.1.1 A Brief Overview of Forestry Scenario

The distribution of vegetation in northern West Bengal varies with elevation and precipitation, the foothills of the Himalayas are densely wooded with Sal and other tropical evergreen trees. The forest becomes predominantly subtropical above 1,000 meters and above 1,500 meters temperate forest trees like Oaks, Conifers and Rhododendrons predominate. As per the Champion & Seth Classification of Forest Types (1968), the forests in West Bengal belong to eight Forest Type Groups, which are further divided into 30 Forest Types. The State has taken initiative for raising plantations in and around industrial areas. West Bengal is one the pioneering States in implementing Joint Forest Management.

Recorded Forest Area (RFA) in the State is 11,879 sq km of which 7,054 sq km is Reserved Forest, 3,772 sq km is Protected Forest and 1,053 sq km is Unclassed Forests. In West Bengal, during the period 1st January 2015 to 5th February 2019, a total of 305.77 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). As per the information received from the State during that last two years, 568.42 ha of plantations were raised in the State.

Six National Parks, 16 Wildlife Sanctuaries and five Conservation Reserves constitute the Protected Area network of the State covering 5.47% of its geographical area.

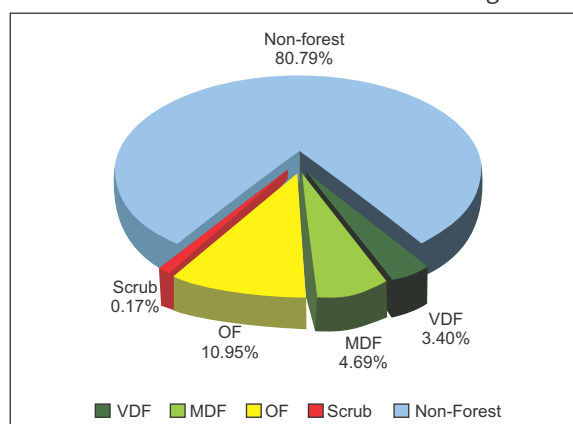
11.30.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Nov 2017 to Feb 2018, the Forest Cover in the State is 16,901.51 sq km. which is 19.04% of the State's geographical area. In terms of forest canopy density classes, the State has 3,018.52 sq km under Very Dense Forest (VDF), 4,160.26 sq km under Moderately Dense Forest (MDF) and 9,722.73 sq km under Open Forest (OF). Forest Cover in the State has increased by 54.51 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.30.2 Forest Cover of West Bengal

(in sq km)		
Class	Area	% of GA
VDF	3,018.52	3.40
MDF	4,160.26	4.69
OF	9,722.73	10.95
Total	16,901.51	19.04
Scrub	146.12	0.17

FIGURE 11.30.1 Forest Cover of West Bengal



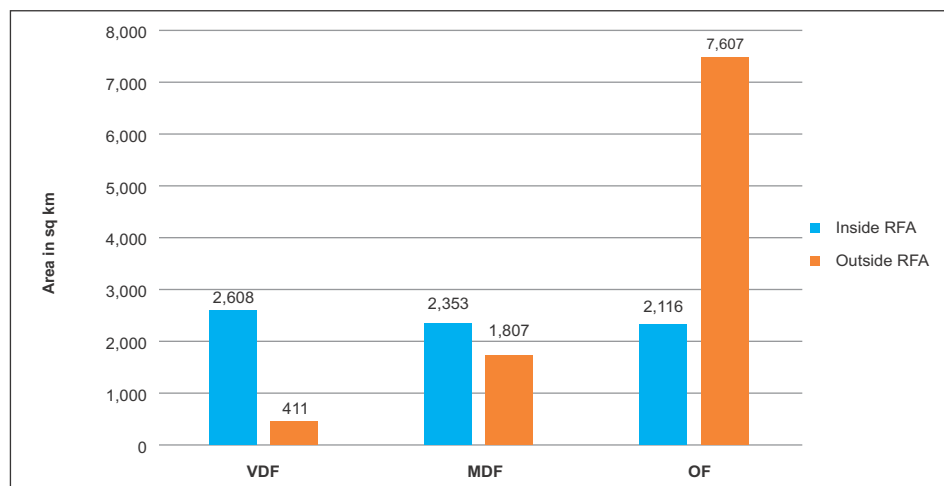
11.30.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The State has reported extent of recorded forest area (RFA) 11,879 sq km which is 13.38% of its geographical area. The reserved, protected and unclassified forests are 59.38% and 31.76% and 8.86% of the recorded forest area in the State respectively. However as the digitized boundary of recorded forest area from the state covers 13,418.77 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.30.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in West Bengal (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
2,608	2,353	2,116	7,077	411	1,807	7,607	9,825
36.85%	33.25%	29.90%		4.18%	18.40%	77.42%	

*in case of West Bengal RFA boundaries have been used.

FIGURE 11.30.2 Forest Cover inside and outside RFA in West Bengal**TABLE 11.30.4** District-wise Forest Cover in West Bengal (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Bankura ^T	6,882	222.33	395.27	667.98	1,285.58	18.68	15.58	28.59
Bardhaman ^T	7,024	57.53	91.78	190.00	339.31	4.83	4.31	7.35
Birbhum ^T	4,545	1.00	34.14	149.66	184.80	4.07	7.80	8.90
Dakshin Dinajpur ^T	2,219	0.00	5.83	81.29	87.12	3.93	0.12	0.00
Darjiling TH	3,149	720.76	654.52	992.52	2,367.80	75.19	2.80	9.21
Haora	1,467	0.00	50.00	253.77	303.77	20.71	-0.23	0.00
Hugli	3,149	0.00	14.00	146.00	160.00	5.08	0.00	0.00
Jalpaiguri ^T	6,227	724.22	434.92	1,703.26	2,862.40	45.97	5.40	39.65
Koch Bihar	3,387	0.00	27.00	322.06	349.06	10.31	0.06	0.00
Kolkata	185	0.00	0.00	1.00	1.00	0.54	0.00	0.00
Maldah ^T	3,733	0.00	209.04	282.65	491.69	13.17	0.69	0.00
Murshidabad ^T	5,324	0.00	53.06	291.83	344.89	6.48	-1.11	0.00
Nadia	3,927	1.00	160.16	318.84	480.00	12.22	0.00	0.00
North Twentyfour Parganas	4,094	13.02	184.98	524.98	722.98	17.66	-0.02	0.00
Paschim Medinipur ^T	9,368	256.21	591.64	1,313.69	2,161.54	23.07	10.54	20.24
Purba Medinipur ^T	4,713	1.99	197.96	620.10	820.05	17.40	0.05	2.50
Puruliya ^T	6,259	37.36	306.94	571.58	915.88	14.63	11.88	28.68
South twentyfour Parganas ^T	9,960	983.10	745.03	1,060.58	2,788.71	27.99	-3.29	1.00
Uttar Dinajpur	3,140	0.00	3.99	230.94	234.93	7.48	-0.07	0.00
Grand Total	88,752	3,018.52	4,160.26	9,722.73	16,901.51	19.04	54.51	146.12

TABLE 11.30.5 Forest Cover Change Matrix for West Bengal

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	2,963	19	7	1	4	2,994
Moderately Dense Forest	53	4,070	17	1	6	4,147
Open Forest	3	65	9,581	9	48	9,706
Scrub	0	0	17	115	4	136
Non Forest	0	6	101	20	71,642	71,769
Total ISFR 2019	3,019	4,160	9,723	146	71,704	88,752
Net Change	25	13	17	10	-65	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.30.6 Altitude-wise Forest Cover in West Bengal

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	86,650	2,389	3,612	9,035	15,036 (88.96%)	146
500-1000	807	141	272	262	675 (3.99%)	0
1000-2000	970	267	228	383	878 (5.19%)	0
2000-3000	292	196	44	40	280 (1.66%)	0
>3000	33	26	4	3	33 (0.20%)	0
Total	88,752	3,019	4,160	9,723	16,902	146

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.30.7 Forest Cover in different slope classes in West Bengal

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	85,130	2,209	3,244	8,729	14,182 (83.90%)	131
5-10	1,227	141	217	227	585 (3.46%)	6
10-15	508	119	151	152	422 (2.50%)	3
15-20	539	147	157	171	475 (2.81%)	2
20-25	514	149	148	168	465 (2.75%)	2
25-30	404	122	117	134	373 (2.21%)	1
>30	430	132	126	142	400 (2.37%)	1
Total	88,752	3,019	4,160	9,723	16,902	146

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.30.3 Forest Cover Map of West Bengal

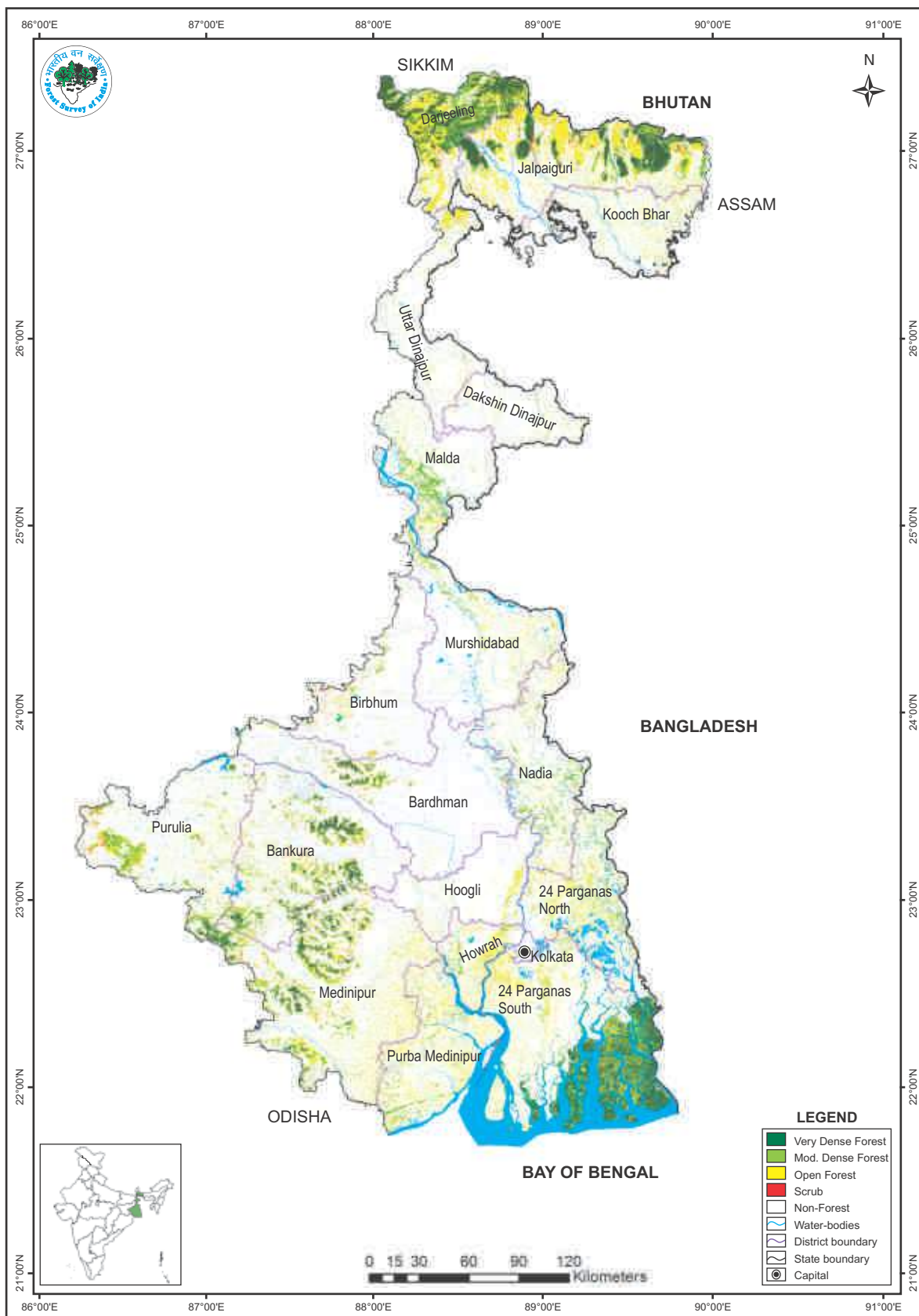


TABLE 11.30.8 Wetlands inside the Recorded Forest Area (or Green Wash) in West Bengal (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	136	568
Ox-bow lake/Cut-off meander	18	172
High altitude Wetland	3	55
Riverine wetland	17	170
Waterlogged	129	801
River/Stream	50	2,18,985
Sub - Total	353	2,20,751
Inland Wetlands -Man-made		
Reservoir/Barrage	136	3,456
Tank/Pond	722	2,043
Waterlogged	5	43
Sub - Total	863	5,542
Inland Wetlands -Man-made		
Sand/Beach	33	1209
Intertidal mud flat	9	510
Mangrove	197	2,00,404
Sub -Total	239	2,02,123
Wetlands (<2.25 ha)	10,060	10,060
Total	11,515	4,38,476
Total Recorded Forest (or Green Wash) Area (in ha)		13,41,877
% of Wetland area inside Recorded Forest (or Green Wash) Area		32.68%

(analysis based on the National Wetland Atlas: India, 2011)

11.30.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of West Bengal as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

Table 11.30.9 Percentage area under different forest types of West Bengal

Sl.No.	Forest Type	% of Forest cover
1.	2B/2S3 Sub Himalayan Secondary Wet Mixed Forest	2.09
2.	3C/C1a(I) East Himalayan Sal	2.35
3.	3C/C1b(I) East Himalayan Upper Bhabar Sal	0.90
4.	3C/C1b(ii) East Himalayan Lower Bhabar Sal	0.69
5.	3C/C1c Eastern Tarai Sal Forest	1.91
6.	3C/C2d (iii) Eastern Heavy Alluvium Plains Sal	0.02
7.	3C/DS1 Moist Sal Savannah	0.07
8.	3C/C3a West Gangatic Moist Mixed Deciduous Forest	0.08
9.	3C/C3b East Himalayan Moist Mixed Deciduous Forest	2.45
10.	3C/C3/2S2 (Secondary Euphorbiaceous Scrub)	0.06
11.	3C/1S1 Low Alluvial Savannah Woodland (<i>Salmalia albizia</i>)	0.18
12.	4B/TS1 Mangrove Scrub	0.71
13.	4B/TS2 Mangrove Forest	5.89

Contd.

Sl.No.	Forest Type	% of Forest cover
14.	4B/TS3 Salt Water Mixed Forest (<i>Heritiera</i>)	2.80
15.	4B/TS4 Brackish Water Mixed Forest (<i>Heritiera</i>)	1.80
16.	4B/E1 Palm Swamp	0.87
17.	4C/FS2 Submontane Hill-Valley Swamp Forest	0.03
18.	4D/SS2 <i>Barringtonia</i> Swamp Forest	0.02
19.	4D/2S2 Eastern Wet Alluvial Grassland	0.01
20.	5B/C1c Dry Peninsular Sal Forest	16.31
21.	5B/C2 Northern Dry Mixed Deciduous Forest	1.49
22.	5B/DS1 Dry Deciduous Scrub	0.21
23.	5/E5 <i>Butea</i> Forest	0.12
24.	5/1S2 <i>Khair-Sissu</i> Forest	1.18
25.	8B/C1 East Himalayan Sub-Tropical Wet Hill Forest	2.81
26.	11B/C1a Lauraceous Forest	0.72
27.	11B/C1b <i>Buk</i> Oak Forest	0.33
28.	11B/C1c High Level Oak Forest	0.12
29.	12/C3a East Himalayan Mixed Coniferous Forest	1.90
30.	14/C2 East Himalayan Sub-Alpine Birch/Fir Forest	0.08
31.	Plantation/ TOF	51.8
	Total	100.00

11.30.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.30.10 and table 11.30.11 in respect of West Bengal.

