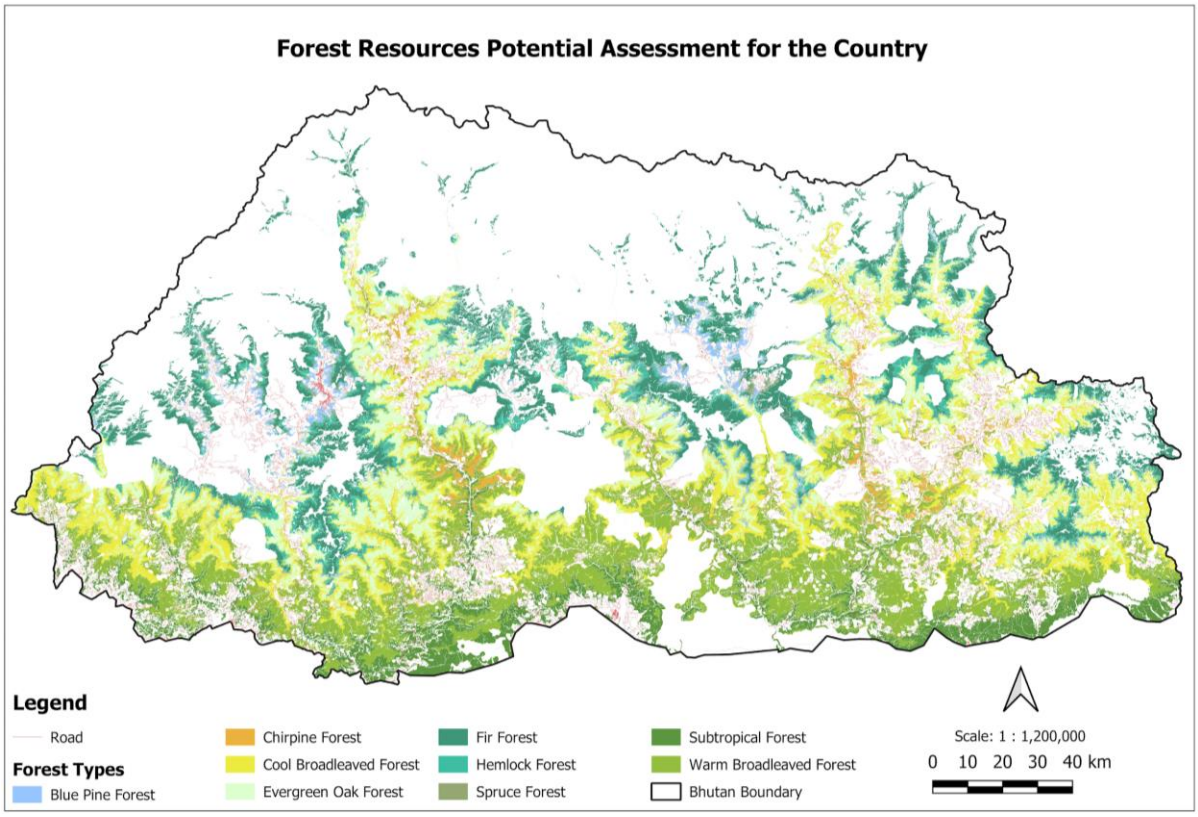
Action Plan for Forest Resources Management for Three Years Through Thinning
August 2023 to August 2026



FOREST MONITORING AND INFORMATION DIVISION
DEPARTMENT OF FORESTS AND PARK SERVICES
MINISTRY OF ENERGY AND NATURAL RESOURCES
AUGUST, 2023

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1 BACKGROUND

Forest is a dominant land cover in Bhutan encompassing about 69.7 % (FMID, 2023b, 2023a) of the total surface area. The forest can play a significant role in the national economy if the forest resources are sustainably managed in addition to rehabilitating degraded and barren areas. Currently, about 29 % of the forest is managed under Protected Area (FMID, 2023a), 7 % under Forest Management Units, 2 % under Community Forests, 2 % under Private Forest and 12 % under local forest management area. Resource allotment in the rural areas is mostly done through selection felling while the Forest Management Units (FMU) mainly cater to the general demand for developmental activities. FMUs are production forests which are intensively managed for production of timber on the sustainable basis with approved management plan. However, it has been observed that all forests including FMU are in need of immediate silvicultural treatment such as thinning to safeguard the rich natural resources. The NFI report also estimated an increasing stem density despite a reduction in growing stock (FMID, 2023b). Therefore, proper management of the forest will play a greater role in mitigation of climate change while enabling our forest to adapt to the changing climate and climate change impacts; fires and pest and diseases infestation.

The DoFPS carried out a desktop analysis to identify potential area for resource utilization similar to the Forest Resources Potential Assessment (FRPA) conducted in 2013 (FRMD, 2013). The FRPA 2013 was conducted to assess the state of forest that can be brought under sustainable forest management with minimum continuous patch of 100 ha. FRPA 2013 used slope of 35 degrees and 45 degrees to assess the potential forest area and estimated potential forest area of 33% (892,680 ha) and 39.62% (1,071,830 ha) of the total forest area respectively, which translate into 23.25% and 27.92% of the total country area. One of the key findings of FRPA, 2013 was that 16.8% of forest was available for timber production. These guided the identification and creation of new FMU, LFMAs and Community Forest over last one decade.

Similarly, the current exercises also help in identifying potential areas to be managed scientifically through thinning and other silvicultural interventions. Criteria for identification of potential areas for this exercise have been updated based on the provisions of the Forest and Nature Conservation Act of Bhutan 2023. Accordingly, areas for short-term and long-term planning have been identified. This exercise shall however focus on a short-term plan; three-year action plan with annual target (area and volume). For the ease of validation, the total target shall be reported by office and Dzongkhag. The process of identification of potential areas, target and way forward shall be discussed in detail in the following sections.

2 OBJECTIVE

The objective of this exercise is to:

- Assess and identify the potential forest area for the enhanced for sustainable forest management
- Estimate the growing stock of forest within potential forest area for production management

- Identify the potential forest area for short-term and long-term thinning

3 METHODOLOGY

This is a rapid assessment and identification of potential forest area which can be brought under enhanced forest management to protect, conserve and utilize the forest resources, under the principles of sustainable forest management. The potential forest area is defined as any forest area which has minimum coverage of 3 ha and located on gentle to moderate slope of up to 45 degrees. Any forests having slope of more than 45 degrees are defined as protection forest and are reserved for protection functions.

3.1 Geospatial Analysis

The potential forest area is identified using the geo-spatial analysis of the existing data, including the Forest Type Map of Bhutan 2022, Forest Cover Map of Bhutan 2022 and National Forest Inventory Volume I: State of Forest Report 2023, Digital Elevation Model (DEM 30 Meter Resolution). Spatial multi-criteria analysis was carried out using the slope as main criteria, where all forest area located in any location with slope less than or equal to 45 degrees are mapped as operable forests and those above 45 degrees are mapped as inoperable forests. Further, all forest adjoining the private registered lands, settlements and seasonal streams are mapped as potential area for immediate thinning.

3.1.1 Discounting the managed forest and protection zones

The potential forest area is exclusive of all forest managed as production forest and other areas prohibited as per the Forest and Nature Conservation Act 2023. The area excluded are as follows:

- Any forest area located on slope more than 45 degrees
- Core zone of Protected Areas
- Forest Management Units and Community Forests
- Private registered land
- Identified/declared RAMSAR sites
- Within 500 m from the religious and cultural sites
- Within 100 feet from the bank or edge of any water bodies

3.2 Potential Forest Area by Accessibility Classification

The potential area determined through geospatial analysis are further categorized into different categories based on the accessibility by road. Areas under four different categories are grouped to plan for short-term and long-term planning.

i. Forests within 1.5 km radius from the nearest road (Scenario I)
ii. Forest within 3 km radius from the nearest road (Scenario II)
iii. Forest within 4.5 km radius from the nearest road (Scenario III)
iv. Forest beyond 4.5 km radius from the nearest road (Scenario IV)

The areas are cumulative areas, for example, the area for management under 1.5 km accounted under the areas under 3 km. However, the conditions of the road could not be verified from the desktop analysis.

3.3 Estimation of the growing stock and increment

The growing stock is estimated using the average volume per hectare reported in the State of Forest Report 2023. Further, periodic annual volume increment was estimated using the national forest inventory data was for twenty Dzongkhags, which is then used for generating the preliminary estimates of periodic annual volume increment (PAI) for potential forest area. Subsequently, the PAI is used to determine thinning yield of the potential forest areas.

4 RESULTS

4.1 Potential Forest Area of the Country

The result of the potential forest area under five different scenarios is described in Table 4.1. The maximum potential forest area is located within 1.5 km distance from the existing roads.

Table 4.1: Details of growing stock under different scenario

Scenario	Distance	Area (ha)	Remarks
I	Within 1.5 km	624,194.98	Within 1.5 km from road
II	Within 3 km	1,011,908.72	Cumulative to scenario I
III	within 4.5km	1,263,143.18	Cumulative to scenario II
IV	Beyond 4.5 km	370,007.20	Outside 4.5 km from road
V	**Total**	**1,633,150.33**	

The total potential area which can be brought under sustainable forest management through appropriate management is 1.63 million ha, which is 61 % of the total forest area of the country. This forest includes any forest area with minimum acreage of 3 ha. However, this potential area is irrespective of accessibility classification as described in earlier in section 3.2. The total Potential Forest area has also been worked out for forest outside the protected areas and forest inside the protected areas. Figure 4.1 shows the distribution of potential forest area in the country.

