

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.

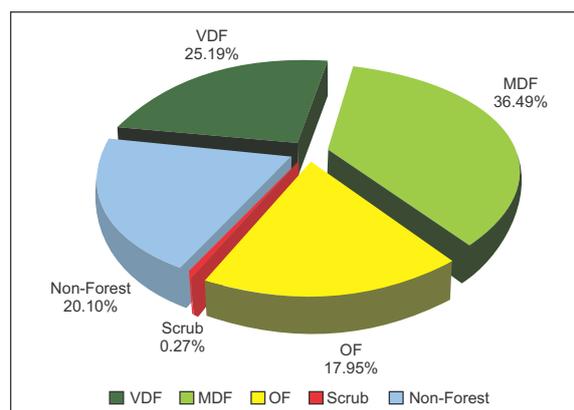
11.2.2 Forest Cover

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 ISFR 2017.

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



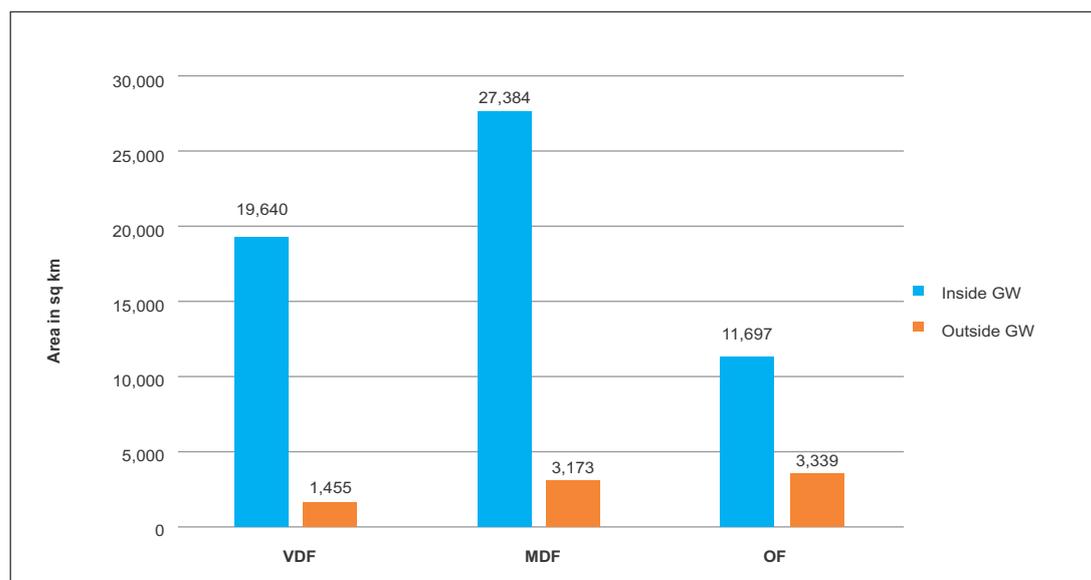
11.2.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