TABLE 11.30.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	113
Shrub	103
Herb	65

TABLE 11.30.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of West Bengal

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 2- Tropical Semi-Evergreen Forests	2.33	2.51	2.40
2	Group 3- Tropical Moist Deciduous Forests	2.76	1.21	1.59
3	Group 4- Littoral and Swamp Forests	*	1.28	1.10
4	Group 5- Tropical Dry Deciduous Forests	2.32	2.49	1.95
5	Group 8- Subtropical Broadleaved Hill Forests	1.76	2.36	2.33
6	Group 11- Montane Wet Temperate Forests	1.51	2.66	1.76
7	Group 12- Himalayan Moist Temperate Forests	1.96	2.72	2.32
8	Group 14- Sub Alpine Forests	1.19	2.03	1.24

*adequate number of sample plots were not available

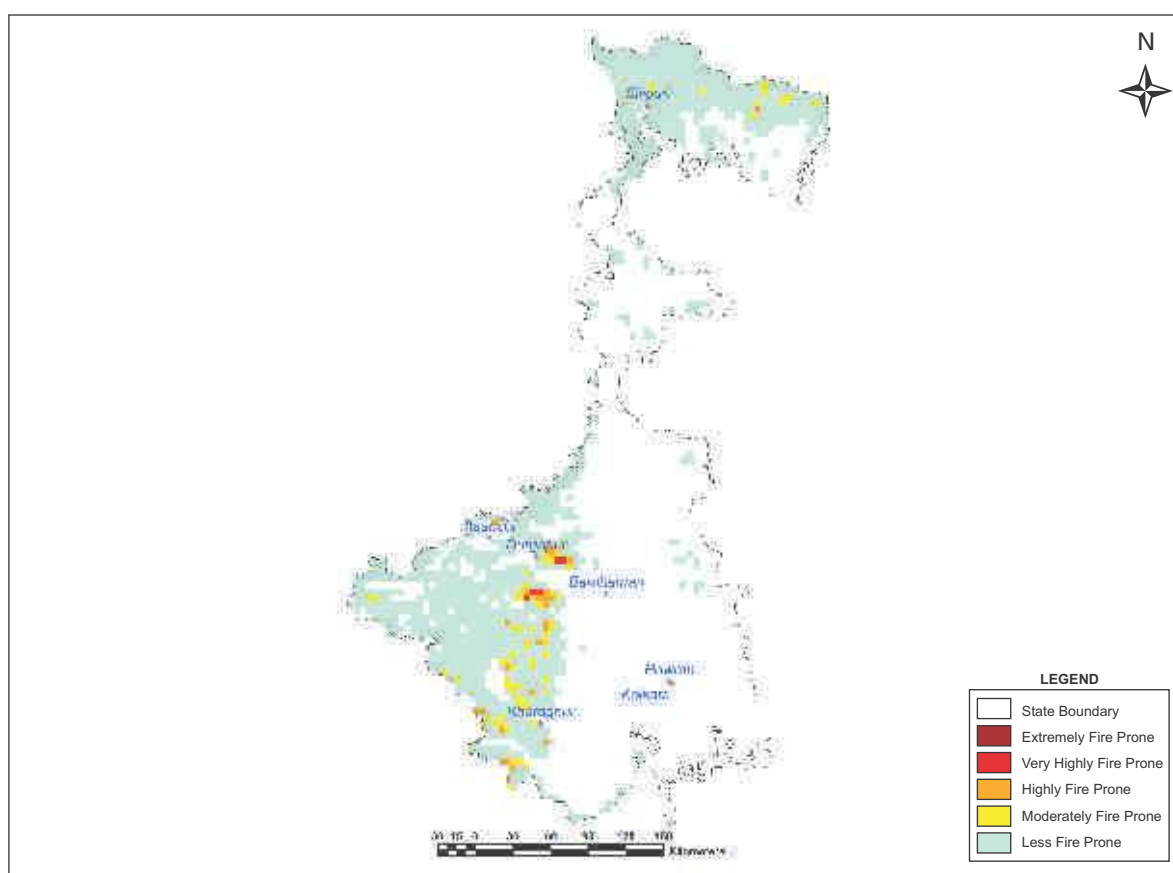
11.30.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.30.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very highly fire prone	129.87	0.98
3.	Highly fire prone	669.09	4.33
4.	Moderately fire prone	1,764.89	10.72
5.	Less fire prone	28,363.70	83.97
	Total	30,927.55	100.00

FIGURE 11.30.4 Fire prone forest areas under different fire prone classes



11.30.5 Tree Cover

Forest cover presented in the section 11.30.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in West Bengal has been estimated as given in table 11.30.13.

TABLE 11.30.13 Tree Cover in West Bengal
(in sq km)

Tree Cover	Area
	2,006

Tree cover of West Bengal has decreased by 130 sq km as compared to the previous assessment reported in ISFR 2017.

11.30.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.30.14 Extent of TOF in West Bengal
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
9,825	2,006	11,831

11.30.7 Growing Stock in West Bengal

Growing stock in the recorded forest areas (RFA) in West Bengal is given in the table 11.30.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.30.16

TABLE 11.30.15 Growing Stock in Forest
(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	54.87	1.28
Growing Stock in TOF	32.63	1.99

TABLE 11.30.16 Diameter class distribution of top five species inside RFA in West Bengal
(in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Shorea robusta</i>	66,187	2,167	194
2.	<i>Tectona grandis</i>	9,400	2,570	226
3.	<i>Schima wallichii</i>	8,221	1,605	441
4.	<i>Eucalyptus species</i>	9,338	327	0
5.	<i>Acacia auriculiformis</i>	16,877	129	0

11.30.8 Carbon Stock in Forest

The total Carbon stock of forest in the State including the TOF patches which are more than 1ha in size is 147.71 million tonnes (541.60 million tonnes of CO₂ equivalent) which is 2.07% of total forest carbon of the country. Pool wise forest carbon in West Bengal is given in the following table

TABLE 11.30.17 Forest Carbon in West Bengal in different pools
(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
40,388	12,193	447	2,533	92,144	1,47,705

11.30.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which includes culms of 1 year age and above, are given in the table 11.30.18

TABLE 11.30.18 Growing Stock of Bamboo in West Bengal

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	855	0.53
Total number of culms (in millions)	384	0.97
Total equivalent green weight (in 000' tonnes)	1,110	0.40

11.30.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in West Bengal in Rural and Urban areas are given in the table 11.30.19 and table 11.30.20 respectively

TABLE 11.30.19 Top five tree species in TOF (Rural) in West Bengal

Sl. No.	Species	Relative Abundance (%)
1.	<i>Bombax ceiba</i>	8.67
2.	<i>Dalbergia sissoo</i>	7.24
3.	<i>Mangifera indica</i>	6.48
4.	<i>Butea frondosa</i>	5.74
5.	<i>Eucalyptus species</i>	5.61

TABLE 11.30.20 Top five tree species in TOF (Urban) in West Bengal

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca catechu</i>	26.63
2.	<i>Cocos nucifera</i>	10.35
3.	<i>Mangifera indica</i>	9.45
4.	<i>Artocarpus integrifolia</i>	4.63
5.	<i>Azadirachta indica</i>	3.54

11.30.11 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.30.21 and table 11.30.22 respectively.

TABLE 11.30.21 Major NTFP species in the State of West Bengal

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Shorea robusta</i>	Tree	75.18
2.	<i>Madhuca indica</i>	Tree	8.44
3.	<i>Butea monosperma</i>	Tree	8.37
4.	<i>Terminalia belerica</i>	Tree	1.85
5.	<i>Terminalia arjuna</i>	Tree	1.35

TABLE 11.30.22 Major invasive species in the State inside the RFA/Green Wash in West Bengal (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	219
2.	<i>Ageratum conyzoides</i>	68
3.	<i>Mikania micrantha</i>	50
4.	<i>Lantana camara</i>	47
5.	<i>Xanthium strumarium</i>	13

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.

11.30.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in West Bengal

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for West Bengal is given in the table 11.30.23

TABLE 11.30.23 Estimation of Dependence of People in Forest Fringe Villages on Forests in West Bengal

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
25,19,384	2,12,08,743	45,470	1,34,946



11.31

ANDAMAN & NICOBAR ISLANDS

11.31.1 Introduction

Andaman & Nicobar Islands comprise 572 Islands (including islets & rocks) and has a geographical area of 8,249 sq km, constituting 0.25% of the total geographical area of the country. The Andaman Sea and the Bay of Bengal are to the eastern and western sides of the Islands. The Union Territory lies between 6°N to 14°N latitude and 92°E to 94°E longitudes. It comprises the Andaman and the Nicobar groups of Islands, which are separated by the 10°N channel. The islands lie along an arc in a long and narrow broken chain, approximately extending North-South over a distance more than 700 km and have a coastline of 1,962 km. The climate is humid and tropical and the humidity ranges between 70% to 90%. The average annual rainfall ranges between 1,400 mm to 3,000 mm. The weather is generally pleasant and annual temperature varies from 24°C and 28°C. The territory is drained by several small rivulets which end up as creeks often lined with dense mangroves. Kalpong is an important river in Diglipur Island. Saddle peak is the highest hill in the Islands. The only active volcano of the country, the Barren Island is located in A&N Islands. As per Census 2011, the UT is divided into 3 districts and has a total population of 0.38 million which constitute 0.03% of the country's population. The urban & rural population constitutes 62.30% and 37.70% respectively. The Tribal population is 7.61%. The Islands are home to six indigenous aboriginal tribal groups viz Jarawa, Sentinelese, Great Andamanese, Onge, Nicobarese and Shompen. Population density is 46 persons per sq km which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 0.15 million.

TABLE 11.31.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	825	
Reporting area for land utilization	757	100.00
Forests	716	94.68
Not available for land cultivation	9	1.16
Permanent pastures and other grazing lands	4	0.49
Land under misc. tree crops and groves	4	0.54
Culturable wasteland	3	0.41
Fallow land other than current fallows	3	0.43
Current fallows	3	0.35
Net area sown	15	1.94

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.31.1.1 A Brief Overview of Forestry Scenario

Andaman & Nicobar Islands support very luxuriant and rich vegetation due to tropical hot and humid climate with abundant rains. As per the Champion & Seth Classification of Forest Types (1968), the forests in Andaman & Nicobar Islands belong to four Type Groups i.e. Tropical Wet Evergreen, Tropical Semi Evergreen, Tropical Moist Deciduous and Littoral & Swamp Forests which are further categorized into 13 Forest Types. Nature has provided these islands with a unique and varied flora and fauna. The surrounding seas are equally rich in marine biodiversity. Due to the geographic isolation of these islands, a large degree of endemism exists which means that the ecosystems of these islands are vulnerable to disturbances. The forestry practices in these islands have undergone significant changes in the last more than 125 years of scientific forestry, influenced by major policy changes and socio-economic situations. The current focus of forest management in the islands is towards biodiversity conservation along with sustainable use of forest produce for local inhabitants, to protect the environment for future generations.

The forests in these islands have a tropical rainforest canopy, made of a mixed flora with elements from Indo-Myanmar and Indo-Malayan floral realms. About 2,200 varieties of plants have been recorded in the Islands, out of which 200 are endemic and 1,300 do not occur in mainland India.

Forests in the South Andaman's have a profuse growth of epiphytic vegetation, mostly ferns, and orchids. The Middle & North Andaman are characterized by Moist Deciduous & Wet Evergreen forests respectively. The Evergreen forests are dominant in the Central & Southern Islands of the Nicobar group. The moist deciduous forests are common in the Andamans, they are almost absent in the Nicobar islands. Grasslands occur only in the Nicobars.

In the Union Territory, RFA is 7,171 sq km of which 5,613 sq km is Reserved Forest and 1,558 sq km is Protected Forest. In Andaman & Nicobar Islands, during the period 1st January 2015 to 5th February 2019, a total of 20.14 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

Nine National Parks, 96 Wildlife Sanctuaries and one Biosphere Reserves constitute the Protected Area network of the UT covering 18.71% of its geographical area.

11.31.2 Forest Cover

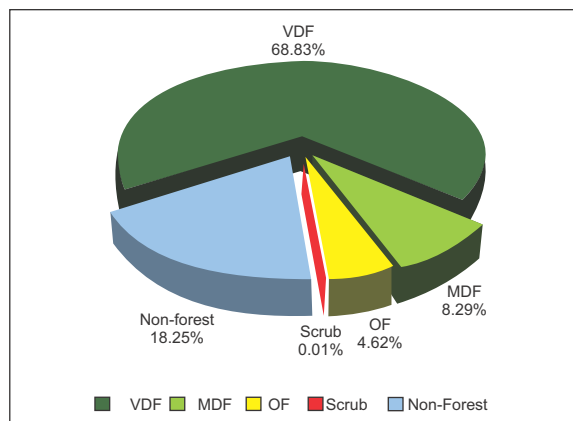
Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Apr 2017 to Mar 2018, the Forest Cover in the UT is 6,742.78 sq km which is 81.74 % of the UT's geographical area. In terms of forest canopy density classes, the UT has 5,677.52 sq km under Very Dense Forest (VDF), 683.89 sq km under Moderately Dense Forest (MDF) and 381.37sq km under Open Forest (OF). Forest Cover in the UT has increased by 0.78 sq km as compared to the previous assessment reported in ISFR 2017.



TABLE 11.31.2 Forest Cover of Andaman & Nicobar Islands

(in sq km)		
Class	Area	% of GA
VDF	5,677.52	68.83
MDF	683.89	8.29
OF	381.37	4.62
Total	6,742.78	81.74
Scrub	1.13	0.01

FIGURE 11.31.1 Forest Cover of Andaman & Nicobar Islands



11.31.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The UT has reported extent of recorded forest area (RFA) 7,171 sq km which is 86.93% of its geographical area. The reserved and protected forests are 78.27% and 21.73% of the recorded forest area in the UT respectively. However, as the digitized boundary of RFA from the UT covers only an area 6,747.11 sq km, the analysis of forest cover inside and outside this area is given below.