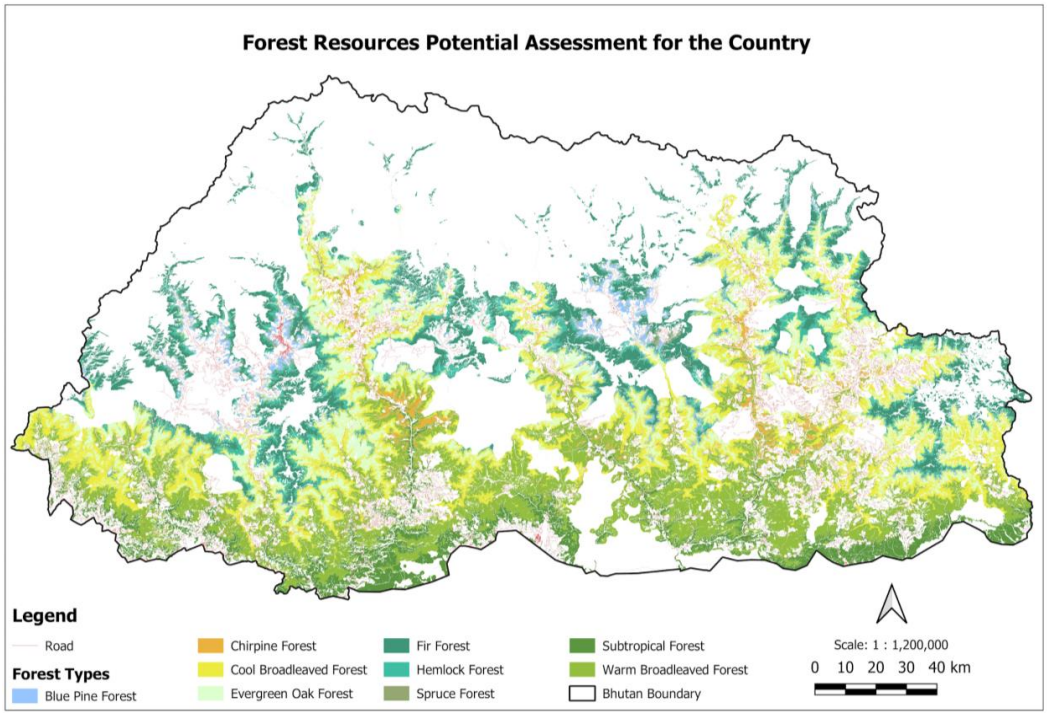

Figure 4.1: Distribution of Potential Forest Area in the Country

4.1.1 Potential Forest Area Outside Protected Area

The potential forest area outside the protected area is 1,081,701.34 ha which is 69.4 % of the total forest outside the protected area networks (Figure 4.2).

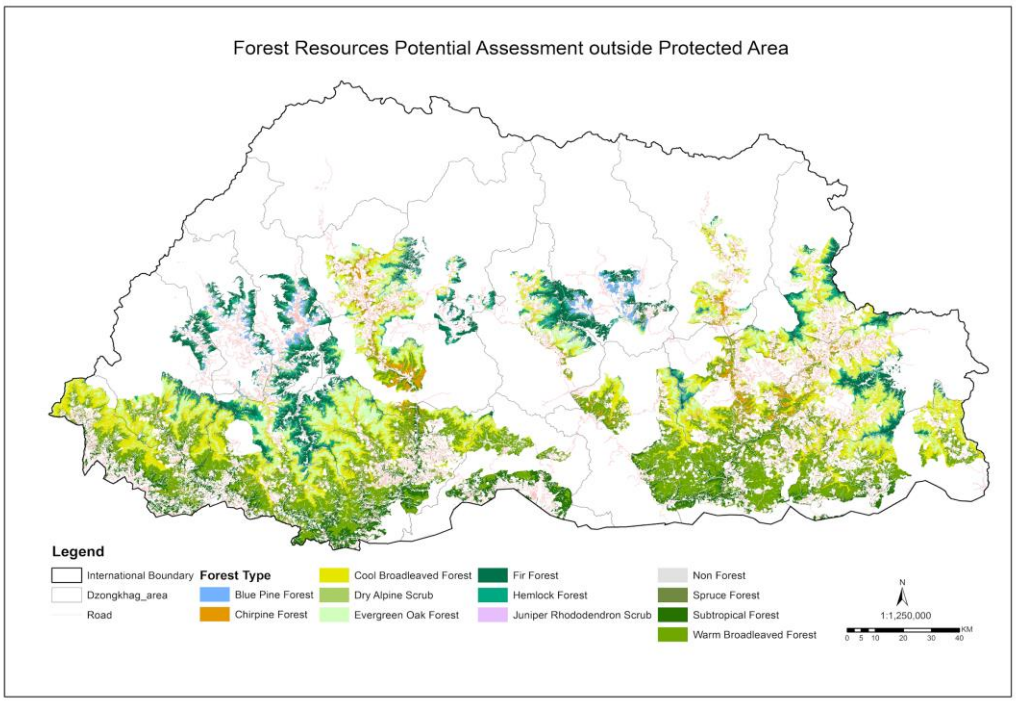

Figure 4.2: Potential Forest Area Outside Protected Areas

4.1.2 Potential Forest Area Inside Protected Area

The potential forest area inside the protected area is 551,833 ha which is 49.4 % of the total forest inside the protected area networks (Figure 4.3).

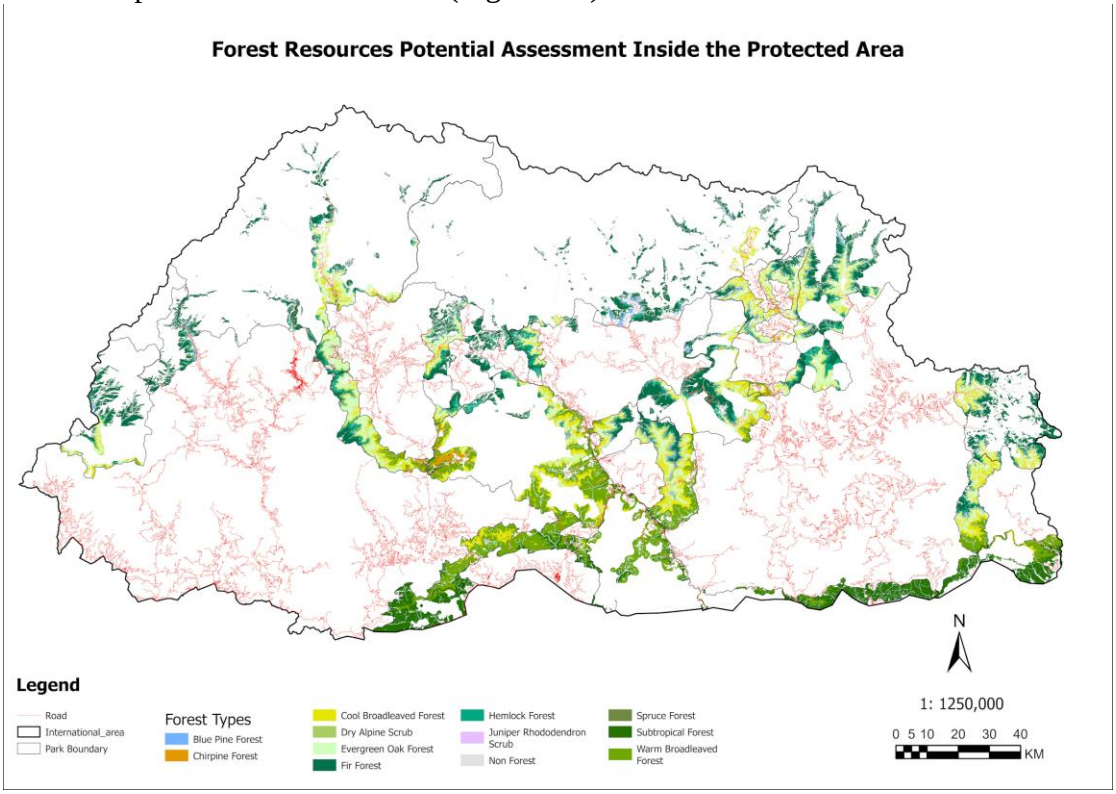

Figure 4.3: Potential Forest Area inside Protected Area

4.2 Estimated Potential Volume for Thinning

For the purpose of this exercise, a thorough discussion was done on Scenario I, II and III. Table 4.2 shows the total growing stock that can be removed as part of thinning under three different scenario of 1.5 km, 3 km and 4.5 km distance from road. Based on existing capacity and review of the past experiences on implementation of similar activities, Scenario I is recommended for immediate thinning for the next three years and subsequently, log volume was estimated for different office by major Forest Class (Broadleaved and Coniferous Forest). However, the log volume for scenario II and III are worked assuming that 38% of the potential area is constituted by Coniferous Forest and 68% by the Broadleaved Forest (FMID, 2023b). This estimate shall provide the basis for long term planning and identification of Forest Management Units (FMU) following the prescription of the Forest and Nature Conservation Code of Best Management Practices 2021.

Table 4.2: Total potential volume of timber for thinning

Scenario	Distance	Area (ha)	Standing volume (m^3)	Log Volume (cft)
I	Within 1.5 km	624,194.98	2,097,422	32,240,792

II	Within 3 km	1,011,908.72	3,369,681	55,208,310
III	within 4.5km	1,263,143.18	4,178,090	68,453,163

5 IMPLEMENTATION FRAMEWORK (SCENARIO I)

While there is huge potential for thinning operation in the forest, thinning operation may be feasible only within 1.5 km distance from the road within 3 years while potential areas beyond 3 km may be explored in longer term as it would involve huge investment in the form of road construction. Therefore, the areas under Scenario I is recommended for immediate harvest and/or short-term planning for harvest through scientific thinning and management on account of the availability of the resources and investment required for thinning.

6 ESTIMATION OF ANNUAL THINNING TARGET

The total potential forest area under scenario I is 624,194.98 ha, which shall be thinned over a period of three years. The annual thinning target is estimated using the PAI, which is most reliable and recommended method for sustainable forest management, when a realistic increment data is available. The periodic annual increment is estimated using data collected during the 2nd National Forest Inventory data Bhutan.

