

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.

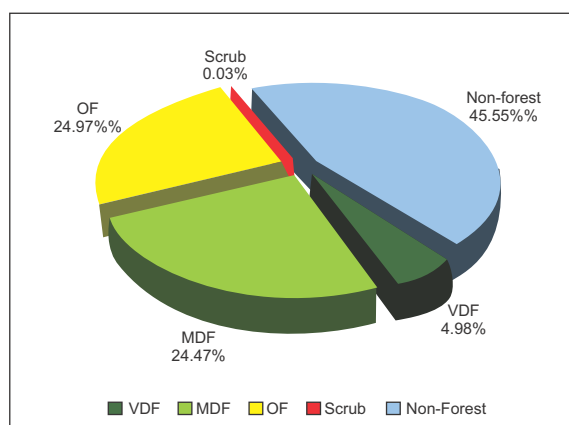
11.14.2 Forest Cover

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

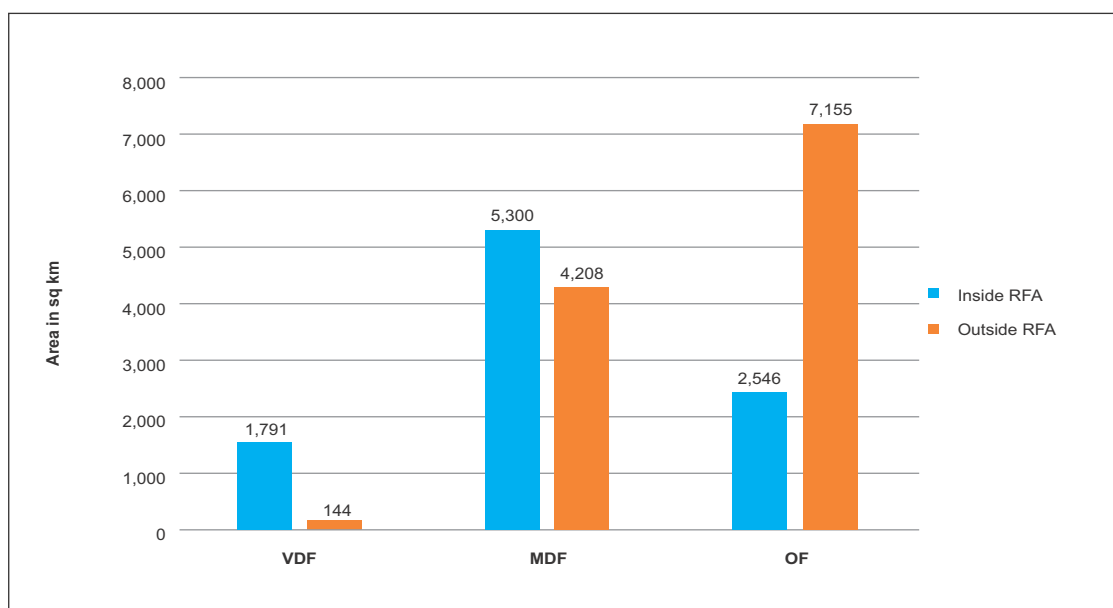


TABLE 11.14.4 District-wise Forest Cover in Kerala

(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

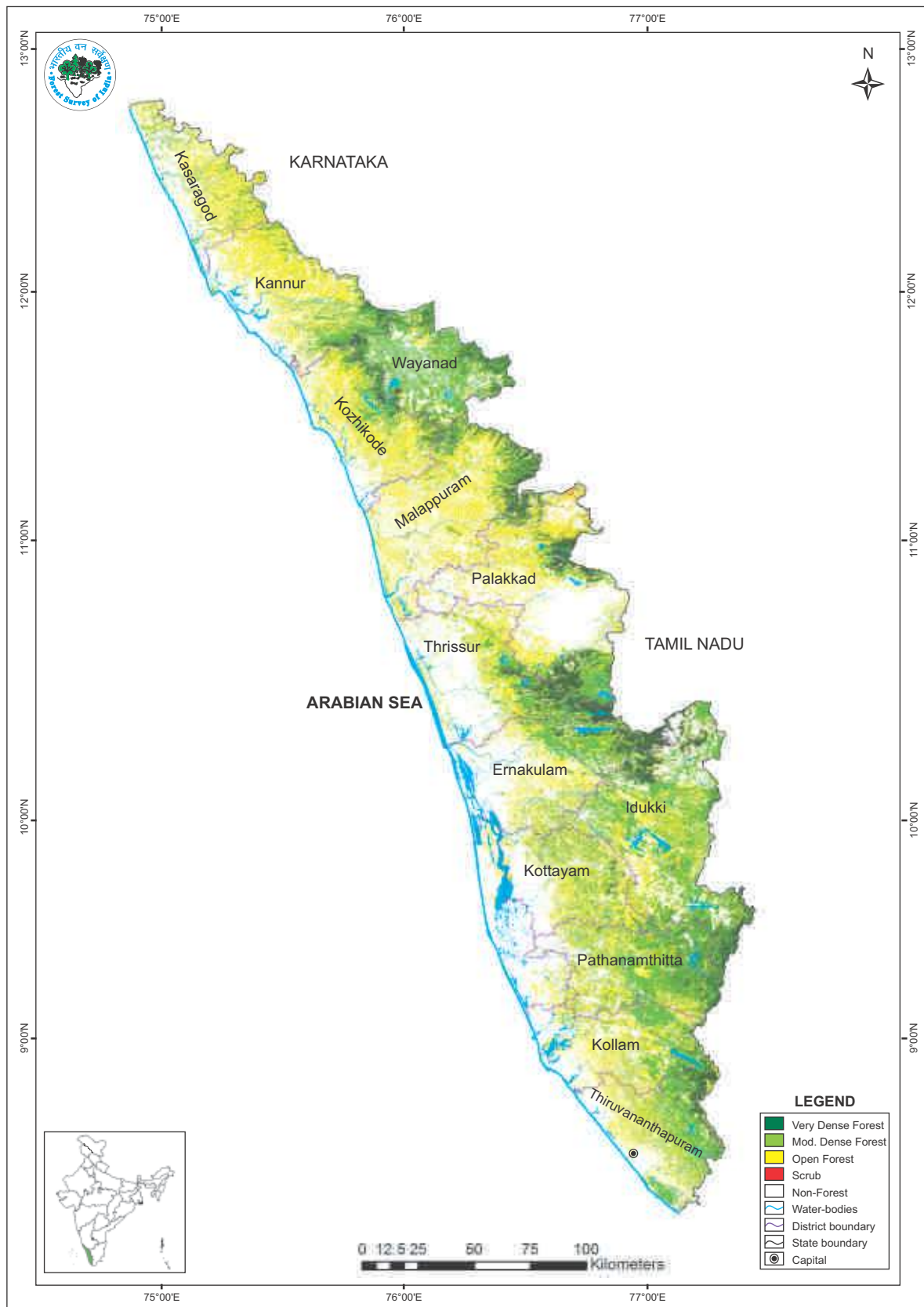