Table 11.31.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Andaman & Nicobar Islands

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
5,408	560	254	6,222	270	124	127	521
86.91%	9.00%	4.09%		51.83%	23.73%	24.44%	

**in case of A&N Islands RFA boundaries have been used*

FIGURE 11.31.2 Forest Cover inside and outside RFA in Andaman & Nicobar Islands

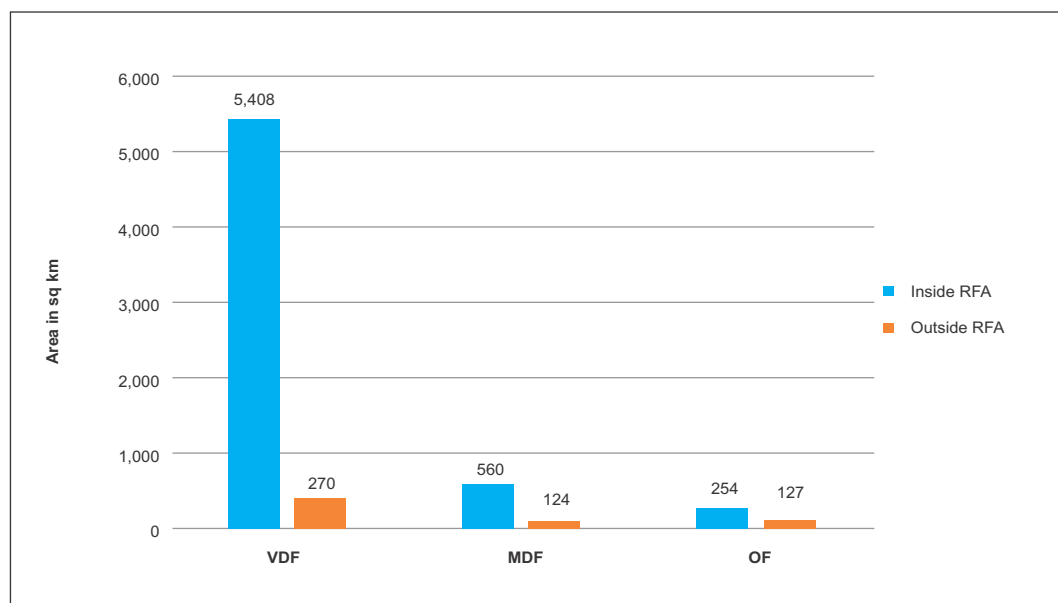


TABLE 11.31.4 District-wise Forest Cover in Andaman & Nicobar Islands

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Nicobars ^T	1,841	1,147.99	104.99	153.19	1,406.17	76.38	0.17	1.00
North & Middle Andaman ^T	3,736	2,670.81	326.90	72.82	3,070.53	82.19	-0.47	0.00
South Andaman ^T	2,672	1,858.72	252.00	155.36	2,266.08	84.81	1.08	0.13
Grand Total	8,249	5,677.52	683.89	381.37	6,742.78	81.74	0.78	1.13

TABLE 11.31.5 Forest Cover Change Matrix for Andaman & Nicobar Islands

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	5,678	0	0	0	0	5,678
Moderately Dense Forest	0	684	0	0	0	684
Open Forest	0	0	380	0	0	380
Scrub	0	0	0	1	0	1
Non Forest	0	0	1	0	1,505	1,506
Total ISFR 2019	5,678	684	381	1	1,505	8,249
Net Change	0	0	1	0	-1	

Main reasons for the increase in forest cover in the UT is plantation and conservation activities as well as improvement in interpretation.

TABLE 11.31.6 Altitude-wise Forest Cover in Andaman & Nicobar Islands

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	8,238	5,667	684	381	6,732 (99.84 %)	1
500-1000	11	11	0	0	11 (0.16 %)	0
Total	8,249	5,678	684	381	6,743	1

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.31.7 Forest Cover in different slope classes in Andaman & Nicobar Islands

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	3,983	2,339	391	262	2,992 (44.37 %)	1
5-10	1,999	1,460	187	76	1,723 (25.55 %)	0
10-15	1,185	949	74	28	1,051 (15.59%)	0
15-20	651	555	22	10	587 (8.71 %)	0
20-25	299	262	7	3	272 (4.03 %)	0
25-30	101	88	2	1	91 (1.35 %)	0
>30	31	25	1	1	27 (0.40 %)	0
Total	8,249	5,678	684	381	6,743	1

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.31.3 Forest Cover Map of Andaman & Nicobar Islands

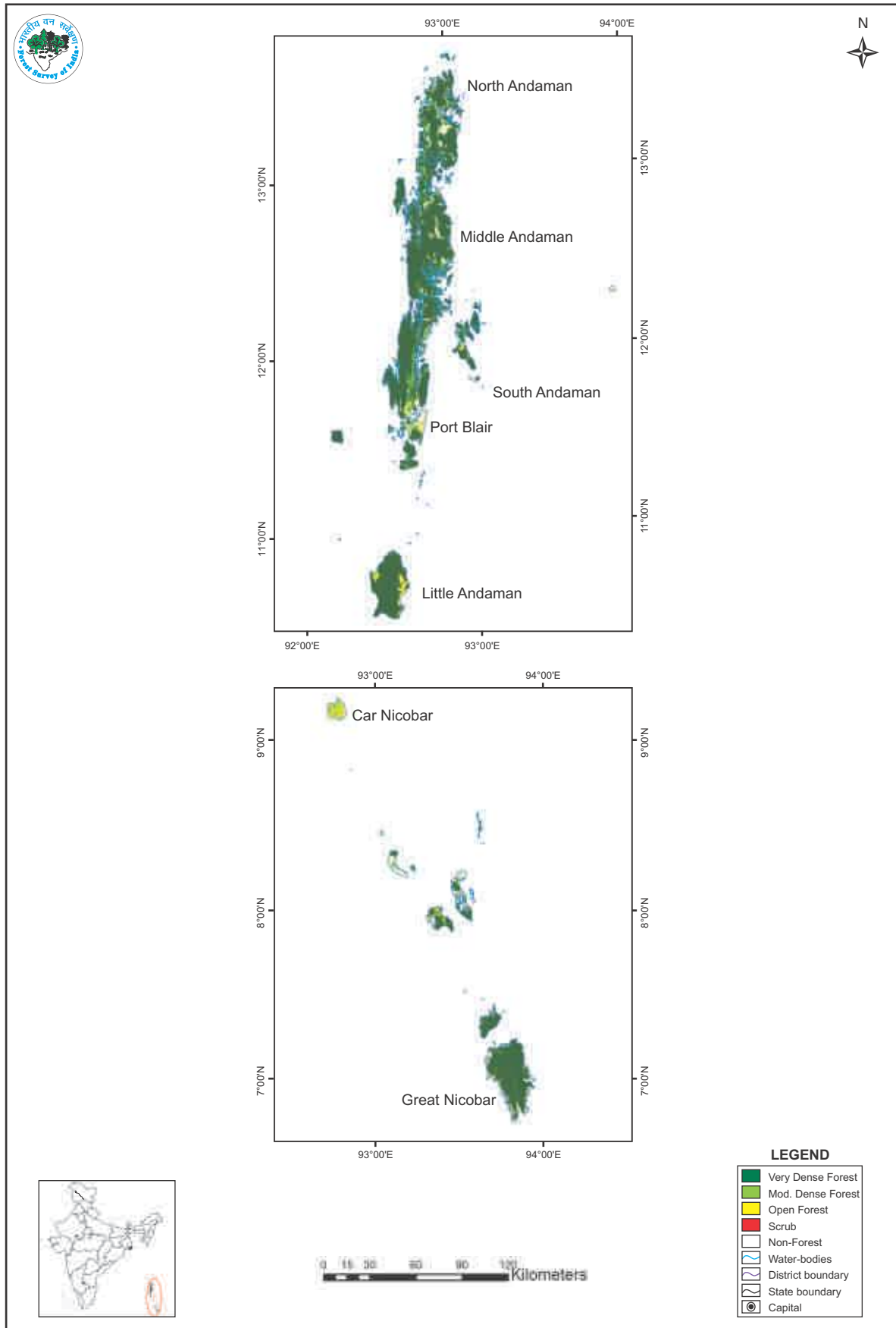


TABLE 11.31.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Andaman & Nicobar Islands (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	6	44
River/Stream	41	1,592
Sub - Total	47	1,636
Inland Wetlands - Man-made		
Reservoir/Barrage	7	278
Sub - Total	7	278
Coastal Wetlands – Natural		
Lagoon	2	11
Creek	118	615
Sand/Beach	336	3,883
Intertidal mud flat	354	8,372
Salt Marsh	315	5,546
Mangrove	653	60,576
Coral Reef	375	8,045
Sub -Total	2,153	87,048
Wetlands (<2.25 ha)	60	60
Total	2,267	89,022
Total Recorded Forest (or Green Wash) Area (in ha)		6,74,711
% of Wetland area inside Recorded Forest (or Green Wash) Area		13.19%

(analysis based on the National Wetland Atlas: India, 2011)

11.31.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Andaman & Nicobar Islands as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.31.9 Percentage area under different forest types in Andaman & Nicobar Islands

Sl.No.	Forest Type	% of Forest cover
1.	1A/C1 Giant Evergreen Forest	0.58
2.	1A/C2 Andamans Tropical Evergreen Forest	43.70
3.	1A/C3 Southern Hilltop Tropical Evergreen Forest	1.20
4.	1A/E1 Andamans Moist Deciduous Forest	2.31
5.	1/E1 Cane Brakes	0.00
6.	1/E2 Wet Bamboo Brakes	0.33
7.	1/2S1 Pioneer Euphorbiaceous Scrub	0.03
8.	2A/C1 Andamans Semi-Evergreen Forest	29.30
9.	2/E2 (Wet Bamboo Brakes)	0.18
10.	3A/C1 Andamans Moist Deciduous Forest	8.12
11.	3A/2S1 Andamans Secondary Moist Deciduous Forest	0.12
12.	4A/L1 Littoral Forest	0.14
13.	4B/TS2 Mangrove Forest	10.96
14.	Plantation/TOF	3.03
	Total	100.00

11.31.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.31.10 and table 11.31.11 in respect of Andaman & Nicobar Islands.

TABLE 11.31.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	89
Shrub	102
Herb	79

TABLE 11.31.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Andaman & Nicobar Islands

Sl. No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1	Group 1-Tropical Wet Evergreen Forests	3.01	3.34	3.28
2	Group 2-Tropical Semi-Evergreen Forests	3.19	3.31	3.21
3	Group 3-Tropical Moist Deciduous Forests	2.67	3.10	2.85
4	Group 4-Littoral and Swamp Forests	*	2.29	2.11

*adequate number of sample plots were not available

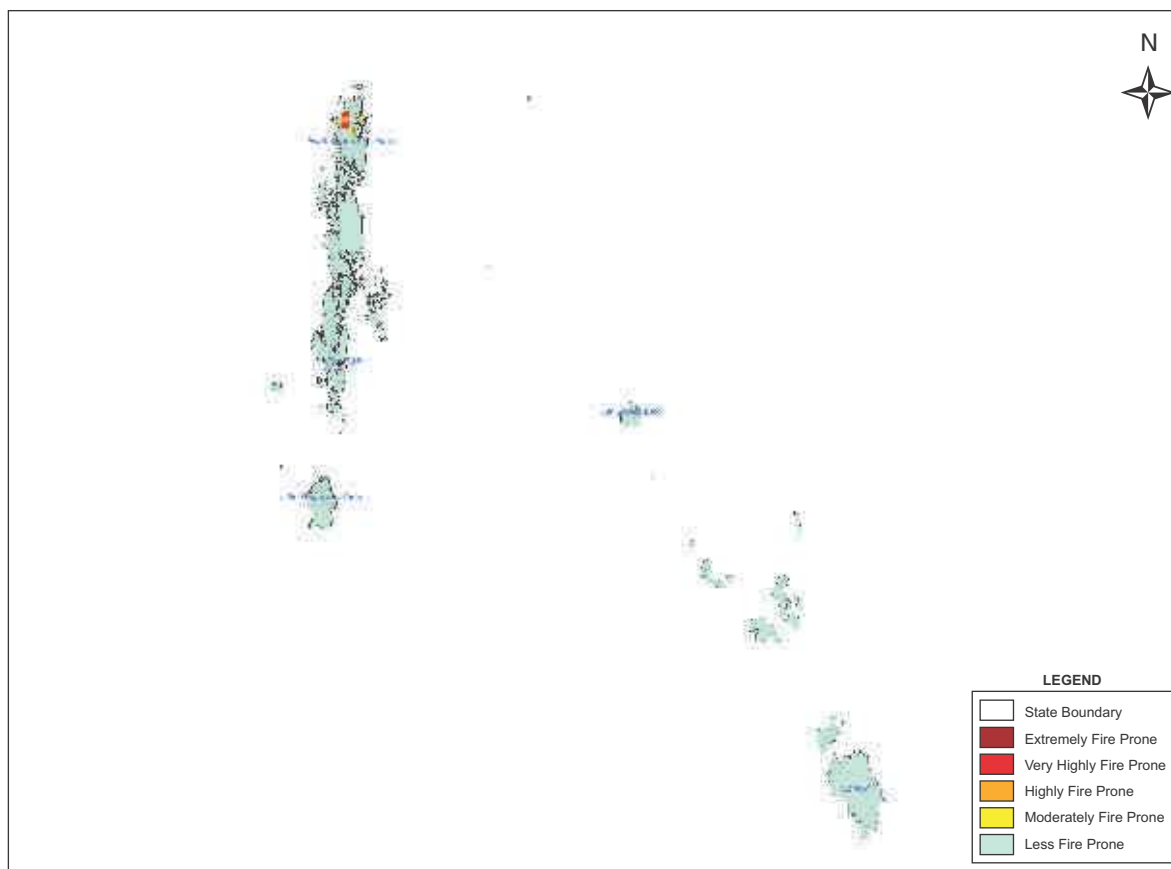
11.31.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.31.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0.00
2.	Very Highly fire prone	52.82	0.52
3.	Highly fire prone	47.84	0.42
4.	Moderately fire prone	51.44	0.38
5.	Less fire prone	8,092.41	98.68
	Total	8,244.51	100.00



FIGURE 11.31.4 Fire prone forest areas under different fire prone classes

11.31.5 Tree Cover

Forest cover presented in the section 11.31.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Andaman & Nicobar Islands has been estimated as given in table 11.31.13.

TABLE 11.31.13 Tree Cover in Andaman & Nicobar Islands
(in sq km)

Tree Cover	Area
	41

Tree cover of Andaman & Nicobar Islands has increased by 6 sq km as compared to the previous assessment reported in ISFR 2017.

11.31.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.31.14 Extent of TOF in Andaman & Nicobar Islands (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
521	41	562

11.31.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Andaman & Nicobar Islands is given in the table 11.31.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.31.16

TABLE 11.31.15 Growing Stock in Andaman & Nicobar Islands (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	90.82	2.13
Growing Stock in TOF	2.75	0.17

TABLE 11.31.16 Diameter class distribution of top five species inside RFA in Andaman & Nicobar Islands (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Canarium euphyllum</i>	2,602	2,417	1,301
2.	<i>Dipterocarpus turbinatus</i>	8,687	3,370	502
3.	<i>Dipterocarpus species</i>	3,532	1,859	558
4.	<i>Myristica species</i>	15,837	688	0
5.	<i>Pterocymbium tinctorium</i>	2,993	3,662	558

11.31.8 Carbon Stock in Forest

The total Carbon stock of forests in the UT including the TOF patches which are more than 1 ha in size is 112.67 million tonnes (413.12 million tonnes of CO₂ equivalent) which is 1.58% of total forest carbon of the country. Pool wise forest carbon in Andaman & Nicobar Islands is given in the following table.

TABLE 11.31.17 Forest Carbon in Andaman & Nicobar Islands in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
49,468	15,823	1,116	2,912	43,347	1,12,666

11.31.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the UT which include culms of 1 year age and above are given in the table 11.31.18

TABLE 11.31.18 Growing Stock of Bamboo in Andaman & Nicobar Islands

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	1,814	1.13
Total number of culms (in millions)	803	2.04
Total equivalent green weight (in '000' tonnes)	7,199	2.59

11.31.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Andaman & Nicobar Islands in Rural and Urban areas are given in the table 11.31.19 and table 11.31.20 respectively

TABLE 11.31.19 Top five tree species in TOF (Rural) in Andaman & Nicobar Islands

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	45.69
2.	<i>Anacardium occidentale</i>	16.80
3.	<i>Ficus carica</i>	12.00
4.	<i>Pandanus odoratissimus</i>	7.86
5.	<i>Areca catechu</i>	6.86

TABLE 11.31.20 Top five tree species in TOF (Urban) in Andaman & Nicobar Islands

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca catechu</i>	37.22
2.	<i>Cocos nucifera</i>	17.28
3.	<i>Mangifera andamanica</i>	6.15
4.	<i>Artocarpus heterophyllus</i>	5.71
5.	<i>Lagerstroemia hypoleuca</i>	3.58

11.31.11 Major NTFP Species

Major NTFP species as assessed from forest inventory data are presented in the table 11.31.21.