Under the best forest management practices, the annual felling must not exceed the annual increment and usually a felling-to-annual-increment ratio of approximately 70 % (Forestry Commission, 2015; EU, 2020). However, there are other reports wherein only 40 % of the increment has been utilized (FAO & UNECE, 2011). This is because the increment is spread across the forest stands and landscapes; and also, certain percent of the increment is reserved to the natural losses and other possible risks.

The annual thinning target is worked out for the Coniferous and Broadleaved Forest based on potential area within 1.5 km distance and the PAI in the potential forest area under each Dzongkhag. Table 5.2 shows the Annual target after taking into account 70 % of the felling increment ratio (Thinning Yield).

Table 6.1: Annual Thinning Target Based on Periodic Annual Increment

Year	Total			Coniferous Forest			Broadleaved Forest		
	Area (ha)	Standing Volume (m^3)	Log Volume (cft)	Area (ha)	Standing Volume (m^3)	Log Volume (cft)	Area (ha)	Standing Volume (m^3)	Log Volume (cft)
Year 1	208,065	699,141	10,746,931	38,283	123,516	2,616,802	169,782	575,625	8,130,128
Year 2	208,065	699,141	10,746,931	38,283	123,516	2,616,802	169,782	575,625	8,130,128
Year 3	208,065	699,141	10,746,931	38,283	123,516	2,616,802	169,782	575,625	8,130,128
Total	**624,195**	**2,097,422**	**32,240,792**	**114,850**	**370,547**	**7,850,407**	**509,345**	**1,726,875**	**24,390,384**

6.1 Implementation Plan

Annual thinning yield is estimated for different Divisional Forest and Park Offices based on the annual thinning yield described in section 5.1. Table 5.3 and 5.4 shows the total and yearly thinning target for Division Forest and Park Office respectively.

Table 6.2: Annual Thinning Target for Divisional Forest Office

Office Name	Dzongkhag	Location	Broadleaved		Conifer		
			Annual Area (ha)	Log Volume (cft)	Annual Area (ha)	Log Volume (cft)	Log Volume (cft)
Bumthang Division	Bumthang	FD	166.28	7,907.69	5,080.57	362,413.87	370,321.56
	Trongsa	BC 4	762.78	22,548.85	40.06	1,776.35	24,325.20
	Trongsa	BC 8	374.96	11,084.49	62.73	2,781.59	13,866.08
	Trongsa	FD	3,949.40	116,750.31	1,289.49	57,179.10	173,929.41
Dagana Division	Dagana	FD	14,876.37	735,398.31	136.27	10,104.31	745,502.62
Gedu Division	Chhukha	FD	17,727.42	743,134.15	918.23	57,738.14	800,872.29
Mongar Division	Lhuentse	BC 7	2,565.82	47,945.11	354.88	9,946.96	57,892.07
	Lhuentse	FD	4,042.10	75,530.89	867.42	24,312.98	99,843.87
	Monggar	BC 7	438.99	18,619.49	65.77	4,184.60	22,804.09
	Monggar	FD	11,335.73	480,798.01	2,045.74	130,152.95	610,950.96
Paro Division	Haa	BC 1	0.00	0.11	145.33	7,004.64	7,004.74
	Haa	FD	35.77	1,149.26	1,560.49	75,212.73	76,361.99
	Paro	BC 1	91.07	6,510.06	525.53	56,348.92	62,858.98
	Paro	FD	364.43	26,049.79	3,037.59	325,697.88	351,747.67
Pemagatshel Division	Pemagatshel	BC 5	650.14	67,877.96			67,877.96
	Pemagatshel	FD	10,285.57	1,073,860.56	227.82	35,678.71	1,109,539.26
Samdrup Jongkhar Division	Samdrup Jongkhar	BC 5	1,634.43	73,201.40	0.05	3.14	73,204.
	Samdrup Jongkhar	FD	6,064.94	271,631.71	0.05	3.58	271,635.29
Samtse Division	Samtse	FD	12,982.63	408,174.09	-	-	408,174.09
Sarpang Division	Sarpang	BC 3	3,615.64	138,341.31	-	-	138,341.31
	Sarpang	FD	6,739.30	257,858.53	-	-	257,858.53

Thimphu Division	Thimphu	FD	489.23	25,877.34	5,021.96	398,450.46	424,327.80
	Thimphu	Royal Botanical Park	0.03	1.76	249.36	19,784.61	19,786.38
Trashigang Division	Trashigang	FD	8,004.56	418,647.87	1,051.38	82,482.35	501,130.22
	Yangtse	FD	3,774.75	164,208.73	170.52	11,126.70	175,335.43
Tsirang Division	Tsirang	BC 3	363.39	21,125.45	-	-	21,125.45
	Tsirang	FD	2,955.34	171,806.68	87.70	7,647.29	179,453.96
Wangdue Division	Punakha	FD	4,277.03	247,373.92	933.34	80,973.47	328,347.39
	Punakha	Royal Botanical Park	869.45	50,286.87	332.84	28,876.09	79,162.96
	Wangdue Phodrang	BC 2	1,218.58	39,998.88	198.53	9,774.88	49,773.76
	Wangdue Phodrang	BC 8	1,567.43	51,449.60	1,062.49	52,313.04	103,762.64
	Wangdue Phodrang	FD	7,504.18	246,318.53	4,440.79	218,647.91	464,966.43
Zhemgang Division	Zhemgang	BC 4	2,137.43	153,843.70	60.11	6,489.35	160,333.04
	Zhemgang	FD	10,226.70	736,075.74	334.80	36,146.66	772,222.40
	Total		**142,091.86**	**,911,387.13**	**30,301.84**	**,113,253.25**	**9,024,640.38**

Table 6.3: Annual Thinning Target for Park Office

Office Name	Dzongkhag	Location	Broadleaved		Conifer		Total
			Annual Area (ha)	Log Volume (cft)	Annual Area (ha)	Log Volume (cft)	Log Volume (cft)
BWS	Lhuentse	BWS	90.78	1696.26	0.00	-	1,696.26
	Monggar	BWS	72.71	3083.81	0.00	-	3,083.81
	Yangtse	BWS	434.15	18886.36	18.27	1,191.95	20,078.31
JDNP	Gasa	JDNP	926.26	18498.72	877.39	26,283.98	44,782.69
	Paro	JDNP	5.92	423.41	267.67	28,700.21	29,123.61

	Punakha	JDNP	1585.19	91683.68	149.68	12,985.45	104,669.13
	Thimphu	JDNP	5.40	285.63	660.90	52,437.11	52,722.74
JKSNR	Haa	FD	4557.38	146438.30	680.97	32,821.49	179,259.79
JSWNP	Sarpang	JSWNP	804.92	30797.65	0.00	-	30,797.65
	Trongsa	JSWNP	2289.94	67694.23	221.64	9,828.03	77,522.26
	Tsirang	JSWNP	108.63	6315.14	26.90	2,345.43	8,660.57
	Wangdue Phodrang	JSWNP	838.90	27536.31	382.42	18,828.93	46,365.24
	Zhemgang	JSWNP	687.94	49514.86	10.28	1,110.23	50,625.09
JWS	Samdrupjongkhar	FD	4054.47	181588.23	31.77	2,134.56	183,722.78
	Samdrupjongkhar	JWS	2288.41	102491.34	0.00	-	102,491.34
PNP	Bumthang	PNP	147.75	7026.33	1678.14	119,706.96	126,733.29
	Lhuentse	PNP	186.95	3493.42	181.12	5,076.63	8,570.05
	Monggar	PNP	1522.17	64562.03	940.99	59,867.04	124,429.06
PWS	Dagana	FD	261.05	12904.91	0.00	-	12,904.91
	Dagana	PWS	331.42	16383.42	0.00	-	16,383.42
	Sarpang	PWS	623.91	23872.12	0.00	-	23,872.12
RMNP	Pemagatshel	RMNP	223.56	23340.69	0.00	-	23,340.69
	Sarpang	RMNP	139.96	5355.27	0.00	-	5,355.27
	Zhemgang	RMNP	3230.99	232553.67	5.86	632.31	233,185.97
SWS	Trashigang	FD	240.31	12568.67	200.88	15,759.39	28,328.06
	Trashigang	SWS	832.77	43554.85	245.65	19,271.67	62,826.52
WCNP	Bumthang	WCNP	46.21	2197.54	1175.30	83,837.75	86,035.29
	Lhuentse	WCNP	928.24	17345.14	6.08	170.42	17,515.56
	Trongsa	WCNP	211.18	6242.71	50.82	2,253.33	8,496.03
	Wangdue Phodrang	WCNP	12.38	406.36	168.70	8,306.32	8,712.69
Total				**1,218,741**	**7,981**	**503,549.17**	**1,722,290.20**

7 VALIDATION AND PLANNING

The total annual thinning yield (Table 5.3 and Table 5.4) has been estimated using the PAI estimated at Dzongkhag level and applied to potential areas estimated from desktop analysis. The estimates provided in the report may overestimate or underestimate the true conditions in the field. Therefore, it is important to undertake the following activities before initiating thinning operations.

Table 7.1: Key activities before handing over thinning sites

Sl. No	Activity	Lead	Collaborators
1	Handing over of shape files and Action Plan for 3 years to FRPMD	FMID	-
2	Validation of the potential mapped area and demarcation of areas for the 3 years	FRPMD	All Field Offices
3	Operational Inventory	All Field Offices	FRPMD, FMID, and concerned agencies
4	Circulate Thinning Guidelines	FRPMD	All field Offices
5	Capacity building on thinning operations	FRPMD	All field offices
6	Thinning	All Field Offices	FRPMD and concerned agencies

8 GENERIC APPROACH OF THINNING

Since one of the main objectives of the thinning is to promote the growth and development of the remaining trees while also obtaining timber to supplement the timber production from the FMUs, intermediate thinning is proposed. This will involve removal of suppressed and co-dominant trees within the forest stand, while opening canopy by selective removal of competing dominant and co-dominant trees (Forestry Commission, 2015).

