

STUDY REPORT

**SOURCING STUDY ON PILOT
REGENERATIVE
INFRASTRUCTURE IN
BHUTAN**



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Prepared by:

Norbu Wangdi, PhD
Nawang Norbu, PhD



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<https://www.csfep.org>

Focal Contact:

Robyn van den Heuvel, Dalberg Catalyst
robyn.vandenheuvel@dalberg.com

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Acronyms

<i>AAC</i>	<i>Annual Allowable Cut</i>
<i>BT FEC</i>	<i>Bhutan Trust Fund for Environmental Conservation</i>
<i>CFO</i>	<i>Chief Forestry Officer</i>
<i>CLT</i>	<i>Cross Laminated Timber</i>
<i>CSFEP</i>	<i>Climate Smart Forest Economy Program</i>
<i>DoFPS</i>	<i>Department of Forests & Park Services</i>
<i>EIA</i>	<i>Environmental Impact Assessment</i>
<i>FMP</i>	<i>Forest Management Plan</i>
<i>FMU/s</i>	<i>Forest Management Unit/s</i>
<i>FNCA</i>	<i>Forest and Nature Conservation Act of Bhutan</i>
<i>FNCR</i>	<i>Forest and Nature Conservation Rules and Regulations</i>
<i>FRPMD</i>	<i>Forest Resources Planning and Management Division</i>
<i>GLT</i>	<i>Glue Laminated Timber</i>
<i>LG</i>	<i>Local Government</i>
<i>MoENR</i>	<i>Ministry of Energy & Natural Resources</i>
<i>NFP</i>	<i>National Forest Policy</i>
<i>NRDCL</i>	<i>Natural Resources Development Corporation Limited</i>
<i>NWFPs</i>	<i>Non- Wood Forest Products</i>
<i>PES</i>	<i>Payment for Ecosystem Services</i>

1. Background

Bhutan, a small landlocked country in South Asia, has made significant progress in implementing sustainable policies, including its commitment to remain a carbon-negative country. The Kingdom of Bhutan, under the leadership of His Majesty King Jigme Khesar Namgyel Wangchuck, has further called for the sustainable transformation of the urban construction sector. The steady urbanisation of the Thimphu-Paro region and its growing demand for housing and infrastructure has threatened both the natural ecosystems and national cultural heritage of its local landscapes. The sector's current reliance on extractive, mineral-based, and energy- and emissions-intensive building materials, means, and methods, on poorly performing urban construction assemblies and structural/architectural typologies, and on outsourced construction labour, management, and finance by non-Bhutanese building developers and workforces, has made Bhutanese city building both unaffordable and unsustainable. If such practices continue, the building sector will be unable to meet demand nor provide for the health, well-being, and livelihood of its urban citizenry, while contributing only marginally to the country's domestic economy. Moreover, the continuing operation and maintenance of building stock produced today will create ongoing technical and financial burdens only to serve as stranded assets in the foreseeable future.

Although Bhutan's abundant forest cover and constitutionally mandated forest protections serve to make this small country a global model of national carbon neutrality, the Bhutanese construction sector creates a significant counterforce to the country's perceived environmental health, its measurement of "gross national happiness" and His Majesty's vision for a deeply sustainable society.

To align building design and construction practice with that vision and to promote potential synergies between regenerative forestry, a robust building economy with minimal ecological impact, and the healthy growth and management of the country's cityscapes, Bhutan is exploring the feasibility of building sector transformation and development of an implementation strategy that would remap the building supply chain and reshape construction practice.

Bhutan is currently exploring the potential of creating a circular regenerative construction economy in Bhutan, fed by an expanding climate-smart forest economy.

To accomplish this, Bhutan is working with *Bauhaus Earth*, which is on a mission to see that buildings, cities and landscapes proactively contribute to climate restoration; global sustainable development consultancy, Arup and the *Climate Smart Forest Economy Program (CSFEP)*, which aims to realise the full climate potential of forests and forest products.