TABLE 11.31.21 Major NTFP species in the UT of Andaman & Nicobar Islands

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Calamus longisetus</i>	Shrub	44.85
2.	<i>Calamus palustris</i>	Shrub	25.00
3.	<i>Curcuma aromatica</i>	Herb	25.00
4.	<i>Diplagium species</i>	Herb	4.78
5.	<i>Heritiera littoralis</i>	Tree	0.37

Major NTFP species are given in terms of relative abundance

11.31.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Andaman & Nicobar Islands

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Andaman & Nicobar Islands is given in the table 11.31.22

Table 11.31.22 Estimation of Dependence of People in Forest Fringe Village Forests in Andaman & Nicobar Islands

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
22,038	83,405	3,737	2,506



11.32

CHANDIGARH

11.32.1 Introduction

The Union Territory of Chandigarh, one of the first planned cities in post-independence India is the joint capital of the States of Punjab and Haryana. It is the fifth largest Union Territory covering an area of 114 sq km, which is 0.003% of the geographical area of the country. The Union Territory lies between 30°39' N to 30°49'N latitude and 75°41'E to 75°51'E longitude and is bordered by the State of Punjab in the north, south and west and by the State of Haryana in the east. Physiographically, the UT falls in the Great Indian Northern Plains although near to the foothills of the Shiwalik Hills. Chandigarh experiences humid subtropical climate characterized by seasonal changes i.e very hot summers, severe winters, moderate to heavy rainfall in monsoon. The average annual rainfall ranges between 400 mm to 600 mm and the average annual temperature varies from 1°C to 45°C. As per the 2011 census, Chandigarh comprises of a single district, which is neither hill nor tribal. The UT has a population of 1.06 million accounting to 0.09% of India's population. The rural and urban population constitute 2.75% and 97.25% respectively. The Tribal population is 30.62%. The population density is 9,298 persons per sq km. The 19th livestock census 2012 has reported a total livestock population of 24,197 in Chandigarh.

TABLE 11.32.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	11	
Reporting area for land utilization	7	100.00
Forests	0.21	3.02
Not available for land cultivation	5.36	76.24
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	0.17	2.45
Culturable wasteland	-	-
Fallow land other than current fallows	0.05	0.71
Current fallows	0.05	0.75
Net area sown	1.18	16.83

Source : Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.32.1.1 A Brief Overview of Forestry Scenario

The Union Territory of Chandigarh is a planned city which is divided into 56 Sectors and is mainly dominated with urban land use. As per the Champion & Seth Classification of Forest Types (1968), the forests of Chandigarh belong to one Forest Type Group i.e. Tropical Dry Deciduous Forest, which is further divided into two Forest Types. Chandigarh has beautiful roadside linear plantations, especially in the older sectors. Chandigarh is one of the greenest cities of the country. Urban forestry is the thrust area for the UT Forest Department which regularly undertakes plantation activities for increasing the forest and tree cover. The UT Department of Forest & Wildlife, Chandigarh, has started a novel initiative 'Forest department at your doorsteps', which is a scheme for free distribution of plants/saplings to general public without any formal application. To increase green cover in Chandigarh, "Annual Greening Chandigarh Action Plan" is being prepared.

Recorded Forest Area (RFA) in the Union Territory is 35 sq km of which 32 sq km is Reserved Forest and 3 sq km is Unclassed Forest. In Chandigarh, during the period 1st January 2015 to 5th February 2019, a total of 0.39 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

The Protected Area network in the UT has two Wildlife Sanctuaries, covering an area of 26.01 sq km which is 22.81% of geographical area of the Union Territory viz Sukhna Wildlife Sanctuary and City Bird Wildlife Sanctuary.

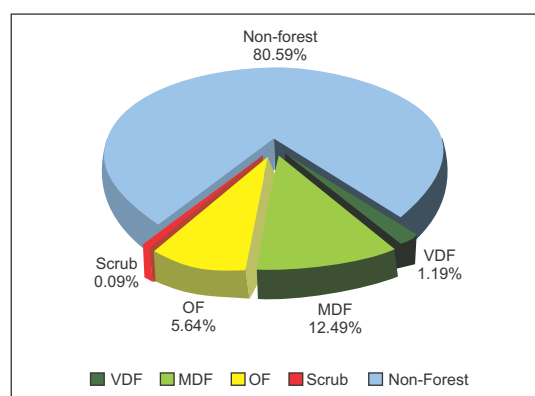
11.32.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the October 2017, the Forest Cover in the UT is 22.03 sq km which is 19.32 % of the UT's geographical area. In terms of forest canopy density classes, the State has 1.36sq km under Very Dense Forest (VDF), 14.24 sq km under Moderately Dense Forest (MDF) and 6.43 sq km under Open Forest (OF). Forest Cover in the UT has increased by 0.47 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.32.2 Forest Cover of Chandigarh

Class	(in sq km)	
	Area	% of GA
VDF	1.36	1.19
MDF	14.24	12.49
OF	6.43	5.64
Total	22.03	19.32
Scrub	0.10	0.09

FIGURE 11.32.1 Forest Cover of Chandigarh



11.32.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The UT has reported extent of recorded forest area (RFA) 35 sq km which is 30.70% of its geographical area. The reserved and unclassified forests are 91.43% and 8.57% respectively of the recorded forest area in the UT. However as the digitized boundary of recorded forest area from the UT covers 9.85 sq km and the analysis of forest cover inside and outside this area is given below.

TABLE 11.32.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Chandigarh (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
1.29	4.93	2.05	8.27	0.07	9.31	4.38	13.76
15.60%	59.61%	24.79%		0.51%	67.66%	31.83%	

*in case of Chandigarh RFA boundaries have been used

FIGURE 11.32.2 Forest Cover inside and outside RFA in Chandigarh

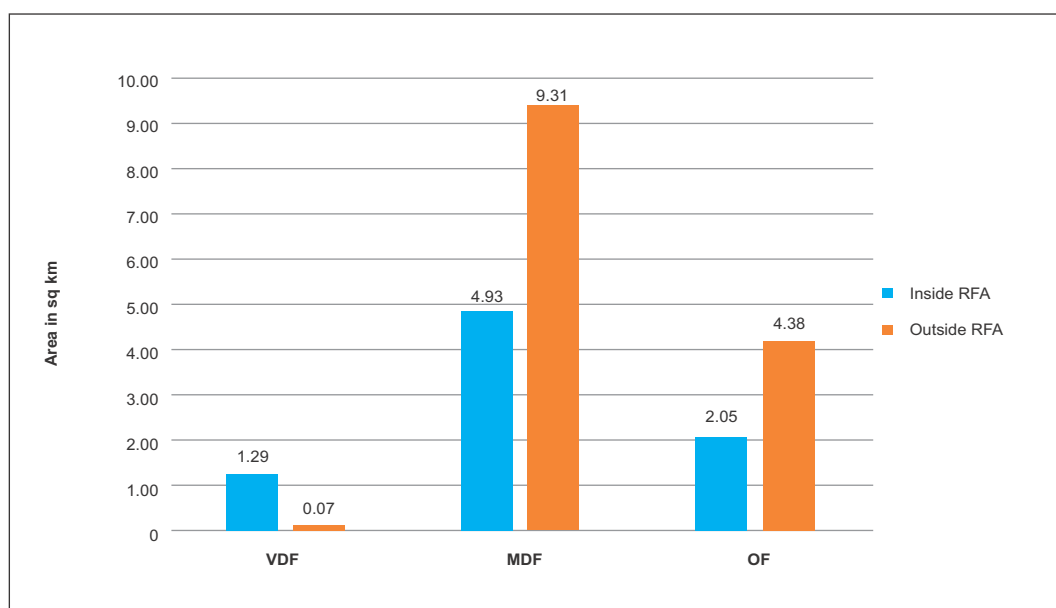


TABLE 11.32.4 District- wise Forest Cover in Chandigarh (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Chandigarh	114	1.36	14.24	6.43	22.03	19.32	0.47	0.10
Grand Total	114	1.36	14.24	6.43	22.03	19.32	0.47	0.10

TABLE 11.32.5 Forest Cover Change Matrix for Chandigarh (in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1.36	0.00	0.00	0.00	0.00	1.36
Moderately Dense Forest	0.00	13.82	0.00	0.00	0.00	13.82
Open Forest	0.00	0.42	5.96	0.00	0.00	6.38
Scrub	0.00	0.00	0.00	0.02	0.00	0.02
Non Forest	0.00	0.00	0.47	0.08	91.87	92.42
Total ISFR 2019	1.36	14.24	6.43	0.10	91.87	114.00
Net Change	0.00	0.42	0.05	0.08	-0.55	

Positive changes observed in forest cover is due to conservation and plantation activities.

TABLE 11.32.6 Altitude-wise Forest Cover in Chandigarh (in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	114	1.36	14.24	6.43	22.03 (100%)	0.10
Total	114	1.36	14.24	6.43	22.03	0.10

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.32.7 Forest Cover in different slope classes in Chandigarh (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	109	1.30	13.39	6.05	20.74 (94.14%)	0.10
5-10	5	0.06	0.85	0.38	1.29 (5.86%)	0
Total	114	1.36	14.24	6.43	22.03	0.10

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.32.3 Forest Cover Map of Chandigarh

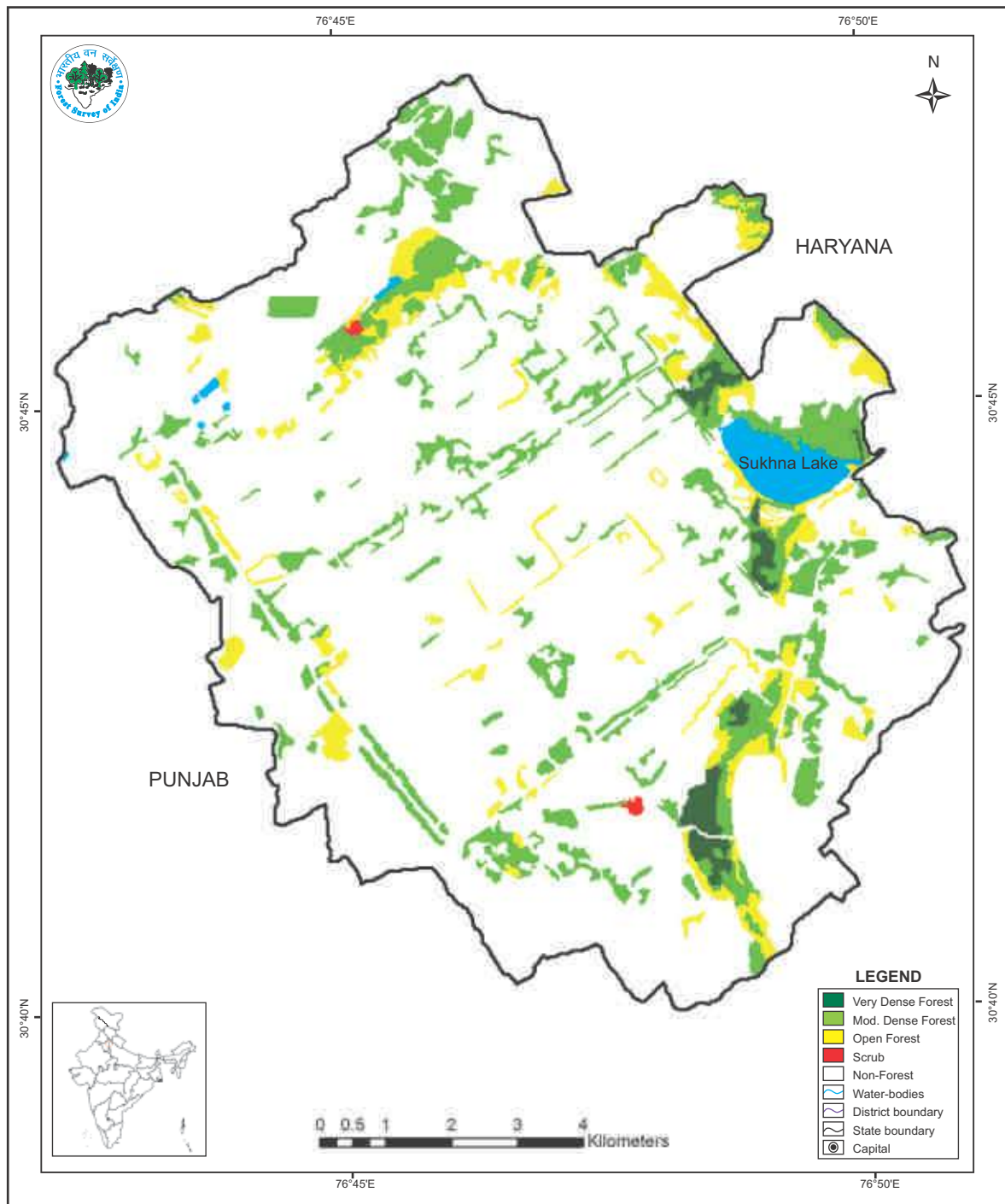


TABLE 11.32.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Chandigarh (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	1	12
River/Stream	3	48
Sub - Total	4	60
Wetlands (<2.25 ha)	0	0
Total	4	60
Total Recorded Forest (or Green Wash) Area (in ha)		985
% of Wetland area inside Recorded Forest (or Green Wash) Area		6.09%

(analysis based on the National Wetland Atlas: India, 2011)

11.32.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest type of Chandigarh as per the Champion & Seth classification (1968), according to the latest exercise is presented in the following table.

TABLE 11.32.9 Percentage area under different forest types of Chandigarh

Sl.No.	Forest Type	% of Forest cover
1.	5B/C2 Northern Dry Mixed Deciduous Forest	48.33
2.	5B/DS1 Dry Deciduous Scrub	0.09
3.	Plantation/ TOF	51.58
	Total	100.00

11.32.3.1 Assessment of Biodiversity

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.32.10 and table 11.32.11 in respect of Chandigarh.

TABLE 11.32.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	21
Shrub	4
Herb	7

TABLE 11.32.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Chandigarh

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 5- Tropical Dry Deciduous Forests	1.60	1.23	1.56

11.32.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness is given in the following table.

TABLE 11.32.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0	0
2.	Very highly fire prone	0	0
3.	Highly fire prone	0	0
4.	Moderately fire prone	0	0
5.	Less fire prone	112.88	100.00
	Total	112.88	100.00

11.32.5 Tree Cover

Forest cover presented in the section 11.32.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Chandigarh has been estimated as in table 11.32.13.

TABLE 11.32.13 Tree Cover in Chandigarh (in sq km)

Tree Cover	Area
	25

Tree cover of Chandigarh has increased by 15 sq km as compared to the previous assessment reported in ISFR 2017.