The thinning method described in this document is not field tested and can be use as general guidance method only. Therefore, all thinning operations shall be based on the thinning guidelines developed by Forest Resources Planning and Management Division for specific forest types based on the Forest and Nature Conservation Code of Best Practices 2021.

8.1 Strip Thinning

This shall be done by the removal of 25 % of the growing stock from the forest stand. However, taking into account the topographic condition in Bhutan, it is proposed to install sky cable lines to safely extract the thinned timber without causing damage to the surrounding environment. Cable lines of a maximum of 4 m width (**cable corridors)** will be cleared felled. The space between the two cable lines (**strip)** will be of minimum of 30 meters including the cable corridor. While laying the cable lines, it is proposed that the **strip** and **cable corridor** be laid alternatively on the either

side of the road to minimize environmental impacts. Figure 6.1, 6.2 and 6.3 shows the general approach for the thinning design with cable lines.

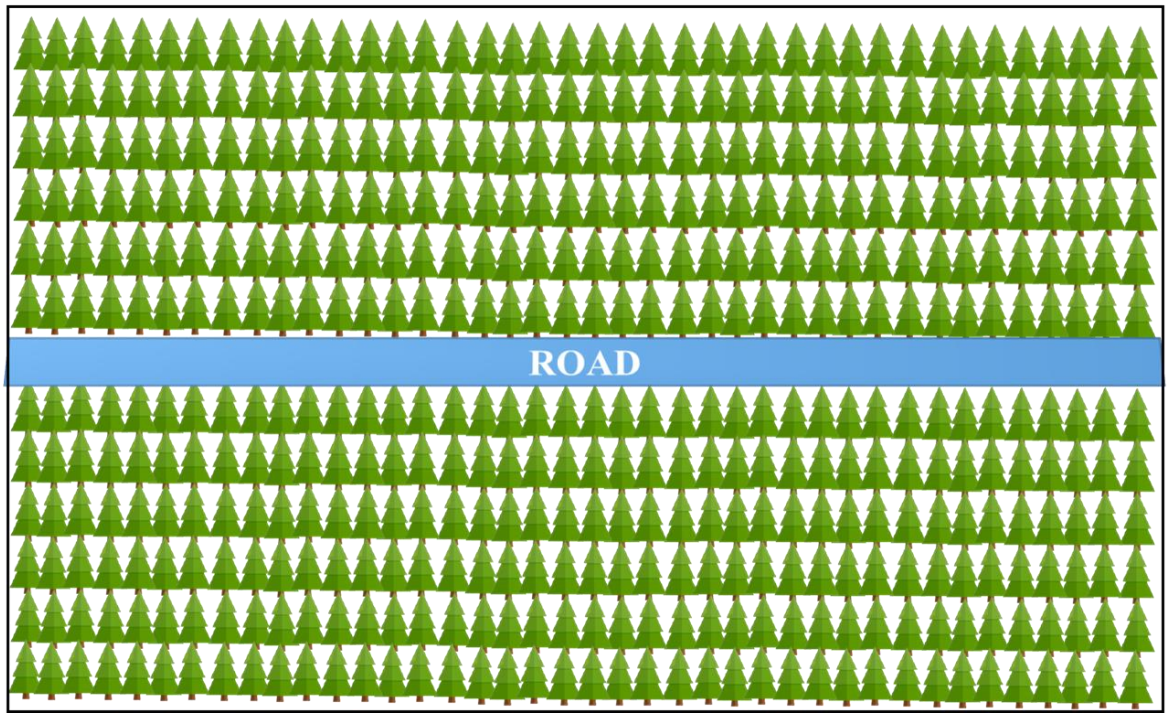

Figure 8.1: Potential forest stand for thinning

Figure 8.2: Layout of the cable lines

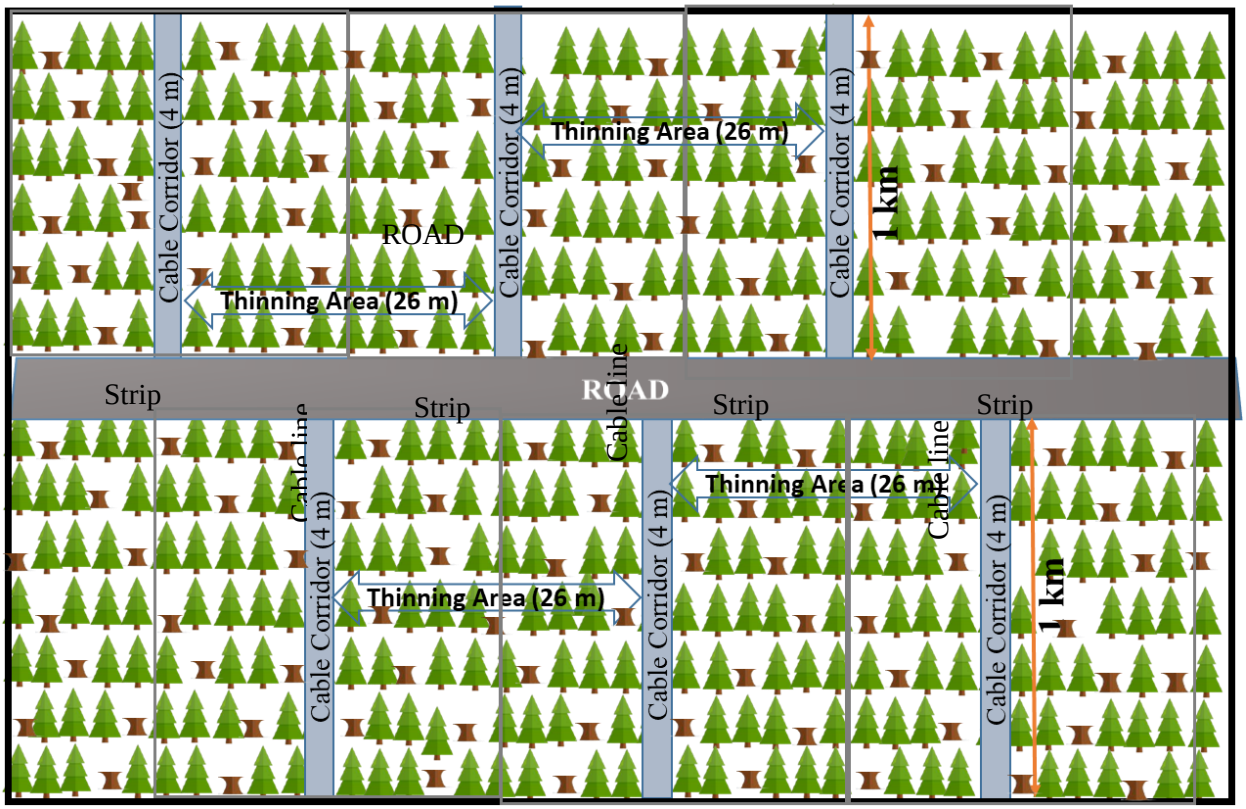

Figure 8.3: Illustration of the strip thinning

8.2 Determination of Cable Lines

Based on the annual thinning target, the volume from the cable lines and thinning between the cable lines may be estimated as follow:

If the cable line is of 1500 m length and 4 m width, and the strip length is 26 m, then (i) estimate the total growing stock for each cable line;

the total area per cable line = 4.5 ha
Total growing stock = area x volume per ha
= 4.5 x 283.65
= 1,276.43 m3

The volume per ha is taken from the NFI report (FMID, 2023). The actual volume per ha generated during the operational inventory or cable line survey shall be taken during the field work.

Then, (ii) estimate the volume to be extracted from each Cable line and its strip:

Thinning Yield per cable line = 25% of the growing stock
=25 % * 1276.43
= 319.11 m3

Since the cable line shall be clear felled,
Volume from cable line = 170.19 m3; and

the volume to be extracted from the strip= 319.11 - 170.19 = 148.92 m3

the number of cable line may then be calculated by dividing the Annual Thinning Target by

(iii) the number of cable line may then be calculated by dividing the Annual Thinning Target by the total volume per cable line

Taking into account the volume for each cable line (319.11 m^3), an example for the potential number of cable line to be installed is worked out for the thinning area in Coniferous Forest under Bumthang Dzongkhag for Bumthang Division.

The potential annual thinning area is 5,080.57 ha with annual thinning yield of 17,106.29 m^3 of timber (Table 5.3). The number of cable lines required to achieve the thinning yield is :

Volume of timber per cable line = 319.11 m^3

Number of cable lines = Annual Thinning Yield / Volume per cable line
= 17,106.29 m^3 / 319.11 m^3
= 53.61 cable lines or **54 cable lines**

The estimation is based on the volume per ha generated from the NFI data and may vary upon field validation.

9 WAY FORWARD

This action plan has been developed with desktop analysis and provides an overview of the potential area and volume of timber that can be thinned out over period of three years. However, as highlighted in Section 6, the following activities has to be implemented by field offices lead by the Forest Resources Planning and Management Division.

- Area and volume validation
- Circulate the thinning guidelines to field offices
- Capacity building of the field offices for thinning operations
- Annual work planning for three years
- Action plan to be developed by respective divisions/parks

10 LIMITATIONS

The analysis is carried out using the available data and may have overestimated the potential area and operability of the identified area is subject to local conditions and field situations. Further, substantial portion of the forest which are registered against individuals, agencies and government

institutions might have been included in the areas mapped and can only be determined in the field.

