

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.

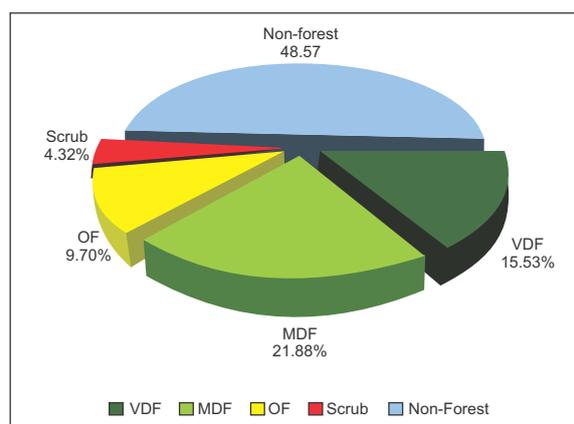
11.24.2 Forest Cover

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



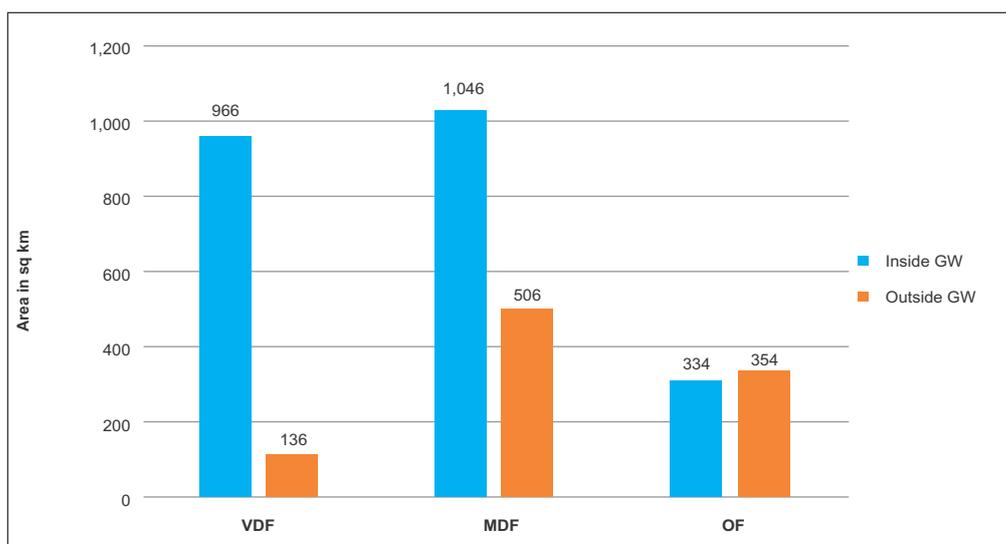
11.24.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