11.32.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.32.14 Extent of TOF in Chandigarh (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
13.76	25	38.76

11.32.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Chandigarh is given in the table 11.32.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.32.16

TABLE 11.32.15 Growing Stock in Chandigarh (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	0.29	0.01
Growing Stock in TOF	0.50	0.03

TABLE 11.32.16 Diameter class distribution of top five species inside RFA in Chandigarh (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Dalbergia sissoo</i>	123	18	0
2.	<i>Leucaena leucocephala</i>	263	15	0
3.	<i>Acacia catechu</i>	319	7	0
4.	<i>Melia azadirachta</i>	81	14	0
5.	<i>Populus species</i>	19	9	0

11.32.8 Carbon Stock in Forest

The total Carbon stock of forests in UT including the TOF patches which are more than 1 ha in size is 0.19 million tonnes (0.70 million tonnes of CO₂ equivalent) which is 0.0027% of total forest carbon of the country. Pool wise forest carbon in Chandigarh is given in the following table

TABLE 11.32.17 Forest Carbon in Chandigarh in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
57	18	0.46	3	111	189

11.32.9 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Chandigarh in Rural and Urban areas are given in the table 11.32.18 and table 11.32.19 respectively

TABLE 11.32.18 Top five tree species in TOF (Rural) in Chandigarh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Eucalyptus species</i>	51.04
2.	<i>Dalbergia sissoo</i>	7.47
3.	<i>Morus species</i>	7.37
4.	<i>Acacia arabica</i>	6.34
5.	<i>Leucaena leucocephala</i>	5.02

TABLE 11.32.19 Top five tree species in TOF (Urban) in Chandigarh

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	13.17
2.	<i>Morus species</i>	8.03
3.	<i>Polyalthia longifolia</i>	7.46
4.	<i>Terminalia arjuna</i>	6.13
5.	<i>Cassia fistula</i>	5.67

11.32.10 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.32.20 and table 11.32.21 respectively.

TABLE 11.32.20 Major NTFP species in the UT of Chandigarh

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Morus species</i>	Tree	61.54
2.	<i>Ziziphus mauritiana</i>	Tree	15.38
3.	<i>Psidium guajava</i>	Tree	5.13
4.	<i>Cassia fistula</i>	Tree	5.13
5.	<i>Azadirachta indica</i>	Tree	5.13

TABLE 11.32.21 Major invasive species in the UT inside the RFA/Green Wash in Chandigarh (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Lantana camara</i>	2.55
2.	<i>Parthenium hysterophorus</i>	1.56
3.	<i>Leucanea leucocephala</i>	0.30
4.	<i>Saccharum spontanem</i>	0.09

Major NTFP species are given in terms of relative abundance whereas invasive species are given in terms of their estimated extent.



11.33

DADRA & NAGAR HAVELI

11.33.1 Introduction

The Union Territory of Dadra & Nagar Haveli is situated between Gujarat and Maharashtra on the foothills of Western Ghats and has an area of 491 sq km. The Union Territory lies between 20°0'N to 20° 25'N latitude and 72°50' E to 73°15'E longitude. The average annual rainfall ranges between 2,000 mm to 2,500 mm and the average annual temperature ranges between 25°C to 27.5°C. The terrain is intersected by the river Damanganga and its three tributaries. As per census 2011, the population of the UT is 0.34 million which is 0.03% of the country's population. The urban and rural population of the UT is 46.72% and 53.28% respectively. About 32% of the population of the UT is Tribal. The population density is 700 per sq km. The 19th Livestock census 2012 reported the livestock population as 0.05 million.

TABLE 11.33.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	49	
Reporting area for land utilization	49	100.00
Forests	20	41.63
Not available for land cultivation	3.76	7.69
Permanent pastures and other grazing lands	0.92	1.89
Land under misc. tree crops and groves	-	-
Culturable wasteland	0.46	0.94
Fallow land other than current fallows	2.14	4.38
Current fallows	2.31	4.72
Net area sown	18.94	38.75

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.33.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Dadra & Nagar Haveli belong to two Type Groups i.e Tropical Moist Deciduous Forests and Tropical Dry Deciduous Forests, which are further divided into four Forest Types. The tribal population of the union territory mainly depends on forests for their requirements of fuel wood, fodder, small timber and livelihood. The main tribes are Dhodia, Kokna and Varli with small groups of Koli, Kathodi, Naika and Dubla scattered over the territory.

Recorded Forest Area (RFA) in the Union Territory is 204 sq km of which 199 sq km is Reserved Forest and 5 sq km is Protected Forest. In Dadra & Nagar Haveli, during the period 1st January 2015 to 5th February 2019, a total of 5.40 hectares of forest land was diverted for various non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

The Protected Area network in the UT has one Wildlife Sanctuary which covers 18.77% of geographical area of the Union Territory.

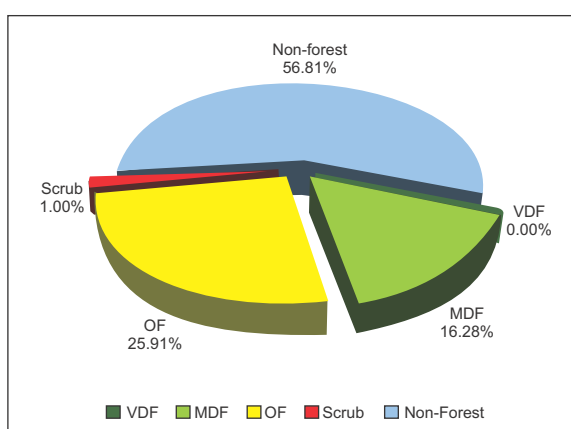
11.33.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct 2017, the Forest Cover in the UT is 207.16 sq km which is 42.19% of the UT's geographical area. In terms of forest canopy density classes, the UT has 79.93 sq km under Moderately Dense Forest (MDF) and 127.23 sq km under Open Forest (OF). Forest Cover in the UT has increased by 0.16 sq km as compared to the previous assessment reported in ISFR 2017.

Table 11.33.2 Forest Cover of Dadra & Nagar Haveli

(in sq km)		
Class	Area	% of GA
VDF	0.00	0.00
MDF	79.93	16.28
OF	127.23	25.91
Total	207.16	42.19
Scrub	4.93	1.00

FIGURE 11.33.1 Forest Cover of Dadra & Nagar Haveli



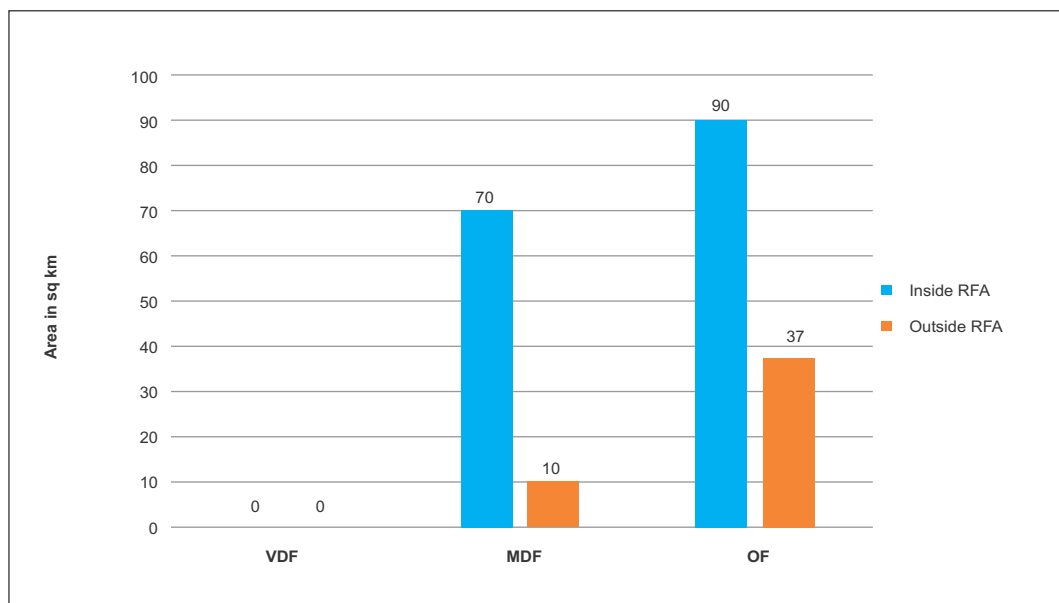
11.33.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The UT has reported extent of recorded forest area (RFA) 204.00 sq km which is 41.55% of its geographical area. The reserved and protected forests are 97.55% and 2.45% respectively of the recorded forest area in the UT. However, as the digitized boundary of recorded forest area from the UT covers only 210.53 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.33.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Dadra & Nagar Haveli (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
0	70	90	160	0	10	37	47
0.00%	43.55%	56.45%		0.00%	21.80%	78.20%	

(*in case of Dadra & Nagar Haveli RFA boundaries have been used.)

FIGURE 11.33.2 Forest Cover inside and outside RFA in Dadra & Nagar Haveli**TABLE 11.33.4** District-wise Forest Cover in Dadra & Nagar Haveli

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Dadra & Nagar Haveli ^T	491	0.00	79.93	127.23	207.16	42.19	0.16	4.93
Grand Total	491	0.00	79.93	127.23	207.16	42.19	0.16	4.93

TABLE 11.33.5 Forest Cover Change Matrix for Dadra & Nagar Haveli

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	0	0	0	0	0	0
Moderately Dense Forest	0	80	0	0	0	80
Open Forest	0	0	126	0	1	127
Scrub	0	0	0	5	0	5
Non Forest	0	0	1	0	278	279
Total ISFR 2019	0	80	127	5	279	491
Net Change	0	0	0	0	0	

Main reasons for the increase in forest cover in the UT are plantation and conservation activities.

TABLE 11.33.6 Altitude-wise Forest Cover in Dadra & Nagar Haveli

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	491	0	80	127	207 (100%)	5
Total	491	0	80	127	207	5

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.33.7 Forest Cover in different slope classes in Dadra & Nagar Haveli

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	326	0	23	61	84 (40.58%)	3
5-10	91	0	24	35	59 (28.50%)	1
10-15	44	0	18	19	37 (17.87%)	1
15-20	19	0	9	8	17 (8.21%)	0
20-25	7	0	4	3	7 (3.38%)	0
25-30	3	0	2	1	3 (1.45%)	0
>30	1	0	0	0	0 (0.00%)	0
Total	491	0	80	127	207	5

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.33.3 Forest Cover Map of Dadra & Nagar Haveli

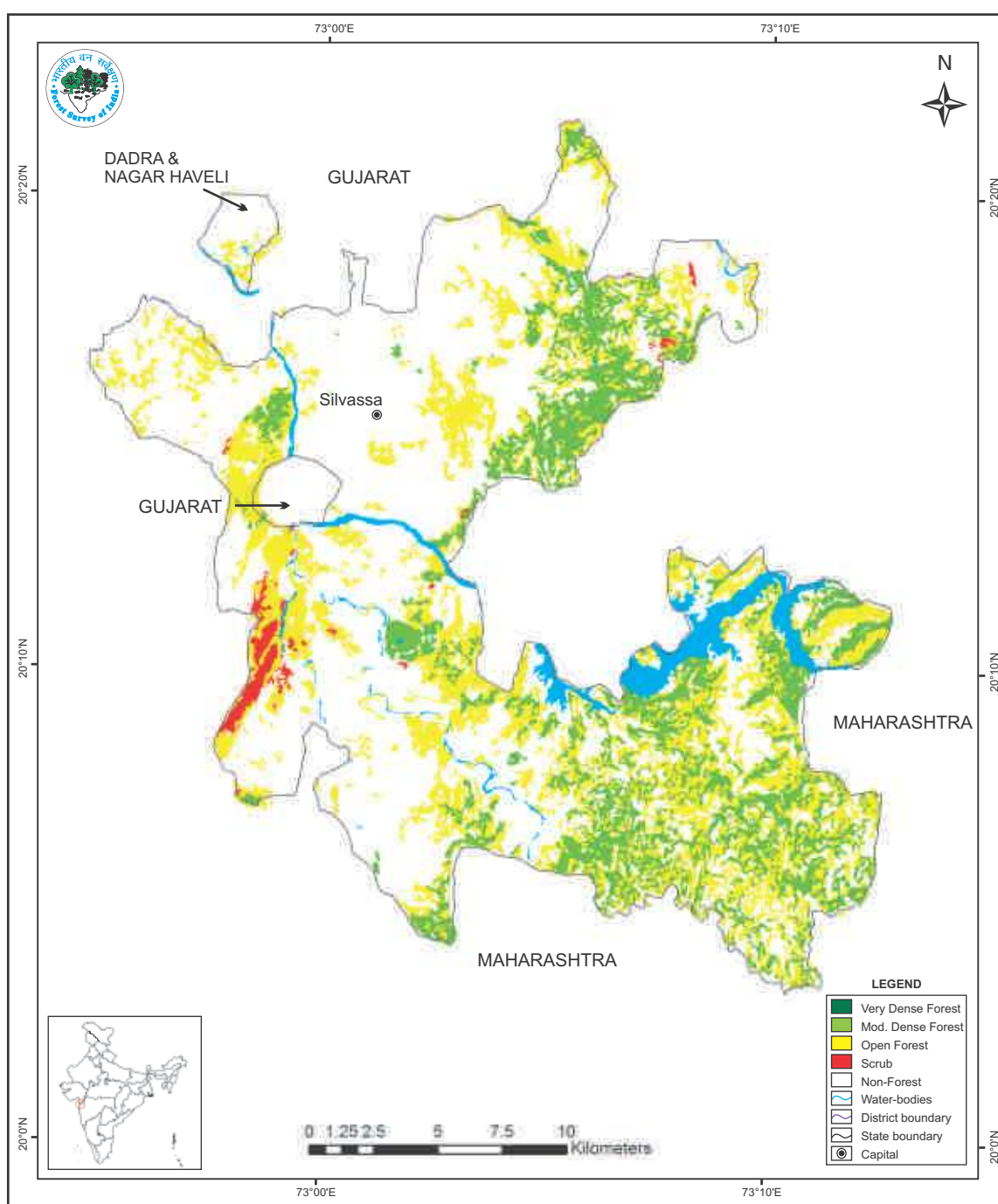


TABLE 11.33.8 Wetlands inside the Recorded Forest Area (or Green Wash) (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
River/Stream	3	58
Sub - Total	3	58
Inland Wetlands - Man-made		
Reservoir/Barrage	1	263
Sub - Total	1	263
Wetlands (<2.25 ha)	1	1
Total	5	322
Total Recorded Forest (or Green Wash) Area (in ha)		21,053
% of Wetland inside Recorded Forest (or Green Wash) Area		1.53%

(analysis based on the National Wetland Atlas: India, 2011)

11.33.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Dadra & Nagar Haveli as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.33.9 Percentage area under different forest types of Dadra & Nagar Haveli

Sl.No.	Forest Type	% of Forest cover
1.	3B/C1b Moist Teak Forest	9.44
2.	3B/C2 Southern Moist Mixed Deciduous	77.66
3.	5A/C3 Southern Dry Mixed Deciduous	4.31
4.	5B/DS1 Dry Deciduous Scrub	2.51
5.	Plantation/ TOF	6.08
	Total	100.00

11.33.3.1 Assessment of Biodiversity

Findings of the Rapid Assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.33.10 and table 11.33.11 in respect of Dadra & Nagar Haveli.