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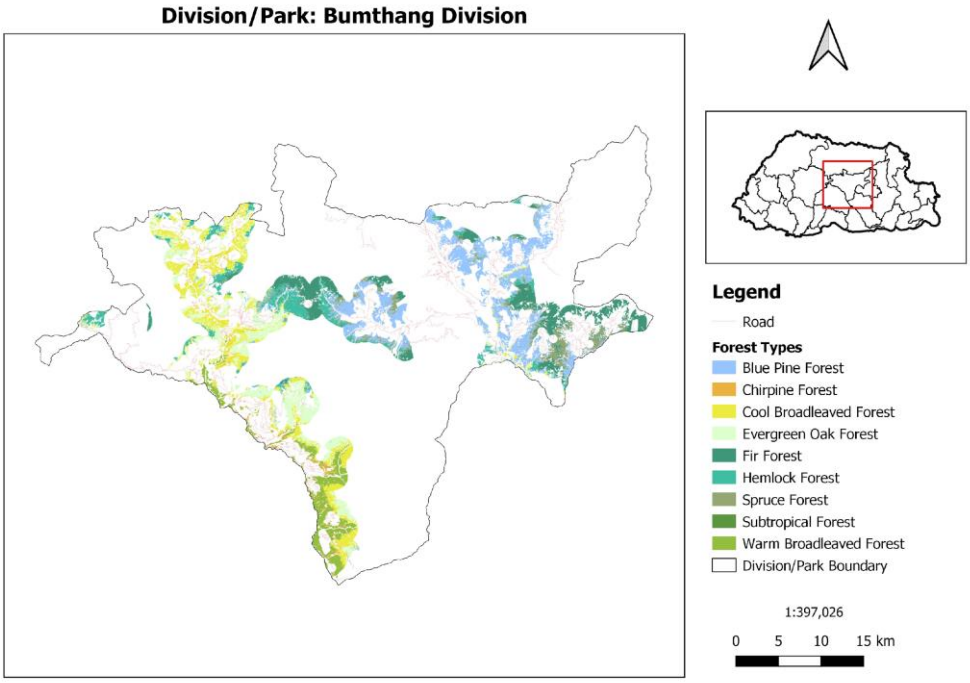
12 ANNEXURE

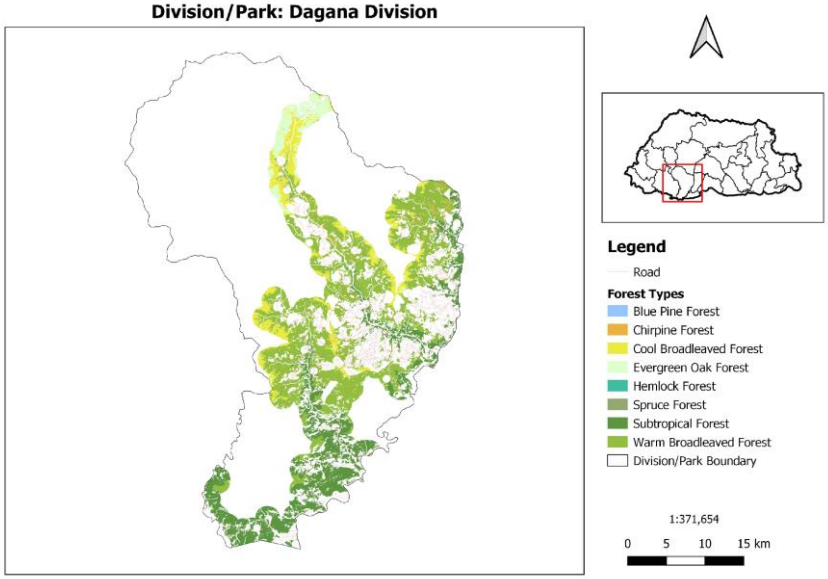
12.1 Potential Forests Area for field offices under Scenario I

To assist field office in planning and carrying the thinning as proposed under the Scenario I for the three years, office wise map has been developed for execution of the thinning.