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

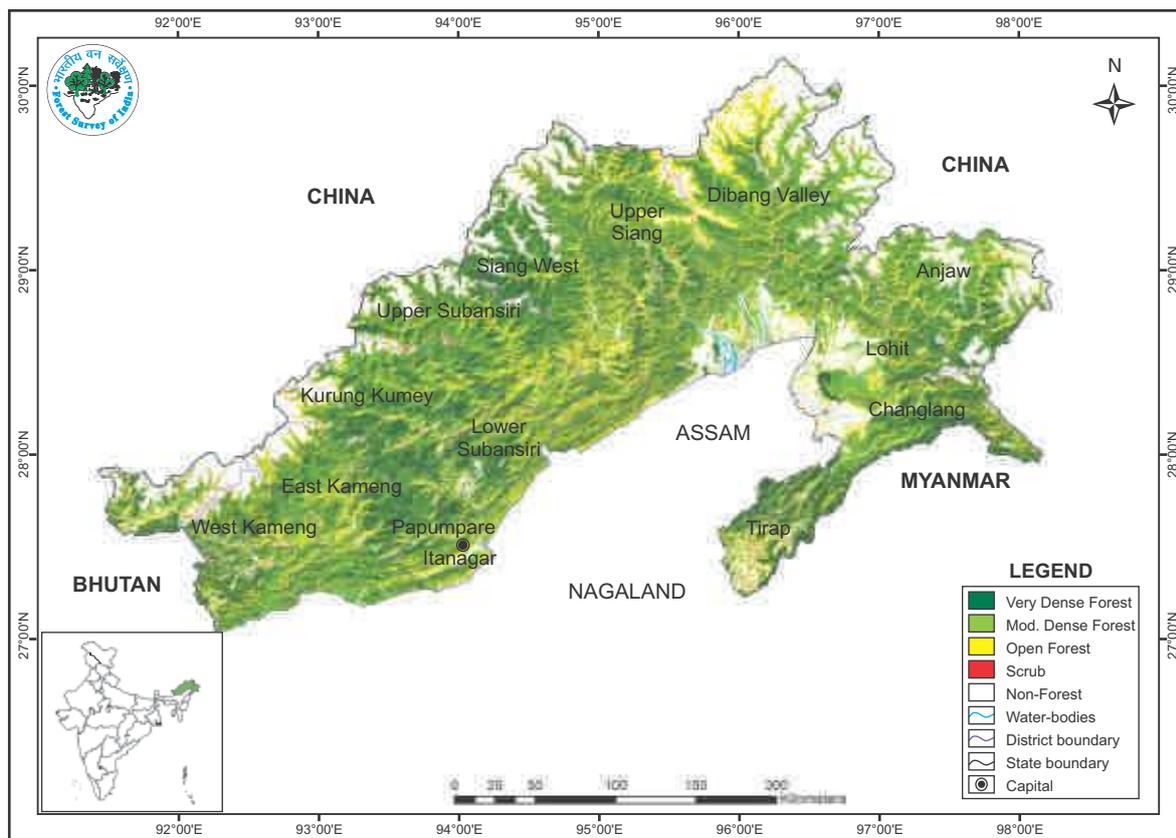


TABLE 11.2.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Arunachal Pradesh (in ha)

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

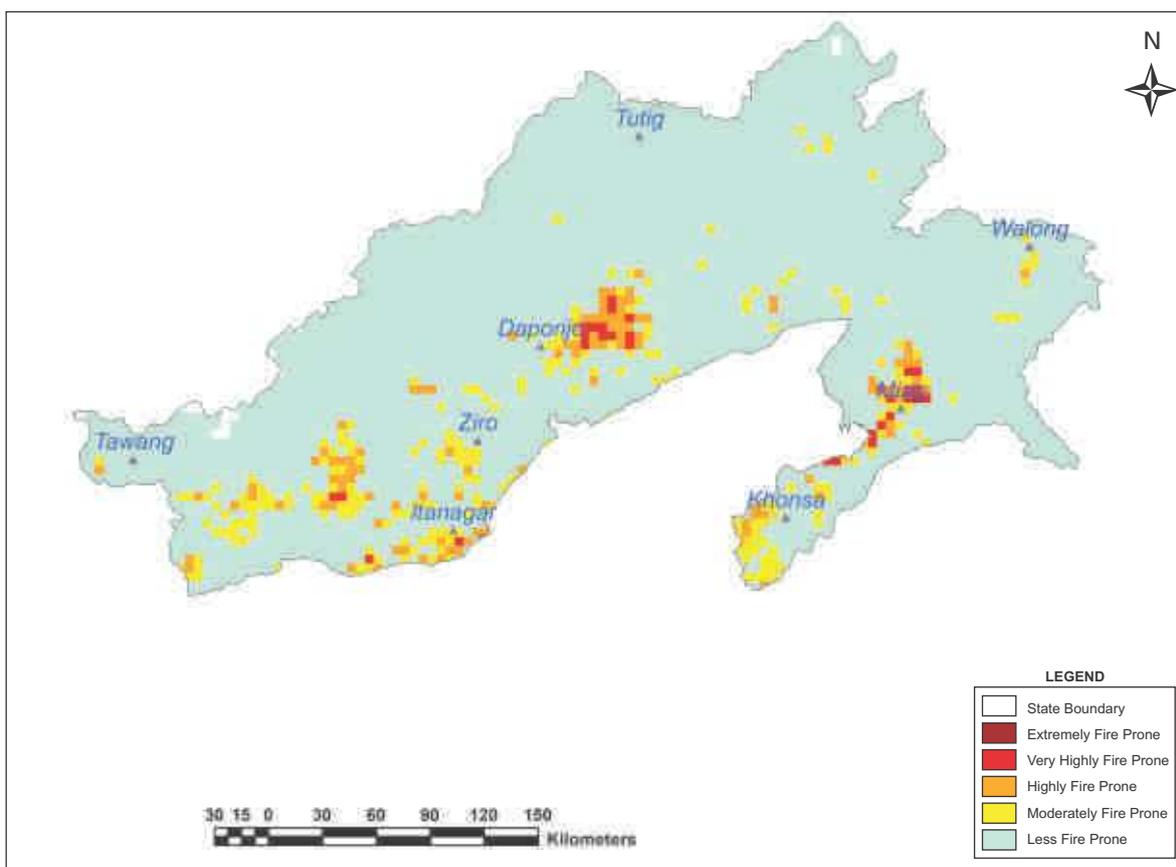
Geographical area under different classes of forest fire proneness are given in the following table.

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