The Bauhaus Earth, Arup and the Climate Smart Forest Economy Program (CSFEP) have identified a pilot project for Bhutan" one of which is the construction of a six storied mixed-use commercial building that demonstrates the capacity to develop an alternative to the high emission producing, reinforced concrete designs that are typically used to supply the urban demand for buildings in Bhutan. This will also demonstrate the capacity of Bhutanese forests to sustainably, or even regeneratively, supply a building boom in Bhutan's cities. For this pilot project a total of 2010 m³ (~70982.48 cft) of timber requirement is estimated interms of glulam beams, columns and Nail laminated floor panels (see Table 1).

Table 1 Timber requirement for the pilot project (Arup, 2023)

Element	Material Volume
Glulam Columns	235 m ³
Glulam Beams & Rafters	650 m ³
Nail-laminated timber floor panels (235mm thick, constructed from 38mm wide x 235mm deep timber joists)	1125 m ³
TOTAL	2010 m³

This assessment will enable Climate Smart Forest Economy Program, Bauhaus Earth and Arup to better understand the sourcing potential, carbon footprints, and relevant safeguards for this project.

2. Research Questions

The following were the key research questions for the study:

- Given the pilot project designs and bill of materials, what are the expected sourcing demands?
- What are factors to be used to prioritise suppliers? i.e., cost, proximity (to minimize carbon impacts from sourcing), experience supplying similar markets, legal compliance, internal environmental safeguards?
- What are the environmental, ecological, and social considerations regarding sourcing?
- What are the key risks and mitigants related to sourcing of trees and reforestation for the initiative?
- What are the right species based on existing products and demand from the pilot project?
- What would be additional pressure on the forest regarding the rate of urbanization and the population growth?

3. Approach & Methods

For this study, a mixed-method approach was employed to gather data and information. Spatial data pertaining to land cover, roads, major towns, and sawmills were obtained from the Department of Forests and Park Services (DoFPS). The most recent Annual Allowable Cut (AAC) data, calculated by the DoFPS, was utilized. Additionally, secondary information was collected from technical reports previously published by the Department of Forests and Park Services and Natural Resources Development Corporation Limited (NRDCL) and other documents.

To further enhance the data collection process, an online survey was conducted to gather insights on the challenges and issues encountered during the pilot project in Bhutan. The gathered data and information were then subjected to validation through stakeholder consultative meetings with relevant stakeholders. This step ensured the accuracy and reliability of the collected data by incorporating diverse perspectives and expertise.

4. Findings

a. Resource Availability

i. Forest Management Units & Annual Allowable Cuts

As of February 2023, Bhutan operates 21 Forest Management Units (FMUs) across the country with a total Annual Allowable Cut (AAC) equivalent to 125,873 m³ (4,657,055 cft). See Table 1 and Figure 1.

Table 2 Forest Management Units, Year of Establishment and Annual Production Capacity

Sl. #	Name of FMU	Dzongkhag	Establishment Year	Total FMU area (Ha)	Total AAC(m ³)
1	Dawathang	Bumthang	2000	15,173.80	10,900.00
2	Rudongla		2002	14,686.58	14,999.00
3	Karshong		1994	6,008.54	7,700.00
4	Metapchhu	Chukha	2007	10,676.53	5,030.00
5	Haa East	Haa	1987	6,580.99	500.00
6	Lon Chhu		2010	12,664.49	6,300.00
7	Sele La		1997	9,155.72	9,230.00
8	Korila	Mongar	1993	13,137.00	3,800.00
9	Lingmithang		1997	10,490.00	9,400.00
10	Paro-Zonglela	Paro	1992	15,803.00	5,118.53
11	Bitekha		2006	7,260.10	4,500.00
12	Chamgang- Helela	Thimphu	1993	4,508.78	1,800.00
13	Gidakom		1977	13,100.00	7,400.00
14	Dongdechuu	Trashigang	2001	4,856.00	5,214.83
15	Chendebji	Trongsa	1996	7,852.98	6,700.00
16	Khotokha	Wangdue	1984	9,281.00	9,800.00
17	Gogona		2005	8,080.60	6,328.00
18	Wangdigang	Zhemgang	1992	8,759.00	2,100.00
19	Rongmanchu	Lhuntse	2007	6,403.13	3,200.00
20	Khaling Kharungla	Trashigang	1996	7,110.30	1,300.00
21	Khengzore	Pema Gatsel	2019	4,096.35	4,100.00
TOTAL				195,684.89	125,420.36