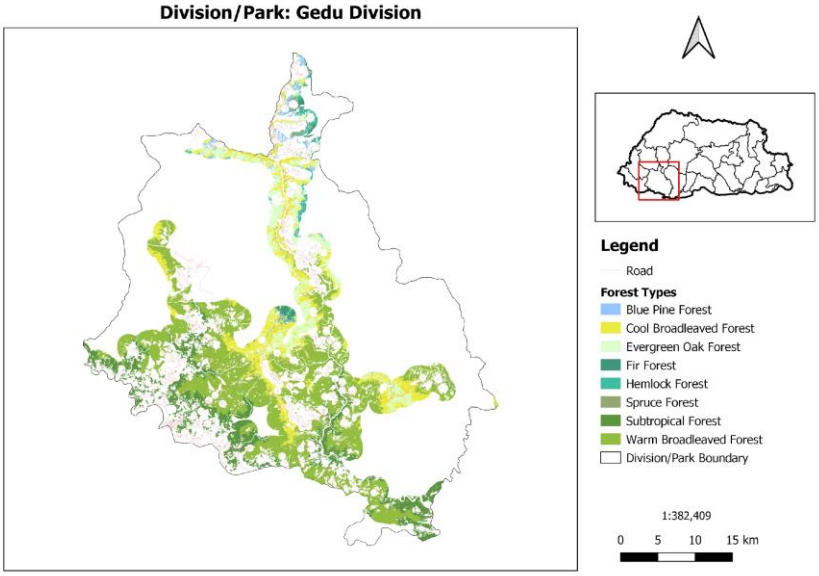
12.1.1 Bumthang Forest Division



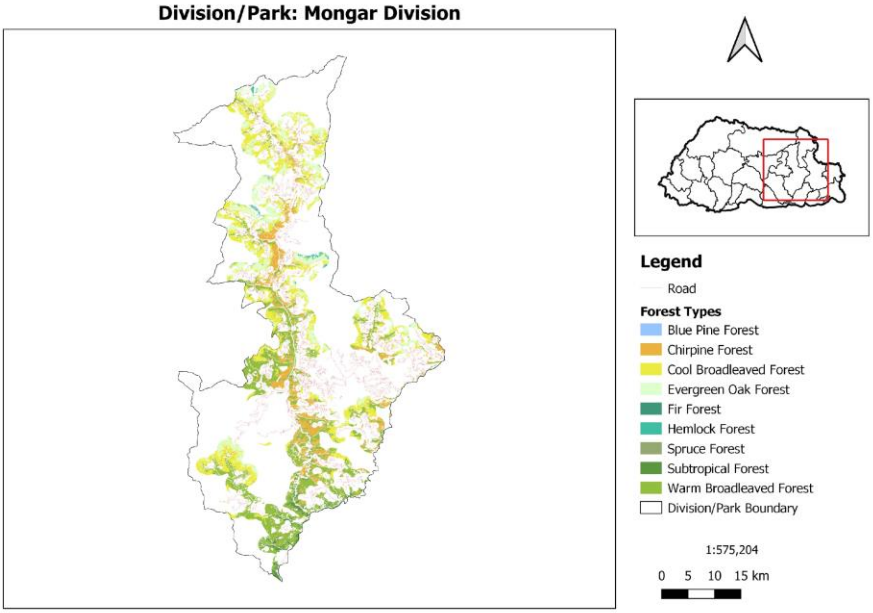
12.1.2 Dagana Forest Division



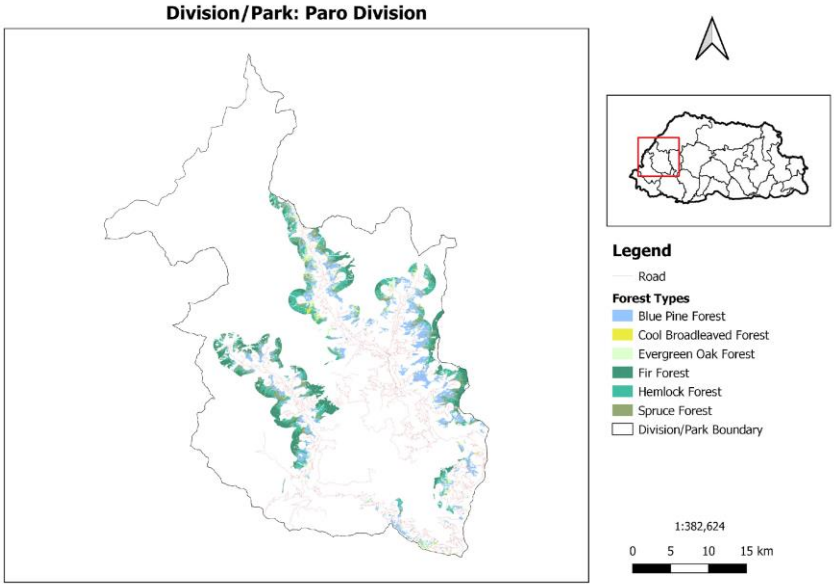
12.1.3 **Gedu Forest Division**



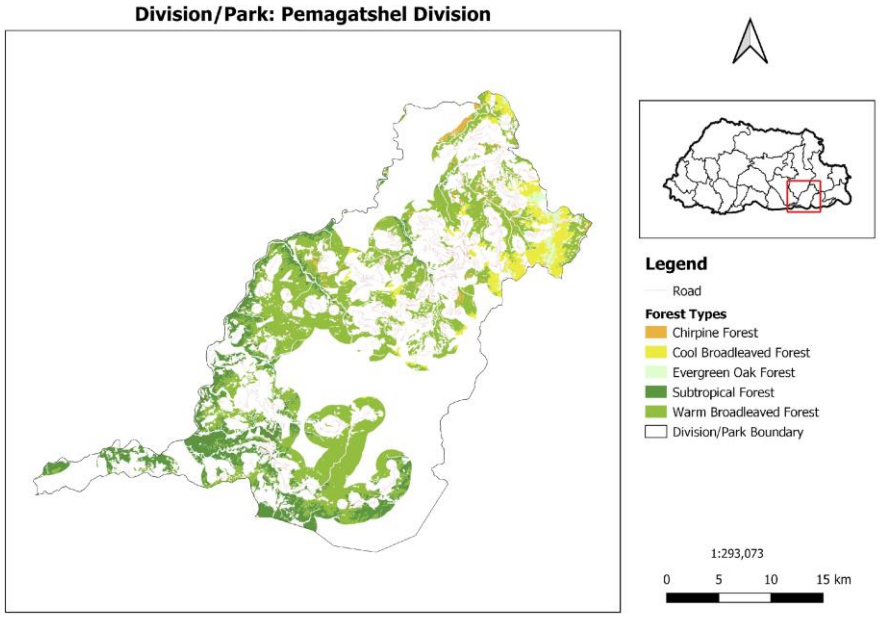
12.1.4 **Mongar Forest Division**



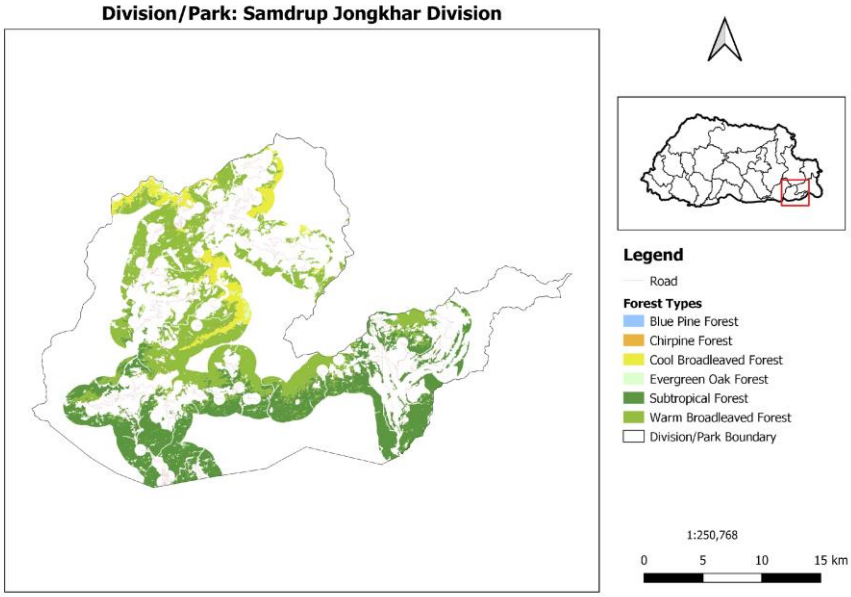
12.1.5 **Paro Forest Division**



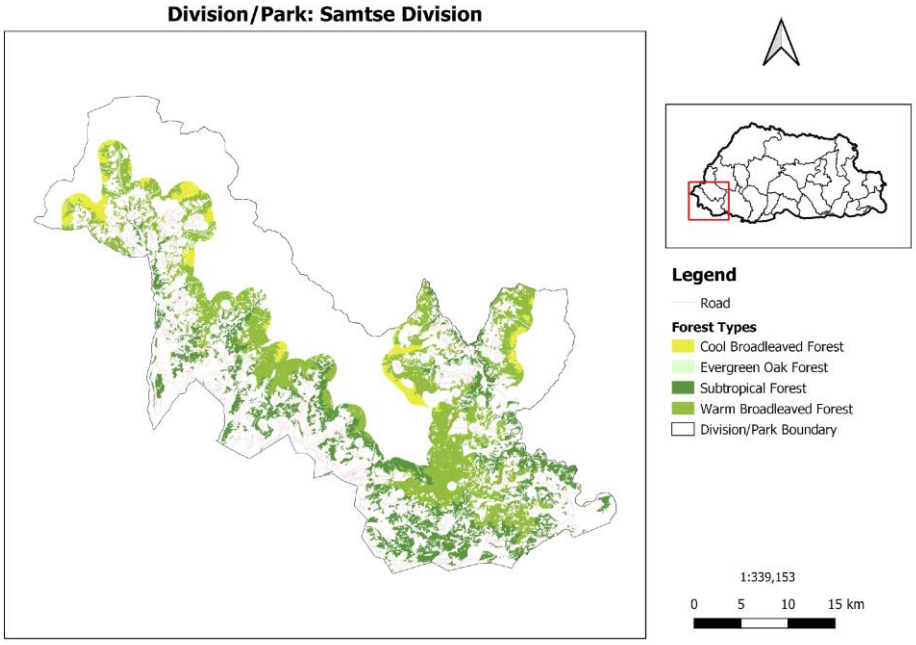
12.1.6 **Pemagatshel Forest Division**



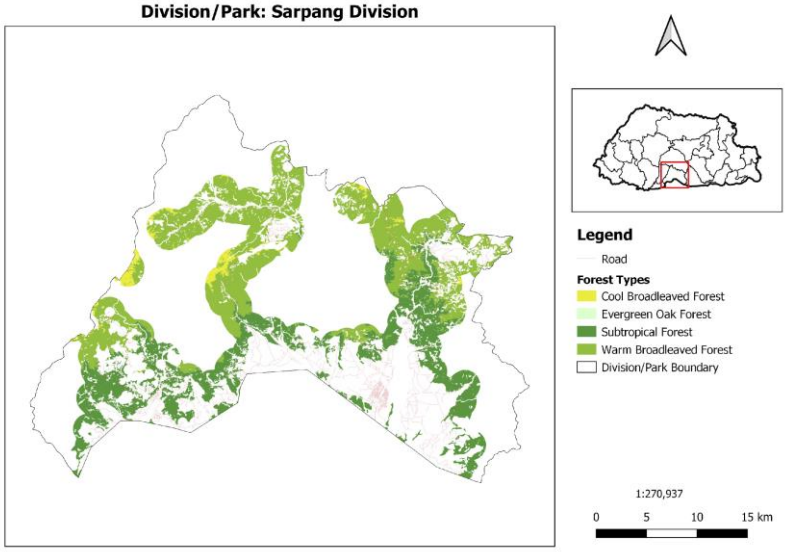
12.1.7 **Samdrup Jongkhar Forest Division**