TABLE 11.33.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	25
Shrub	8
Herb	11

TABLE 11.33.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Dadra & Nagar Haveli

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 3- Tropical Moist Deciduous Forests	2.48	0.97	1.33
2.	Group 5- Tropical Dry Deciduous Forests	*	*	0.69

*adequate number of sample plots were not available

11.33.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.33.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	0.00	0
2.	Very highly fire prone	0.00	0
3.	Highly fire prone	0.00	0
4.	Moderately fire prone	21.09	0
5.	Less fire prone	458.08	100.00
	Total	479.17	100.00

11.33.5 Tree Cover

Forest cover presented in the section 11.33.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Dadra & Nagar Haveli has been estimated as given in table 11.33.13.

TABLE 11.33.13 Tree Cover in Dadra & Nagar Haveli (in sq km)

Tree Cover	Area
	28

Tree cover of Dadra & Nagar Haveli has decreased by 2 sq km as compared to the previous assessment reported in ISFR 2017.

11.33.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.33.14 Extent of TOF in Dadra & Nagar Haveli (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
47	28	75

11.33.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Dadra & Nagar Haveli is given in the table 11.33.15. Diameter class-wise distribution of top 5 species in numbers, derived from the forest inventory data is presented in the table 11.33.16

TABLE 11.33.15 Growing Stock in Dadra & Nagar Haveli (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	0.74	0.02
Growing Stock in TOF	1.16	0.07

TABLE 11.33.16 Diameter class distribution of top five species inside RFA in Dadra & Nagar Haveli (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Terminalia crenulata</i>	458	0	0
2.	<i>Tectona grandis</i>	295	0	0
3.	<i>Butea monosperma</i>	162	27	0
4.	<i>Bridelia retusa</i>	297	27	0
5.	<i>Anogeissus latifolia</i>	269	0	0

11.33.8 Carbon Stock in Forest

The total Carbon stock of forests in the UT including the TOF patches which are more than 1 ha in size is 1.80 million tonnes (6.60 million tonnes of CO₂ equivalent) which is 0.0253% of total forest carbon of the country. Pool wise forest carbon in Dadra & Nagar Haveli is given in the following table

TABLE 11.33.17 Forest Carbon in Dadra & Nagar Haveli in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
500	113	7	47	1,133	1,800

11.33.9 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Dadra & Nagar Haveli in Rural and Urban areas are given in the table 11.33.18 and table 11.33.19 respectively

TABLE 11.33.18 Top five tree species in TOF (Rural) in Dadra & Nagar Haveli

Sl. No.	Species	Relative Abundance (%)
1.	<i>Phoenix sylvestris</i>	21.69
2.	<i>Saccopetalum tomentosum</i>	11.15
3.	<i>Terminalia tomentosa</i>	9.64
4.	<i>Butea frondosa</i>	8.56
5.	<i>Wrightia tinctoria</i>	8.56

TABLE 11.33.19 Top five tree species in TOF (Urban) in Dadra & Nagar Haveli

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	21.71
2.	<i>Mangifera indica</i>	13.66
3.	Palm oil tree	8.85
4.	<i>Polyalthia species</i>	7.23
5.	<i>Moringa species</i>	5.23

11.33.10 Major NTFP and Invasive Species

Major NTFP and invasive species as assessed from forest inventory data are presented in the table 11.33.20 and table 11.33.21 respectively.

TABLE 11.33.20 Major NTFP species in the UT of Dadra & Nagar Haveli

Sl. No.	Species	Plant Type	Relative Abundance (%)
1.	<i>Anogeissus latifolia</i>	Tree	30.30
2.	<i>Lannea coromandelica</i>	Tree	27.27
3.	<i>Diospyros melanoxylon</i>	Tree	15.15
4.	<i>Madhuca indica</i>	Tree	9.09
5.	<i>Acacia catechu</i>	Tree	9.09

TABLE 11.33.21 Major invasive species in the UT inside the RFA/Green Wash in Dadra & Nagar Haveli
(in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Cassia tora</i>	7
2.	<i>Glinsoga parviflora</i>	3
3.	<i>Chromolaena odorata</i>	1
4.	<i>Ageratum conyzoides</i>	1

Major invasive species are given in terms of their estimated extent.

11.33.11 Quantified estimation of Dependence of People living in forest fringe villages on forests in Dadra & Nagar Haveli

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Dadra & Nagar Haveli is given in the table 11.33.22

TABLE 11.33.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Dadra & Nagar Haveli

Fuel wood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
32,518	2,73,884	3,102	8,057



11.34

DAMAN & DIU

11.34.1 Introduction

Daman & Diu is a Union Territory on the western coast of India. Prior to 1987, it was part of the union territory of Goa, Daman & Diu. Daman is located in the Gulf of Cambay and Diu is an Island located in the same Gulf. The geographical area of Daman & Diu is 111 sq km which constitute 0.003% of the total area of the country. The Daman lies between 20°22'N to 20°28' N latitude and 71° 46' E to 72° 55' E longitude and Diu lies between 20°42'N to 20°48'N latitude and 70°00'E to 71°10'E longitude. The average annual rainfall ranges between 2,300 mm to 4,800 mm and the mean annual temperature ranges between 25°C to 28°C. The UT has two districts of which one is tribal. As per Census 2011, the population of the UT is 0.24 million which constitutes 0.02% of the country's population. The urban & rural population constitute 75.17% and 24.83% respectively. The population density is 2,191 per sq km. According to the 19th Livestock Census, 2012, the UT has 0.004 million livestock.

TABLE 11.34.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	11	
Reporting area for land utilization	3.15	100
Forests	-	0
Not available for land cultivation	0.18	5.85
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	0.06	1.78
Culturable wasteland	0.06	1.78
Fallow land other than current fallows	0.01	0.25
Current fallows	0.12	3.66
Net area sown	2.73	86.68

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.34.1.1 A Brief Overview of Forestry Scenario

As per the Champion & Seth Classification of Forest Types (1968), the forests in Daman & Diu belong to the Type Group 'Littoral & Swamp Forests. Diu is an important tourist destination on the west coast of India. The mangroves in the 'Fudam Bird Sanctuary' forms the spawning ground for fishes and acts as feeding ground for several species of avifauna. The UT Forest Department under takes plantation activities on available land. The department implements various schemes and activities such as distribution of seedlings to public free of cost, creation and maintenance of urban gardens/parks/road side plantations and awareness programmes.

Recorded Forest Area (RFA) in the Union Territory is 8 sq km all of which is Unclassed Forest. In Daman & Diu, no forest land has been diverted for various non-forestry purposes under the Forest Conservation Act, 1980 in the last four years (MoEF&CC, 2019).

The Protected Area network in the State has one Wildlife Sanctuary, which covers 1.96% of geographical area of the Union Territory.

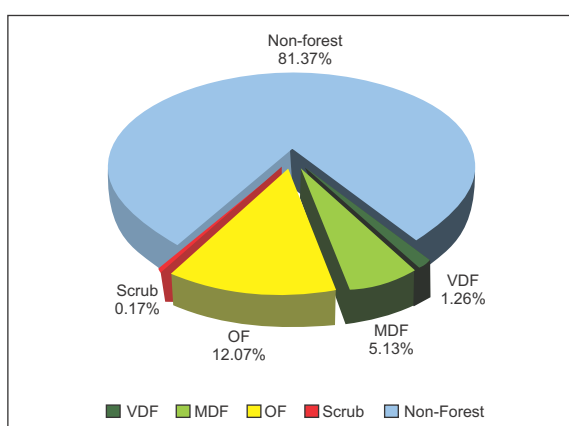
11.34.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of Oct 2017, the Forest Cover in the UT is 20.49 sq km which is 18.46 % of the UT's geographical area. In terms of forest canopy density classes, the UT has 1.40 sq km under Very Dense Forest (VDF), 5.69 sq km under Moderately Dense Forest (MDF) and 13.40 sq km under Open Forest (OF).

TABLE 11.34.2 Forest Cover of Daman & Diu

(in sq km)		
Class	Area	% of GA
VDF	1.40	1.26
MDF	5.69	5.13
OF	13.40	12.07
Total	20.49	18.46
Scrub	0.19	0.17

FIGURE 11.34.1 Forest Cover of Daman & Diu

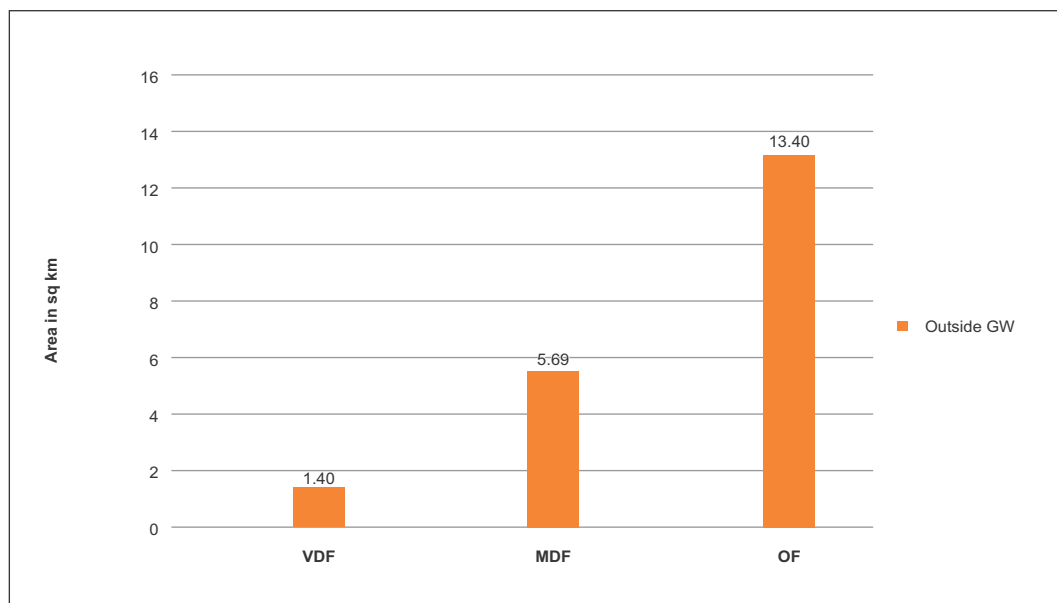


11.34.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The recorded forest area of UT is 8 sq km all of which is unclassified and constitutes 7.21% of its geographical area. There are no Green wash areas in the UT as per Survey of India toposheets. Therefore, all forest cover fall outside green wash area.

TABLE 11.34.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
0.00	0.00	0.00	0.00	1.40	5.69	13.40	20.49
0.00%	0.00%	0.00%		6.83%	27.77%	65.40%	

FIGURE 11.34.2 Forest Cover Outside Green Wash in Daman & Diu**TABLE 11.34.4** District-wise Forest Cover in Daman & Diu

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Daman ^T	72	0.00	1.93	8.98	10.91	15.15	-0.05	0.19
Diu	39	1.40	3.76	4.42	9.58	24.56	0.05	0.00
Grand Total	111	1.40	5.69	13.40	20.49	18.46	0.00	0.19

TABLE 11.34.5 Forest Cover Change Matrix for Daman & Diu

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	1.40	0.00	0.00	0.00	0.00	1.40
Moderately Dense Forest	0.00	5.69	0.00	0.00	0.13	5.82
Open Forest	0.00	0.00	13.20	0.00	0.07	13.27
Scrub	0.00	0.00	0.00	0.19	0.08	0.27
Non Forest	0.00	0.00	0.20	0.00	90.04	90.24
Total ISFR 2019	1.40	5.69	13.40	0.19	90.32	111.00
Net Change	0.00	-0.13	0.13	-0.08	0.08	

TABLE 11.34.6 Altitude-wise forest cover in Daman & Diu

(in sq km)

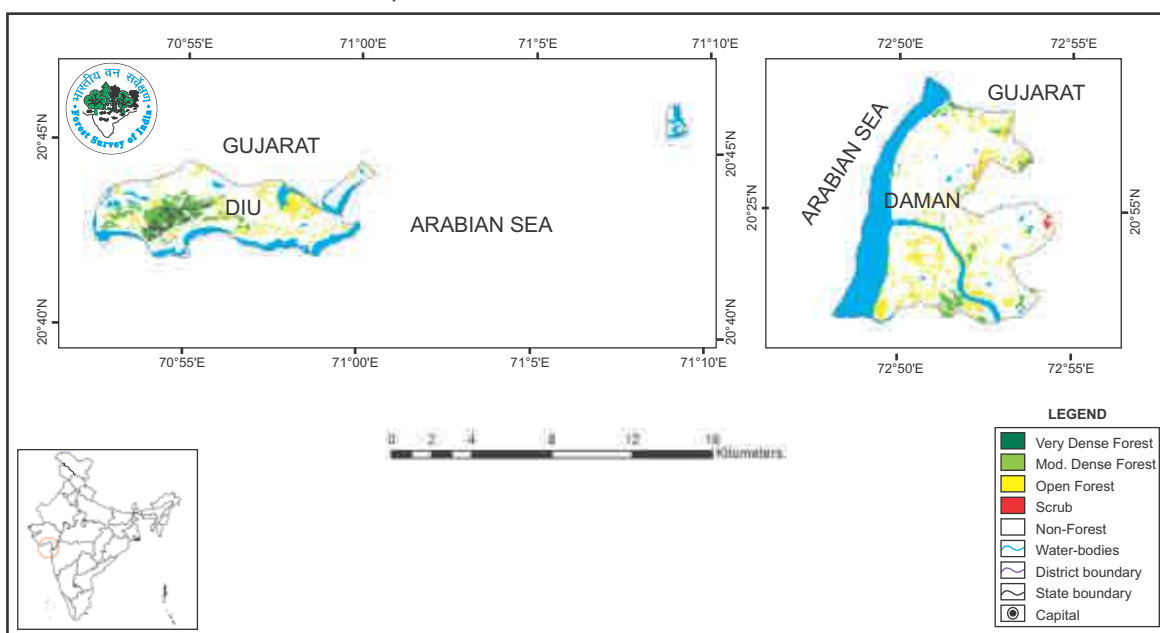
Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	111	1.40	5.69	13.40	20.49 (100%)	0.19
Total	111	1.40	5.69	13.40	20.49	0.19

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.34.7 Forest Cover in different slope classes in Daman & Diu (in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	106	1.39	5.54	12.86	19.79 (96.58%)	0.11
5-10	4	0.01	0.14	0.47	0.62 (3.03%)	0.04
10-15	1	0.00	0.01	0.04	0.05 (0.24%)	0.03
15-20	0	0.00	0.00	0.03	0.03 (0.15%)	0.01
Total	111	1.40	5.69	13.40	20.49	0.19

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.34.3 Forest Cover Map of Daman & Diu

11.34.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Daman & Diu as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.34.8 Percentage area under different forest types in Daman & Diu

Sl.No.	Forest Type	% of Forest cover
1.	4A/L1 Littoral Forest	6.69
2.	4B/TS2 Mangrove Forest	14.79
3.	5A/C3 Southern Dry Mixed Deciduous forest	1.30
4.	5/DS1 Dry Deciduous Scrub	1.35
5.	6B/C1 Desert Thorn forest	14.45
6.	TOF/Plantation 61.42 Total	100.00

11.34.4 Tree Cover

Forest cover presented in the section 11.34.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Daman & Diu has been estimated as given in table 11.34.9.