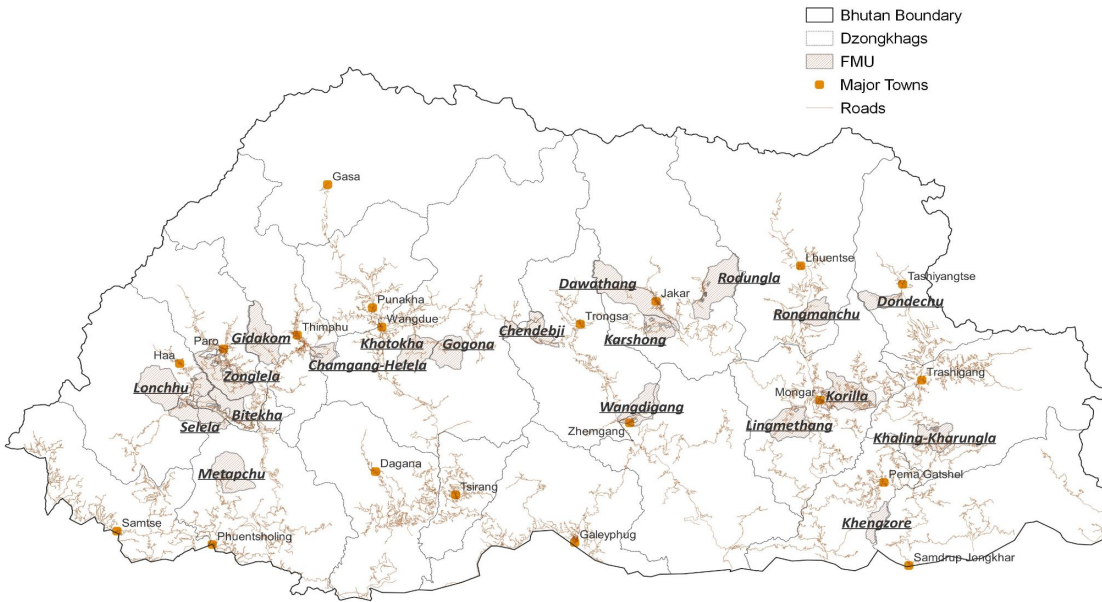


Figure 1 Location and distribution of FMUs across Bhutan

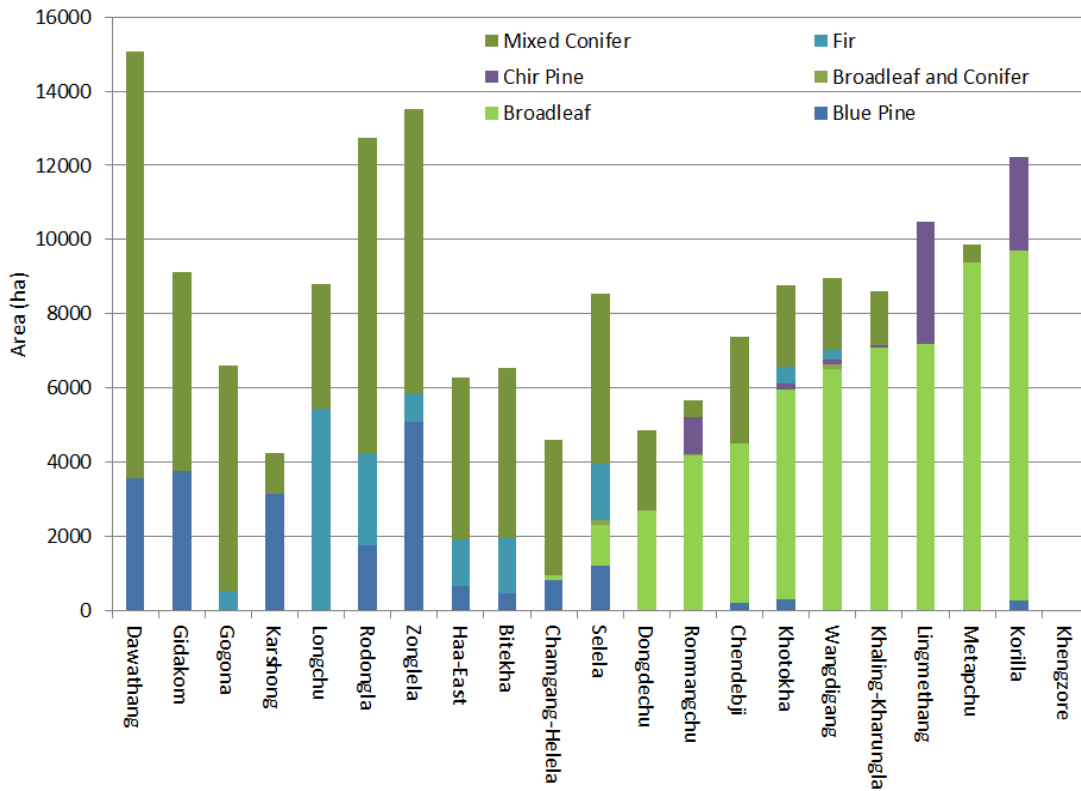


Figure 2 FMUs and forest composition