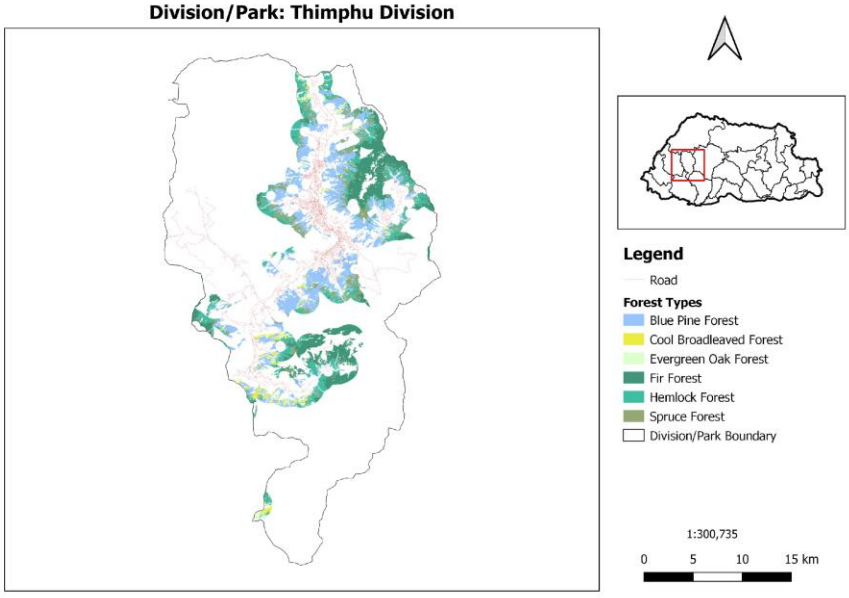
12.1.8 **Samtse Forest Division**



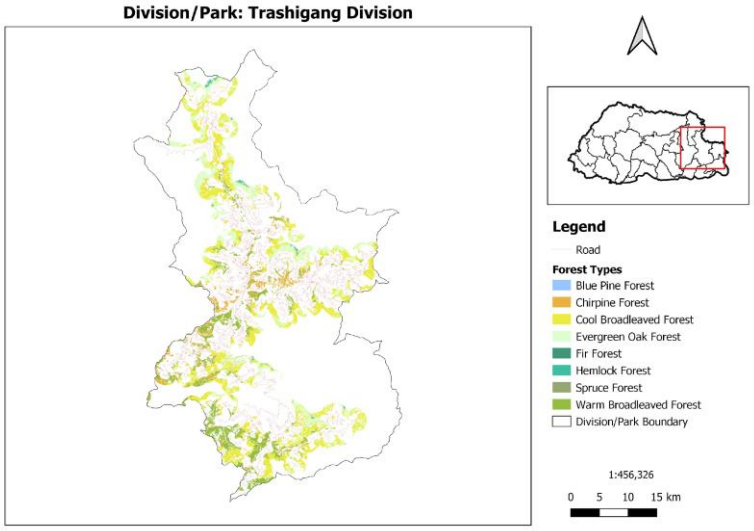
12.1.9 **Sarpang Forest Division**



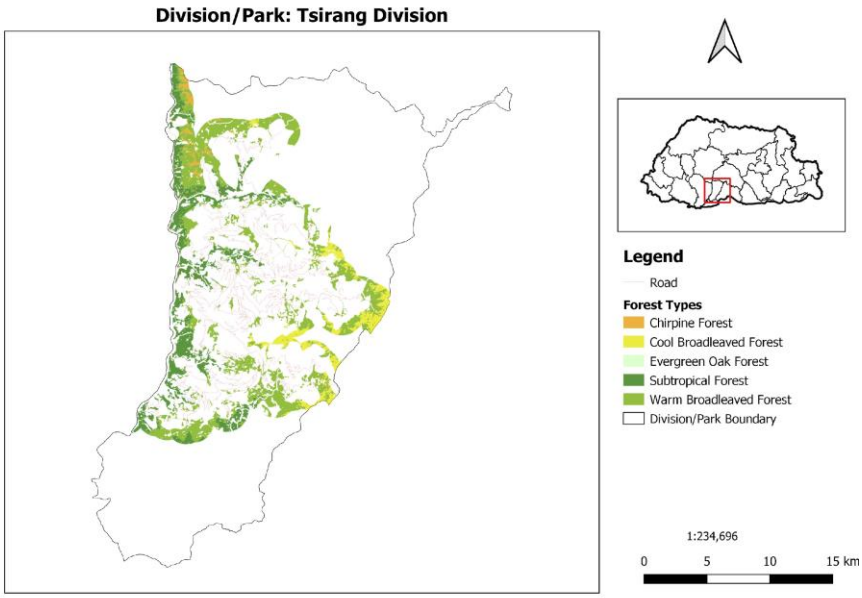
12.1.10 **Thimphu Forest Division**



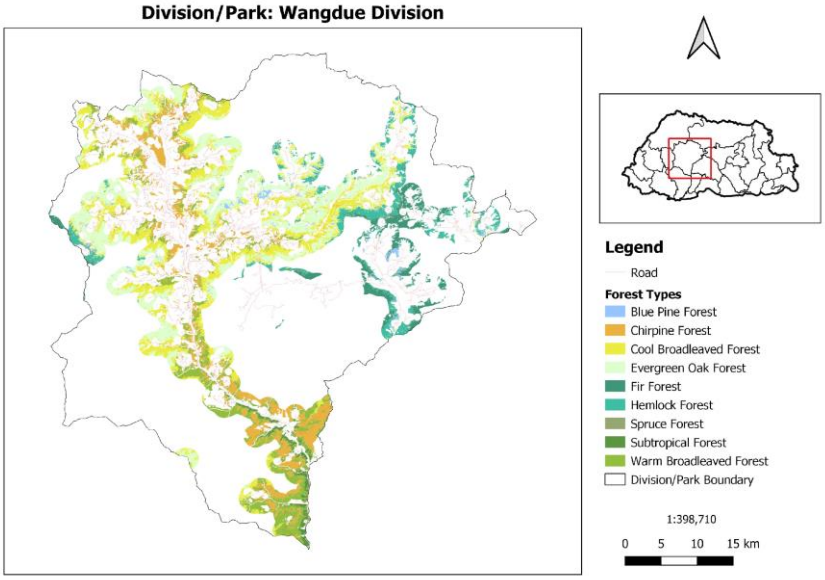
12.1.11 **Trashigang Forest Division**



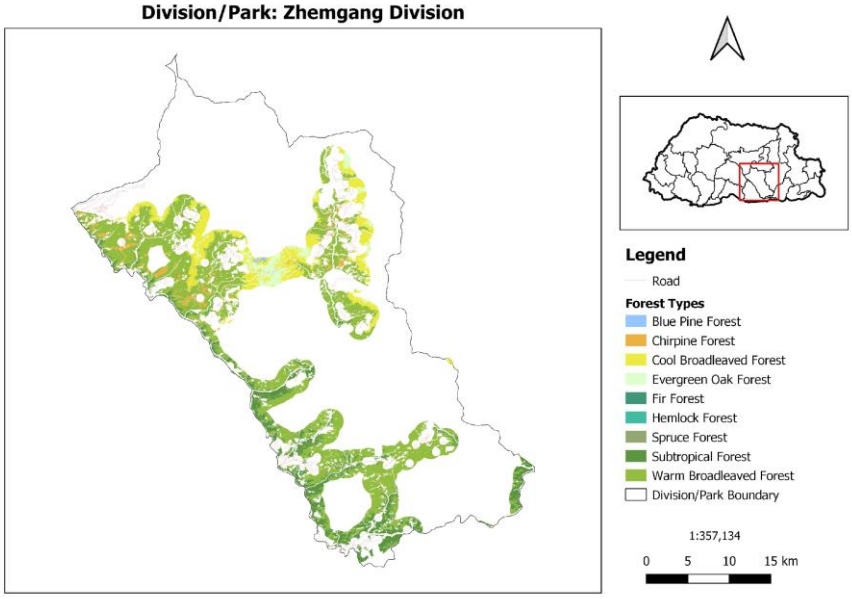
12.1.12 **Tsirang Forest Division**



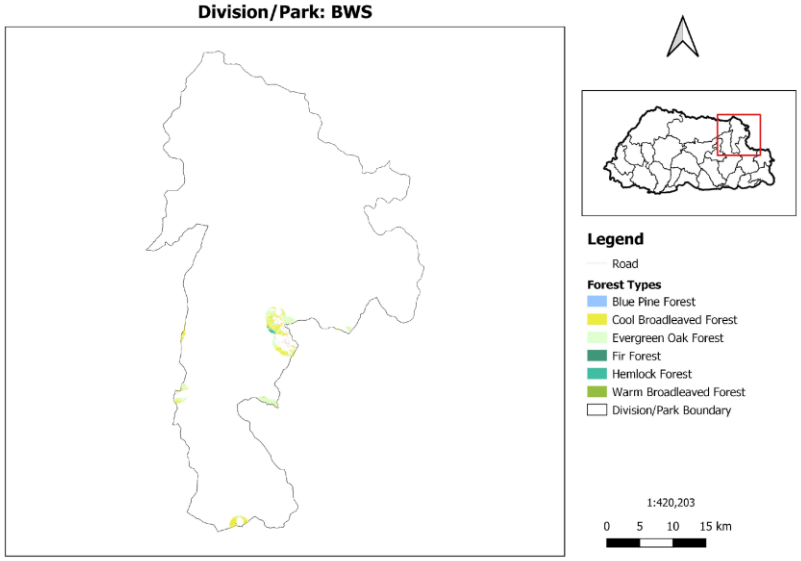
12.1.13 **Wangdue Forest Division**



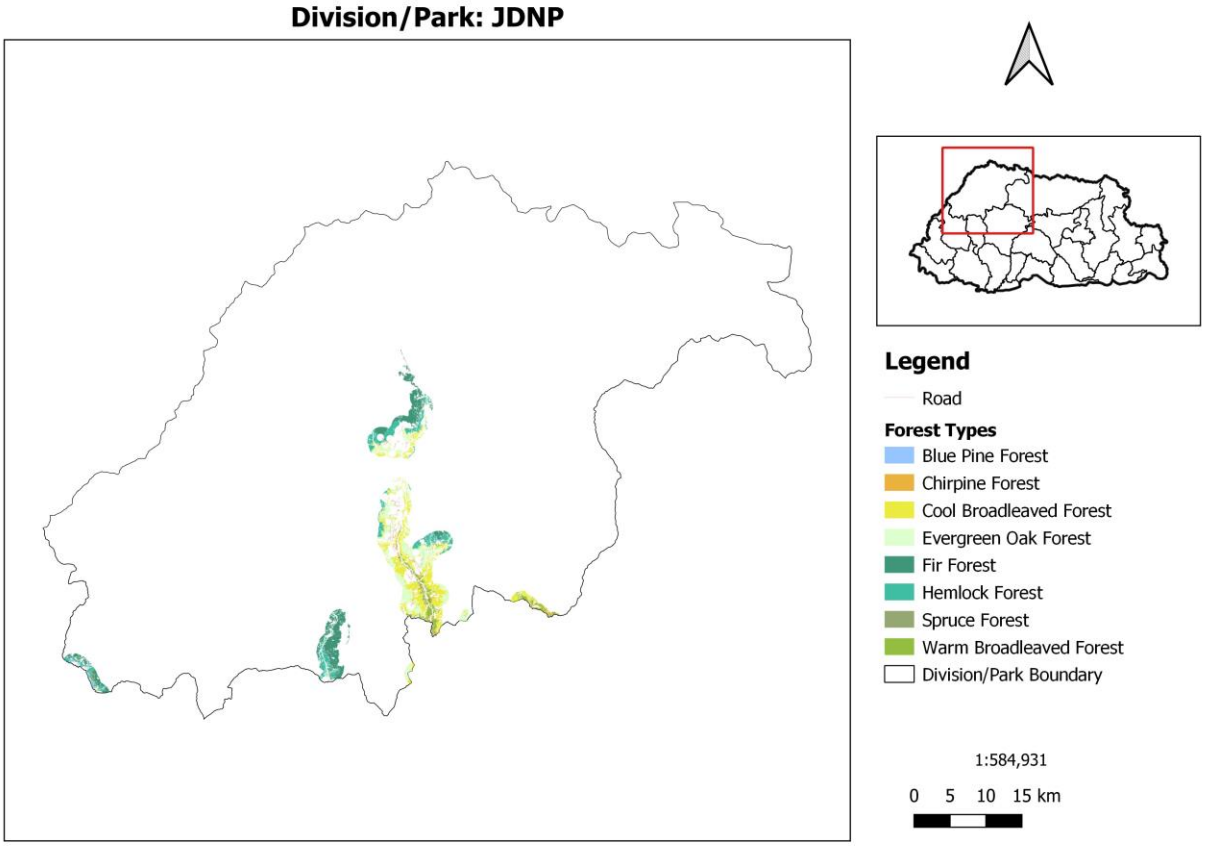
12.1.14 **Zhemgang Forest Division**



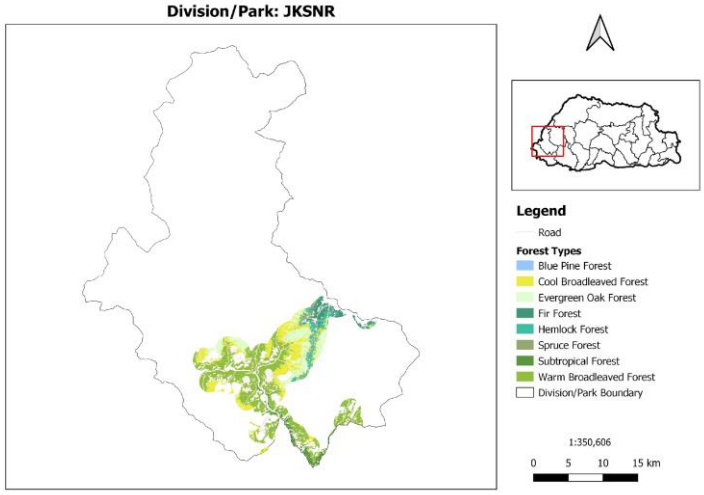
12.1.15 **Bumdeling Wildlife Sanctuary**