TABLE 11.34.9 Tree Cover in Daman & Diu
(in sq km)

Tree Cover	Area
	5

Tree cover of Daman & Diu has decreased by 5 sq km as compared to the previous assessment reported in ISFR 2017

11.34.5 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.34.10 Extent of TOF in Daman & Diu
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
20.49	5	25.49

11.34.6 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Daman & Diu is given in the table 11.34.11. Diameter class-wise distribution of top 5 species in numbers, derived from the forest inventory data is presented in the table 11.34.12

TABLE 11.34.11 Growing Stock in Daman & Diu
(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	0.09	0.002
Growing Stock in TOF	0.15	0.01

TABLE 11.34.12 Diameter class distribution of top five species inside RFA in Daman & Diu
(in '000)

Sl. No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Casuarina equisetifolia</i>	242	34	1
2.	<i>Prosopis juliflora</i>	144	3	0
3.	<i>Acacia arabica</i>	59	3	0
4.	<i>Azadirachta indica</i>	8	3	0

11.34.7 Carbon Stock in Forest

The total Carbon stock of forests in the UT including the TOF patches which are more than 1 ha in size is 0.15 million tonnes (0.55 million tonnes of CO₂ equivalent) which is 0.0021% of total forest carbon of the country. Pool wise forest carbon in Daman & Diu is given in the following table

TABLE 11.34.13 Forest Carbon in Daman & Diu in different pools
(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
35	10	0.27	2	105	152

11.34.8 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Daman & Diu in Rural and Urban areas are given in the table 11.34.14 and table 11.34.15 respectively.

TABLE 11.34.14 Top five tree species in TOF (Rural) in Daman & Diu

Sl. No.	Species	Relative Abundance (%)
1.	<i>Mangifera indica</i>	29.78
2.	<i>Manihot utilissima</i>	12.80
3.	<i>Phoenix sylvestris</i>	11.89
4.	<i>Cocos nucifera</i>	11.55
5.	<i>Casuarina equisetifolia</i>	9.29

TABLE 11.34.15 Top five tree species in TOF (Urban) in Daman & Diu

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	20.00
2.	<i>Moringa species</i>	16.67
3.	<i>Leucaena leucocephala</i>	13.33
4.	<i>Zizyphus jujuba</i>	6.67
5.	<i>Ficus virene</i>	6.67



11.35

LAKSHADWEEP

11.35.1 Introduction

Located in the Arabian Sea, Lakshadweep is a group of 36 islands comprising of 12 atolls, three reefs, five submerged sand banks and 10 inhabited islands. It is the smallest Union Territory of India with a total geographical area of only 30 sq km. The UT lies between 8°15' N to 11°45' N latitude and 72°E to 74°E longitude. The only district of the Union Territory is a tribal district. Lakshadweep islands have a tropical humid, warm and generally pleasant climate. The annual rainfall ranges between 1,000 mm to 2,000 mm and the annual temperature varies from 25°C to 35°C. Though the islands receive high rainfall but lack of surface storage capacity makes fresh water a precious commodity in the UT. As per the 2011 Census, Lakshadweep has a population of 0.064 million. The rural and urban population constitute 21.94% and 78.06% respectively. Tribal population of the UT is 6.99%. The population density is 2,015 per sq km. The 19th Livestock Census 2012 has reported a total livestock population of 0.049 million in the UT.

TABLE 11.35.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	3	
Reporting area for land utilization	3.37	100.00
Forests	-	-
Not available for land cultivation	1.02	30.35
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	-	-
Culturable wasteland	-	-
Fallow land other than current fallows	-	-
Current fallows	-	-
Net area sown	2.35	69.65

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.35.1.1 A Brief Overview of Forestry Scenario

The Union Territory of Lakshadweep does not have any notified forests. About 82% of the land mass is covered by privately owned coconut plantations. Being an archipelago consisting of 36 islands with an area of 30 sq km, Lakshadweep has a vast lagoon of 4,200 sq km with sandy beaches and abundance of marine fauna. Lakshadweep also has coral atolls. The livelihood of inhabitants of Lakshadweep is dependent on fishery and tourism. Coastal erosion is a serious concern in the Islands and hence plantations of native species which are present in the seashores, are encouraged. The Union Territory does not have any recorded forest area. As per the information received from the UT during that last two years, 7.7 ha of plantations were raised in the UT.

The protected area network in the Lakshadweep has one Wildlife Sanctuary which covers 0.03% of geographical area of the Union Territory.

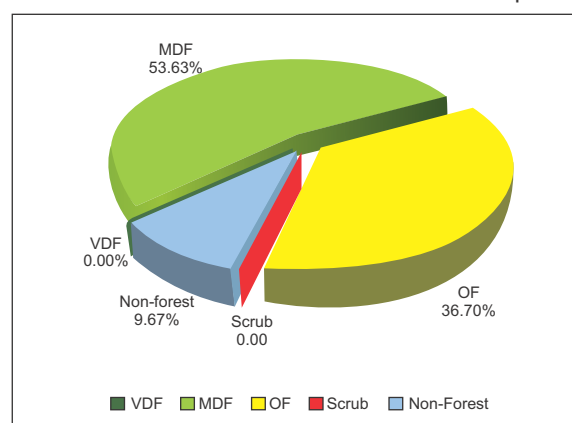
11.35.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period of November 2017 to July 2018. The Forest Cover in the UT is 27.10 sq km which is 90.33% of the UT's geographical area. In terms of forest canopy density classes, the UT has 16.09 sq km under Moderately Dense Forest (MDF) and 11.01 sq km under Open Forest (OF). Forest Cover in the UT has no change as compared to the previous assessment reported in ISFR 2017.

TABLE 11.35.2 Forest Cover of Lakshadweep
(in sq km)

Class	Area	% of GA
VDF	0.00	0.00
MDF	16.09	53.63
OF	11.01	36.70
Total	27.10	90.33
Scrub	0.00	0.00

FIGURE 11.35.1 Forest Cover of Lakshadweep

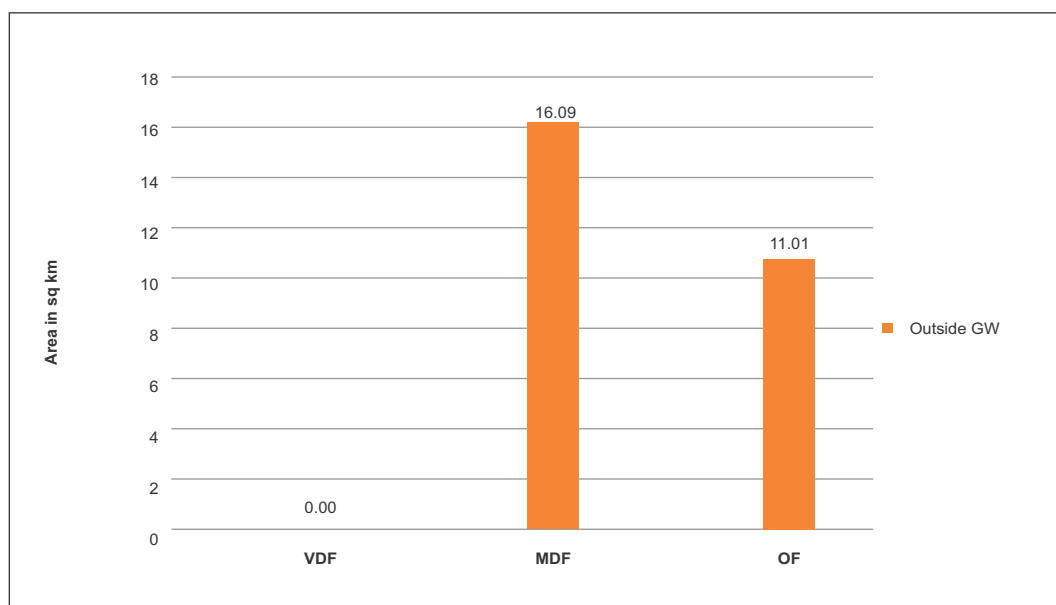


11.35.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The UT has not reported any Recorded Forest Area and the Green Wash Area is also not available in Sol toposheets. Therefore, all the forest cover fall outside green wash area.

TABLE 11.35.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Lakshadweep
(in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
0.00	0.00	0.00	0.00	0.00	16.09	11.01	27.10
0.00%	0.00%	0.00%		0.00%	59.37%	40.63%	

FIGURE 11.35.2 Forest Cover outside Green Wash in Lakshadweep**TABLE 11.35.4** District-wise Forest Cover in Lakshadweep

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Lakshadweep ^T	30	0.00	16.09	11.01	27.10	90.33	0.00	0.00
Grand total	30	0.00	16.09	11.01	27.10	90.33	0.00	0.00

TABLE 11.35.5 Forest Cover Change Matrix for Lakshadweep

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00
Moderately Dense Forest	0.00	15.85	1.19	0.00	0.00	17.04
Open Forest	0.00	0.24	9.82	0.00	0.00	10.06
Scrub	0.00	0.00	0.00	0.00	0.00	0.00
Non Forest	0.00	0.00	0.00	0.00	2.90	2.90
Total ISFR 2019	0.00	16.09	11.01	0.00	2.90	30.00
Net Change	0.00	-0.95	0.95	0.00	0.00	

TABLE 11.35.6 Altitude-wise Forest Cover in Lakshadweep

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	30	0.00	16.09	11.01	27.10 (100%)	0.00
Total	30	0.00	16.09	11.01	27.10	0.00

(based on SRTM, Digital Elevation Model, 30 m, 2016)

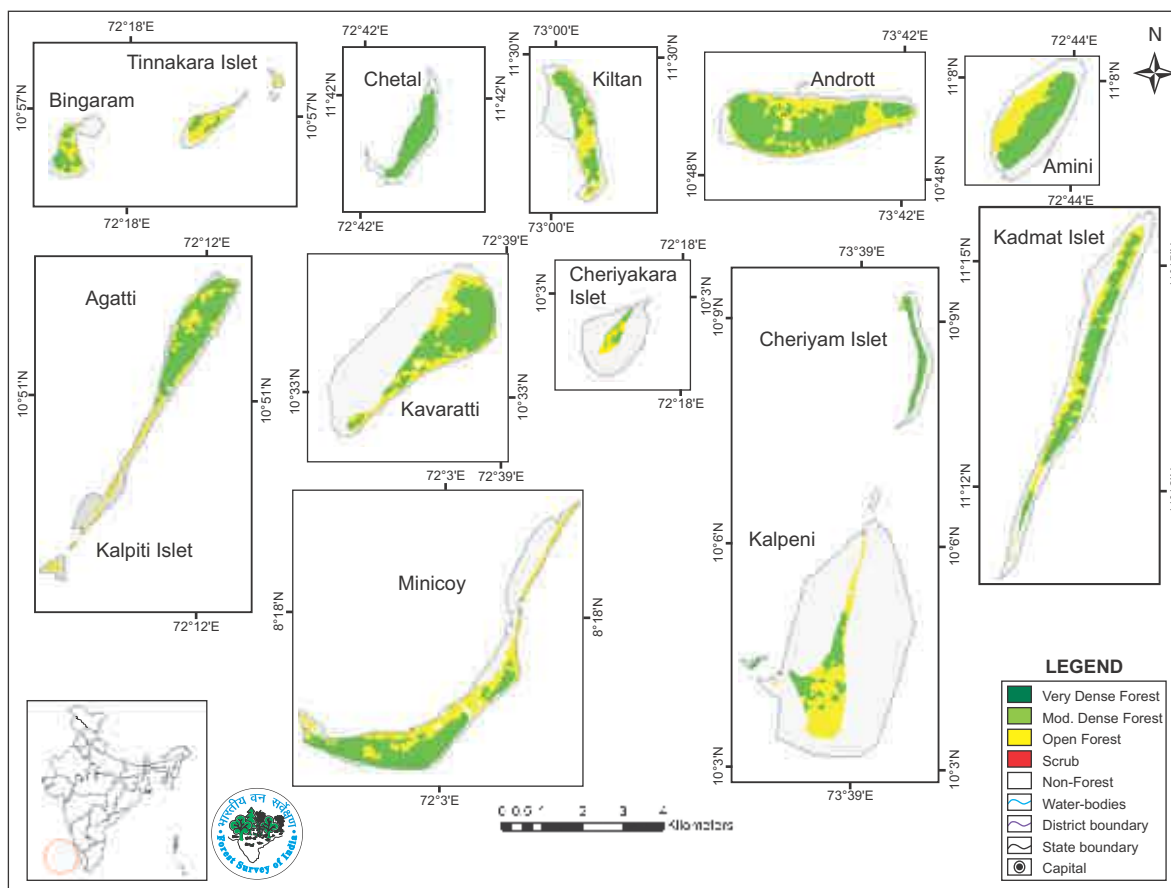
TABLE 11.35.7 Forest Cover in different slope classes in Lakshadweep

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	30	0.00	16.09	11.01	27.10 (100%)	0.00
Total	30	0.00	16.09	11.01	27.10	0.00

(based on SRTM, Digital Elevation Model, 30 m, 2016)

FIGURE 11.35.3 Forest Cover Map of Lakshadweep



11.35.3 Forest Types & Biodiversity

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Lakshadweep as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.35.8 Percentage area under different forest types of Lakshadweep

Sl.No.	Forest Type	% of Forest cover
1.	Plantation/ TOF	100.00
	Total	100.00

11.35.4 Tree Cover

Forest cover presented in the section 11.35.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Lakshadweep has been estimated as given in the table 11.35.9.

TABLE 11.35.9 Tree Cover in Lakshadweep
(in sq km)

Tree Cover	Area
	0.29

Tree cover of Lakshadweep has decreased by 1.71 sq km as compared to the previous assessment reported in ISFR2017.

11.35.5 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.35.10 Extent of TOF in Lakshadweep
(in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
27.10	0.29	27.39

11.35.6 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Lakshadweep is given in the table 11.35.11.

TABLE 11.35.11 Growing Stock in Lakshadweep
(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	-	0.00
Growing Stock in TOF	0.07	0.00

11.35.7 Carbon Stock in Forest

The total Carbon stock of forest in the UT including the TOF patches which are more than 1 ha in size is 0.24 million tonnes (0.88 million tonnes of CO₂ equivalent) which is 0.0034% of total forest carbon of the country. Pool wise forest carbon in Lakshadweep is given in the following table

TABLE 11.35.12 Forest Carbon in Lakshadweep in different pools
(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
67	15	0.47	5	149	236

11.35.8 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Lakshadweep in Rural areas are given in the table 11.35.13

TABLE 11.35.13 Top five tree species in TOF (Rural) in Lakshadweep

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	85.85
2.	<i>Thespesia populnea</i>	4.13
3.	<i>Artocarpus altilis</i>	1.18
4.	<i>Artocarpus hirsute</i>	1.11
5.	<i>Mallotus philippinensis</i>	0.61

11.36

PUDUCHERRY

11.36.1 Introduction

Puducherry is a Union Territory located in the southern part of the country having geographical area of 490 sq km scattered over four locations and each having the status of a district. Puducherry & Karaikal are bordered by Tamil Nadu, Yanam is bordered by Andhra Pradesh and Mahe is bordered by Kerala. The main territory of Puducherry lies on the Coromondal coast, about 180 km south of Chennai between 11°45' N to 12°30' N latitude and 79°36' E to 79°53' E longitude. Karaikal is about 150 km south of Puducherry lies between 10°49'N to 11°01'N latitude and 79°43'E to 79°52'E longitude. Mahe on the Malabar coast on the Western Ghats situated between 11°42' N to 11°46' N latitude and 75°31' E to 75°33' E longitude. Yanam on the east coast adjoining Godavari district, lies between 16°42'N to 16°46'N latitude and 82°11'E to 82°19'E longitude. Out of four districts none are hill districts or tribal districts. As per the 2011 census, Puducherry has a population of 1.25 million. The rural and urban population constitutes 32% and 68% respectively. The population density of the UT is 2,547 per sq km, which is much higher than the national average. The 19th Livestock Census 2012 has reported a total livestock population of 0.12 million.