TABLE 11.14.8 Wetlands inside the Recorded Forest Area (or Green wash) in Kerala (in ha)

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

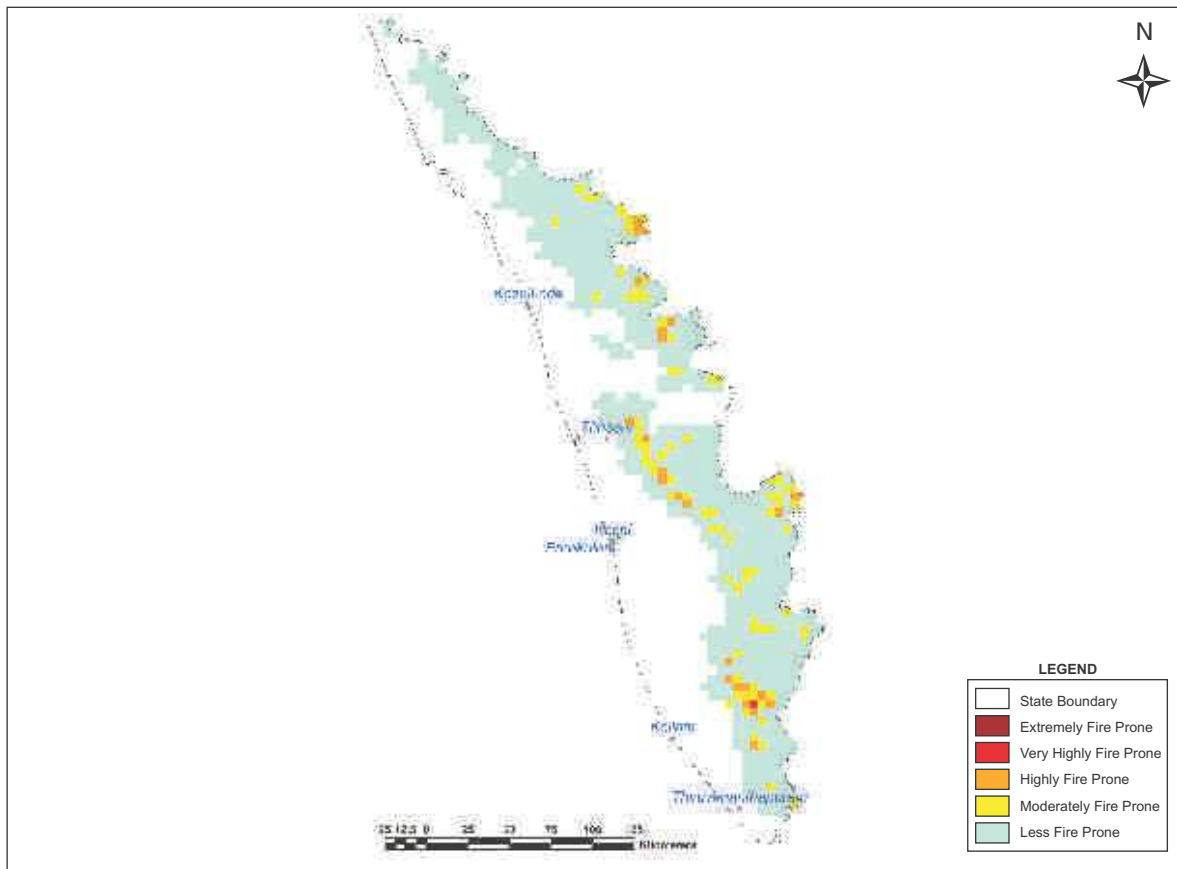
Geographical area under different classes of forest fire proneness are given in the following table.

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