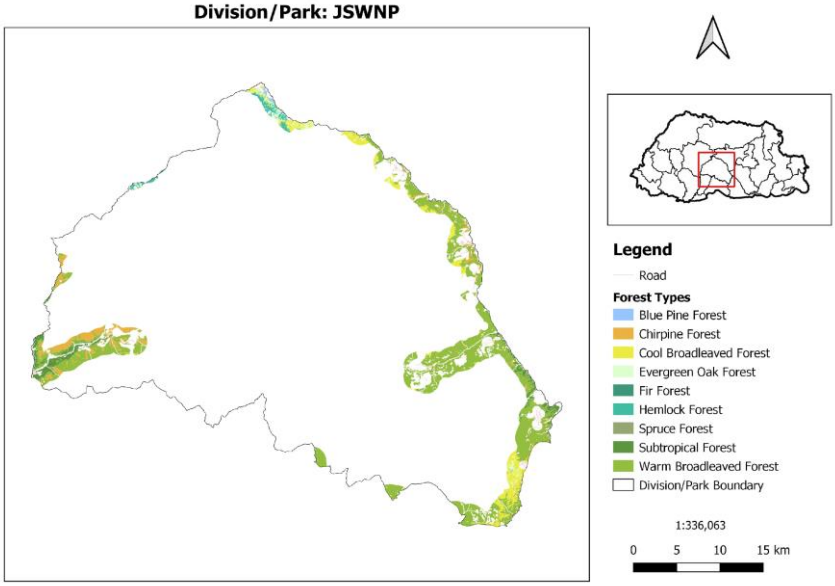
12.1.16 **Jigme Dorji National Park**



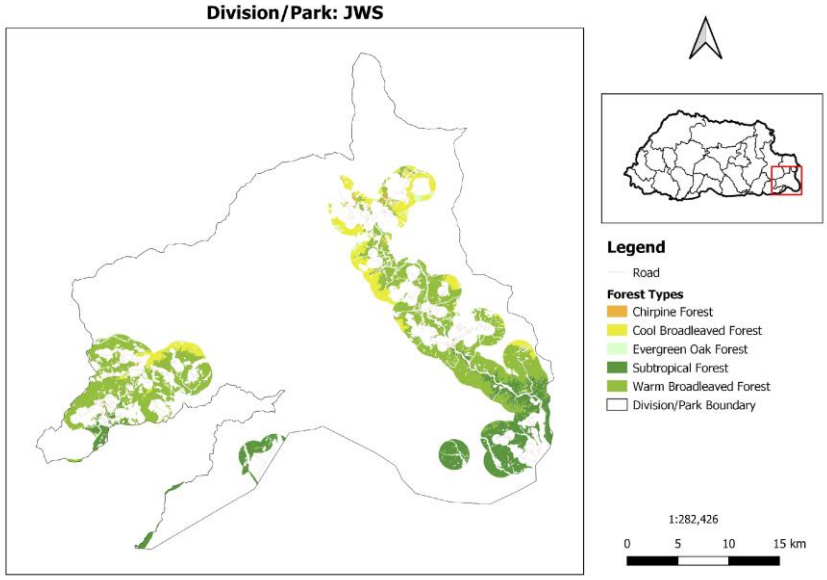
12.1.17 **Jigme Khesar Strict Nature Reserve**



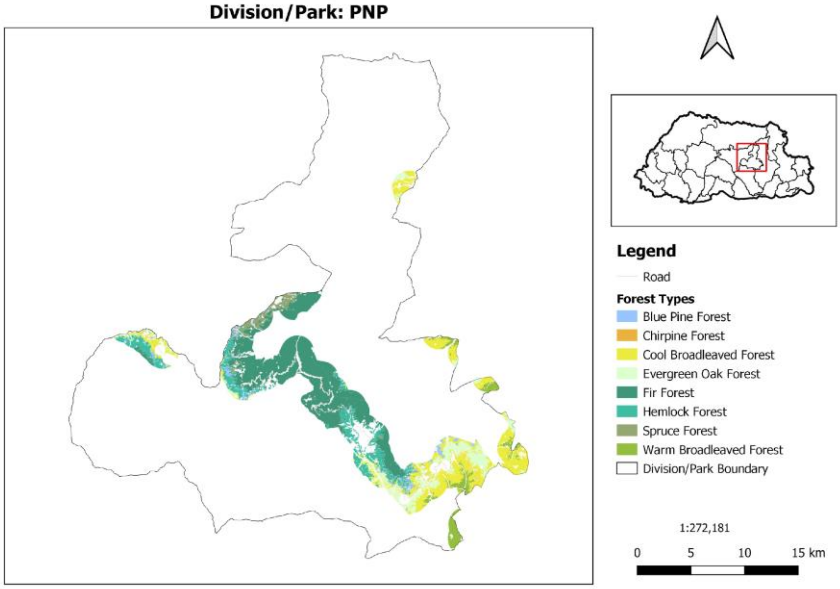
12.1.18 **Jigme Singye Wngchuck National Park**



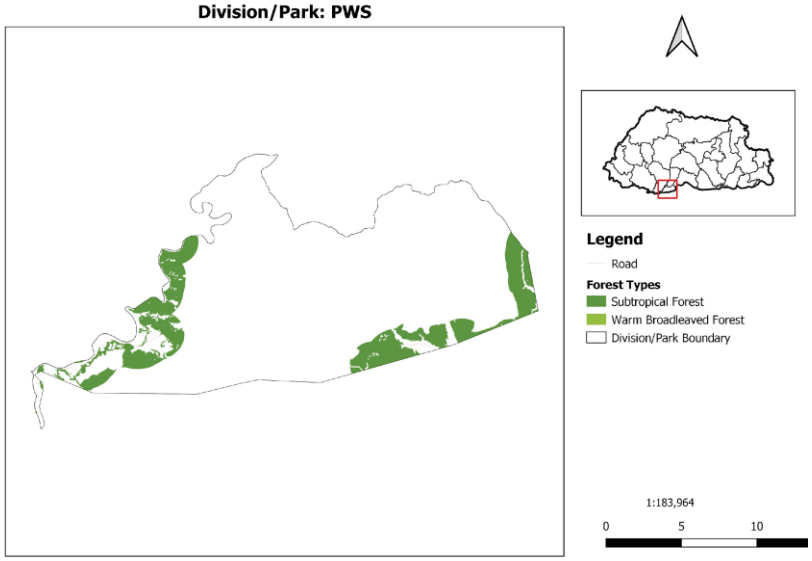
12.1.19 **Jomotshangkha Wildlife Sanctuary**



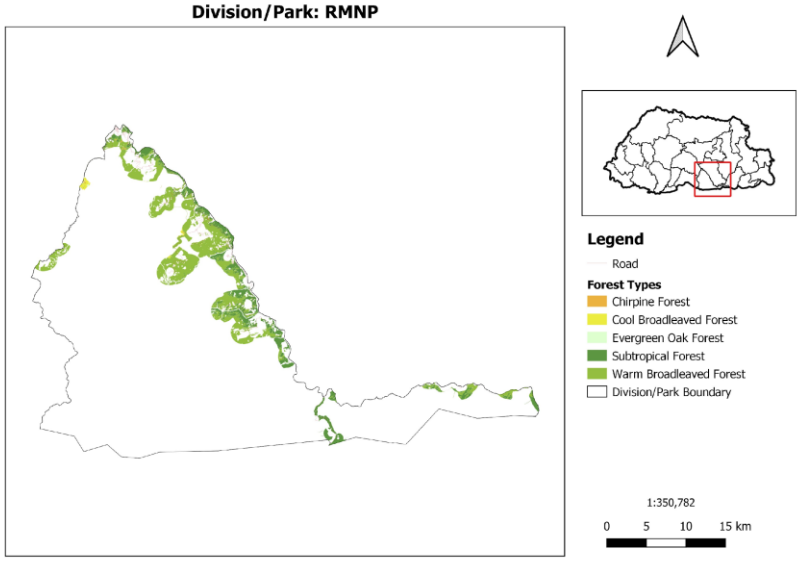
12.1.20 **Phrumsengla National Park**



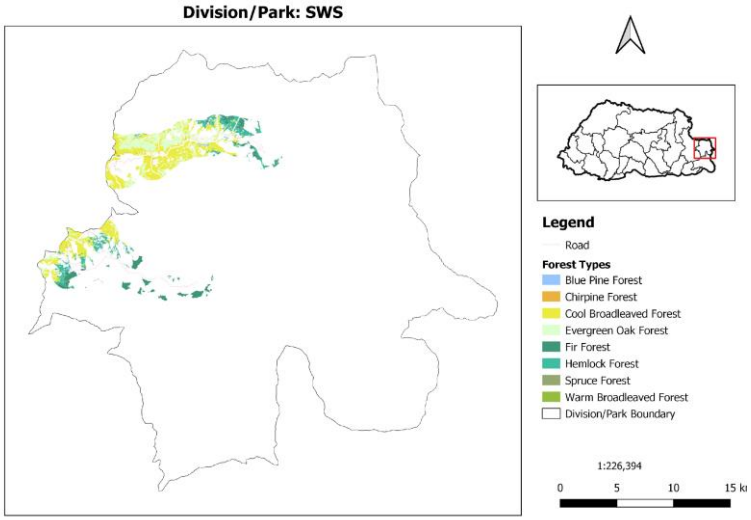
12.1.21 **Phibsoo Wildlife Sanctuary**



12.1.22 **Royal Manas National Park**



12.1.23 **Sakteng Wildlife Sanctuary**



12.1.24 **Wangchuck Centennial National Park**