TABLE 11.36.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	48	
Reporting area for land utilization	48.65	100.00
Forests	0.40	0.82
Not available for land cultivation	19.03	39.12
Permanent pastures and other grazing lands	-	-
Land under misc. tree crops and groves	1.19	2.44
Culturable wasteland	4.55	9.36
Fallow land other than current fallows	2.87	5.91
Current fallows	4.76	9.78
Net area sown	15.85	32.57

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)



11.36.1.1 A Brief Overview of Forestry Scenario

Union Territory of Puducherry does not have any natural forests inside its jurisdiction. As per the Champion & Seth Classification of Forest Types (1968), the forests in Puducherry belong to Type Group 'Littoral & Swamp Forests'. The forest department is taking up plantations on Government lands regularly and encourages agroforestry. The farmers of Puducherry are now cultivating *Casuarina spp.* in the area of 1,600 hectares out of net cultivable area of 15,000 hectares.

Recently the Government of Puducherry has constituted Puducherry Union Territory Wetland Authority for conservation of existing flora and fauna in the wetlands of the UT. The department has developed a small tree arboretum in its department premises wherein 80 species are being accommodated with display of their usages. An urban forest trail has been created and opened for public visit from December 2018 onwards.

The Union Territory is endowed with a rich diversity of wild life, Avi fauna (birds) and Reptiles in particular. The main mandate of the department is maintenance of green cover and taking measures to increase the area under forest. Recorded Forest Area (RFA) in the Union Territory is 13 sq km of which 2 sq km is Protected Forest and 11 sq km is Unclassed Forests. In Puducherry, during the period 1st January 2015 to 5th February 2019, no area of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019).

As per the information received, during last two years, 80 ha of plantations were raised in the UT. The Protected Area network in the UT has one Wildlife Sanctuary known as 'Fudam' covering an area of 2,008 hectares which covers 0.80% of geographical area of the Union Territory.

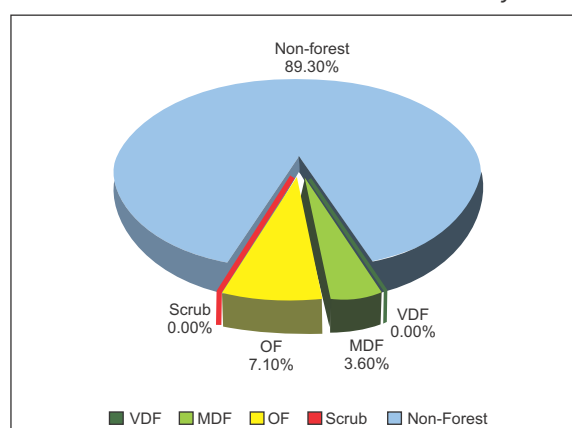
11.36.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period December 2017 to August 2018, the Forest Cover in the UT is 52.41 sq km which is 10.70% of the UT's geographical area. In terms of forest canopy density classes, the UT has 17.66 sq km under Moderately Dense Forest (MDF) and 34.75 sq km under Open Forest (OF). Forest Cover in the UT has decreased by 1.26 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.36.2 Forest Cover of Puducherry
(in sq km)

Class	Area	% of GA
VDF	0.00	0.00
MDF	17.66	3.60
OF	34.75	7.10
Total	52.41	10.70
Scrub	0.00	0.00

FIGURE 11.36.1 Forest Cover of Puducherry



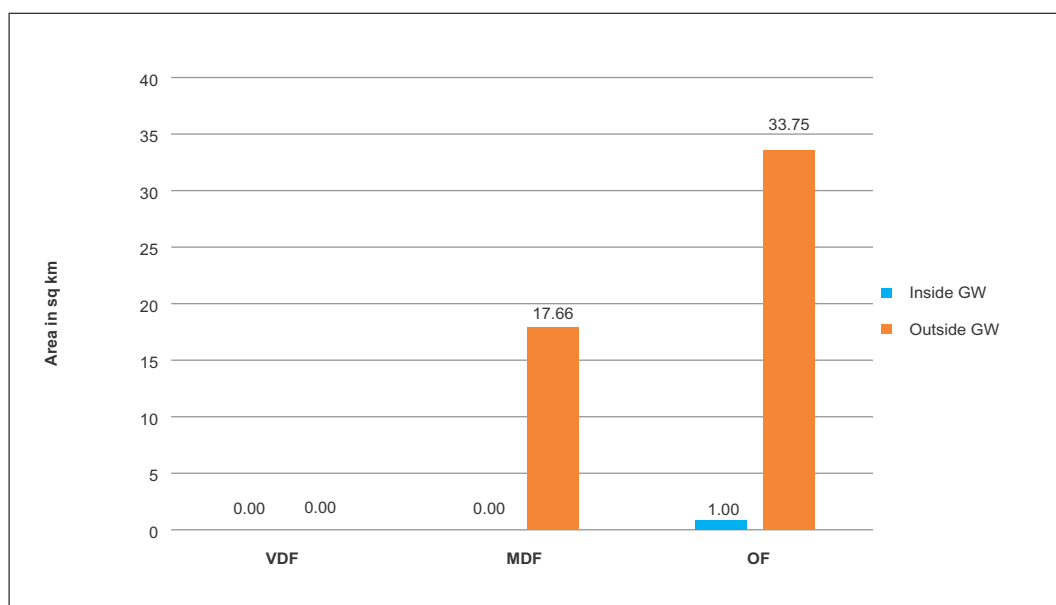
11.36.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

The UT has reported extent of recorded forest area (RFA) 13 sq km which is 2.65% of its geographical area. The Protected and unclassified forests are 15.38 % and 84.62% of the recorded forest area in the UT respectively. Due to non-availability of digitized boundary of recorded forest areas from the UT, the updated Green Wash from Sol toposheets which is 3.05 sq km has been used as proxy to the RFA boundary and the analysis of forest cover inside and outside this area is given below.

TABLE 11.36.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Puducherry (in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
0.00	0.00	1.00	1.00	0.00	17.66	33.75	51.41
0.00%	0.00%	100.00%		0.00%	34.35%	65.65%	

*in case of Puducherry Green Wash boundaries have been used

FIGURE 11.36.2 Forest Cover inside and outside Green Wash in Puducherry**TABLE 11.36.4** District-wise Forest Cover in Puducherry (in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
Karaikal	157	0.00	6.83	8.34	15.17	9.66	-0.23	0.00
Mahe	9	0.00	1.06	4.61	5.67	63.00	0.00	0.00
Puducherry	294	0.00	9.77	15.35	25.12	8.55	-0.98	0.00
Yanam	30	0.00	0.00	6.45	6.45	21.50	-0.05	0.00
Grand Total	490	0.00	17.66	34.75	52.41	10.70	-1.26	0.00

TABLE 11.36.5 Forest Cover Change Matrix for Puducherry

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00
Moderately Dense Forest	0.00	17.56	0.00	0.00	0.04	17.60
Open Forest	0.00	0.00	34.06	0.00	2.01	36.07
Scrub	0.00	0.00	0.00	0.00	0.00	0.00
Non Forest	0.00	0.10	0.69	0.00	435.54	436.33
Total ISFR 2019	0.00	17.66	34.75	0.00	437.59	490.00
Net Change	0.00	0.06	-1.32	0.00	1.26	

Main reasons for the decrease in forest cover in the UT can be attributed to harvesting of trees outside forests.

TABLE 11.36.6 Altitude-wise Forest Cover in Puducherry

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	490	0.00	17.66	34.75	52.41 (100%)	0.00
Total	490	0.00	17.66	34.75	52.41	0.00

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.36.7 Forest Cover in different slope classes in Puducherry

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	449	0.00	17.27	34.03	51.30 (97.88 %)	0.00
5-10	41	0.00	0.39	0.72	1.11 (2.12 %)	0.00
Total	490	0.00	17.66	34.75	52.41	0.00

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.36.3 Forest Cover Map of Puducherry

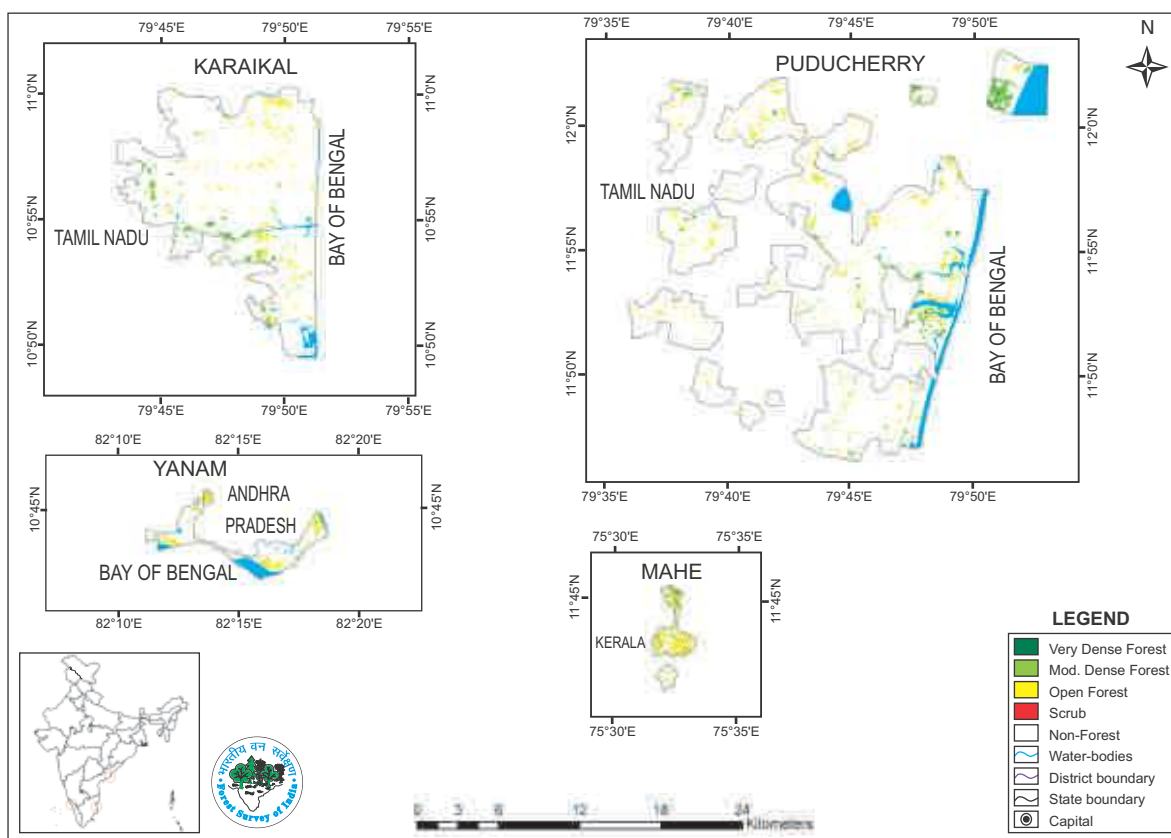


TABLE 11.36.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Puducherry (in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
River/Stream	1	6
Sub - Total	1	6
Coastal Wetlands - Natural		
Creek	1	29
Intertidal mud flat	3	6
Mangrove	3	86
Sub -Total	7	121
Wetlands (<2.25 ha)	0	0
Total	8	127
Total Recorded Forest (or Green Wash) Area (in ha)		305
% of Wetland area inside Recorded Forest (or Green wash) Area		41.64%

(analysis based on the National Wetland Atlas: India, 2011)

11.36.3 Forest Types & Biodiversity

Forest Types Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Puducherry as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.36.9 Percentage area under different forest types of Puducherry

Sl.No.	Forest Type	% of Forest cover
1	4B/TS2 Mangrove Forest	3.19
2	Plantation/TOF	96.81
	Total	100.00

11.36.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.36.10 Forest Fire Prone Classes (in sq km)

Sl.No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1	Extremely fire prone	0.00	0.00
2	Very highly fire prone	0.00	0.00
3	Highly fire prone	0.00	0.00
4	Moderately fire prone	0.00	0.00
5	Less fire prone	1.57	100.00
	Total	1.57	100.00

11.36.5 Tree Cover

Forest cover presented in the section 9.36.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Puducherry has been estimated as given in table 11.36.11.

TABLE 11.36.11 Tree Cover in Puducherry

Tree Cover	Area
	23

(in sq km)

Tree cover of Puducherry has decreased by 4 sq km as compared to the previous assessment reported in ISFR 2017.

11.36.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section

TABLE 11.36.12 Extent of TOF in Puducherry (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
51.41	23	74.41

11.36.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Puducherry is given in the table 11.36.13.

TABLE 11.36.13 Growing Stock in Puducherry

(in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	0.05	0.001
Growing Stock in TOF	0.40	0.02

11.36.8 Carbon Stock in Forest in Puducherry

The total Carbon stock of forests in the UT including the TOF patches which are more than 1 ha in size is 0.40 million tonnes (1.47 million tonnes of CO₂ equivalent) which is 0.0056% of total forest carbon of the country. Pool wise forest carbon in Puducherry is given in the following table

TABLE 11.36.14 Forest Carbon in Puducherry in different pools

(in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
97	22	0.63	7	276	403

11.36.9 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Puducherry in Rural and Urban areas are given in the table 11.36.15 and table 11.36.16 respectively.

TABLE 11.36.15 Top five tree species in TOF (Rural) in Puducherry

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	25.58
2.	<i>Azadirachta indica</i>	17.41
3.	<i>Borassus flabelliformis</i>	13.64
4.	<i>Tectona grandis</i>	7.92
5.	<i>Mangifera indica</i>	4.65

TABLE 11.36.16 Top five tree species in TOF (Urban) in Puducherry

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	29.91
2.	<i>Moringa pterygosperma</i>	13.93
3.	<i>Azadirachta indica</i>	13.24
4.	<i>Mangifera indica</i>	11.64
5.	<i>Artocarpus integrifolia</i>	3.20





About FSI

Forest Survey of India (FSI) is a premier national organization under the Ministry of Environment, Forest and Climate Change, Government of India. It is responsible for assessment and monitoring of the forest resources of the country on regular basis. Established on 1st June 1981, Forest Survey of India succeeded the “Pre-investment Survey of Forest Resources” (PISFR), a project initiated in 1965 by Government of India with the sponsorship of FAO and UNDP. The main objective of PISFR was to ascertain the availability of raw material for establishment of wood based industries in selected areas of the country. In its report in 1976, the National Commission on Agriculture (NCA) recommended for the creation of a National Forest Survey Organization for a regular, periodic and comprehensive forest resources survey of the country leading to creation of FSI.

The major activities of FSI include remote sensing based nation-wide forest cover mapping in biennial cycle, National Forest Inventory based on large number of sample plots laid across the country, forest fire monitoring, forest carbon assessment, forest type mapping and several projects on emerging issues and State specific requirements. Since 1987, FSI is publishing biennial 'State of Forest Reports' on the status of the forest resources of the country. These reports are widely acclaimed nationally and as well as internationally and are treasure trove of primary information on Indian Forests.

FSI has headquarters at Dehradun and has pan India presence with four regional offices at Shimla, Kolkata, Nagpur and Bangalore. The Eastern zone has a sub center at Burnihat.



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