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

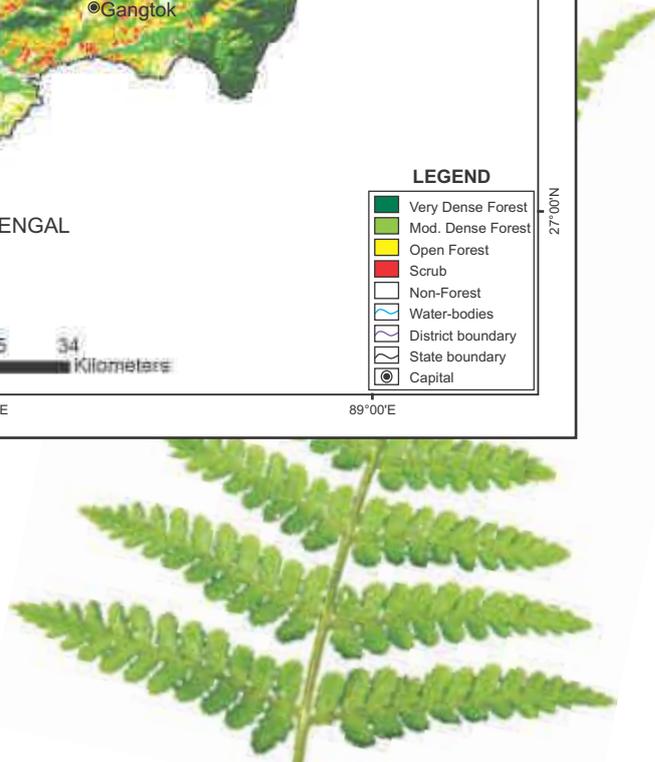
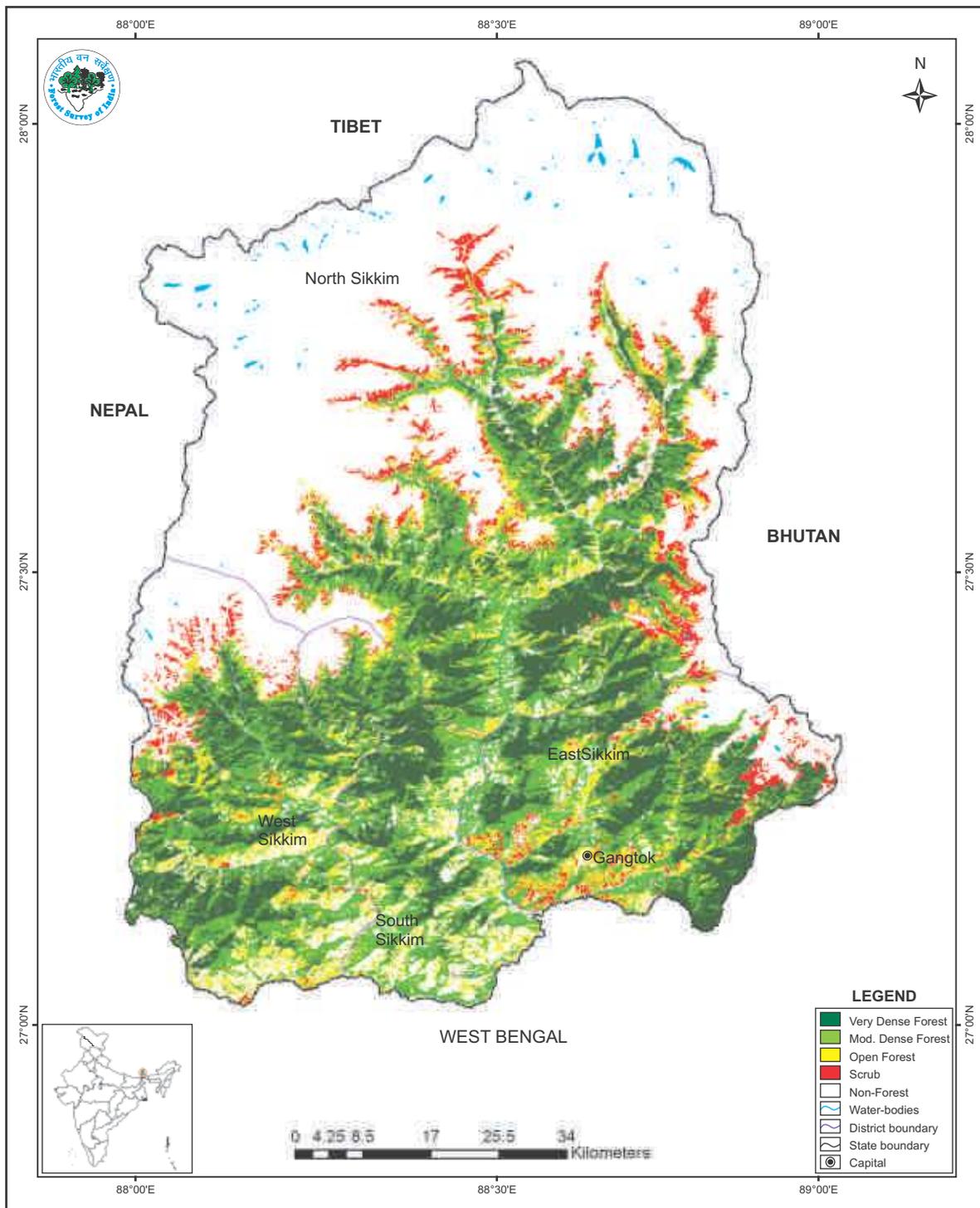


TABLE 11.24.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Sikkim (in ha)

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