ii. Species & Dimensions

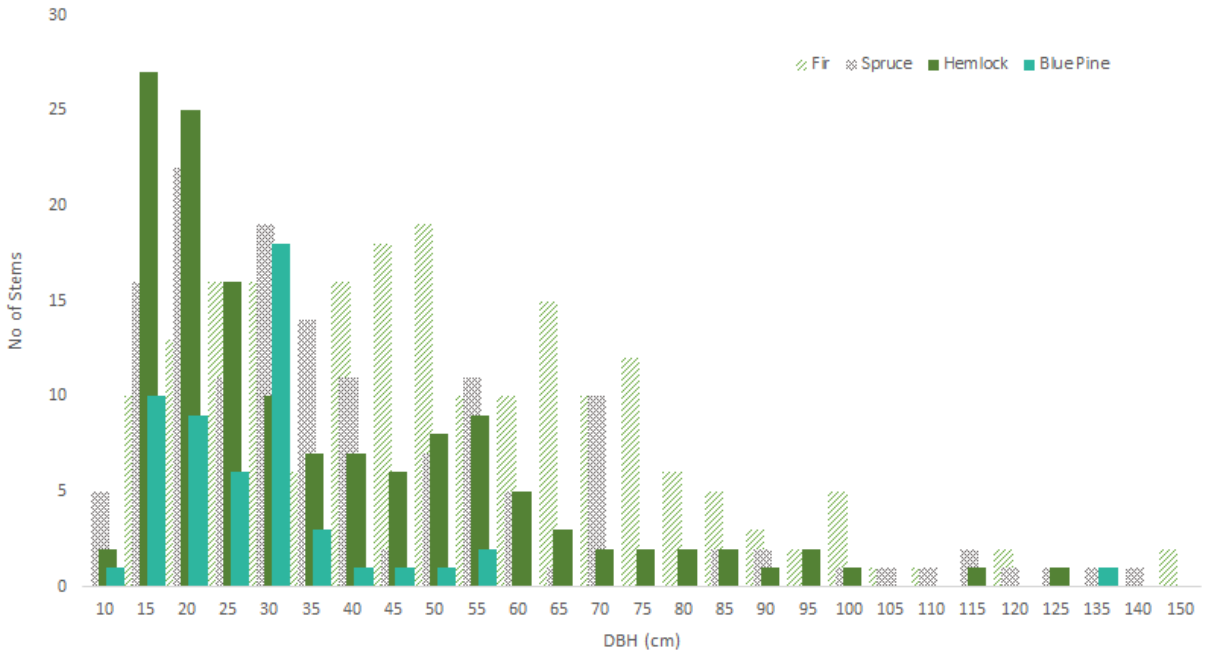


Figure 3 DBH distribution of Conifer species (Fir, Spruce, Hemlock and Bluepine) in Bitekha FMU

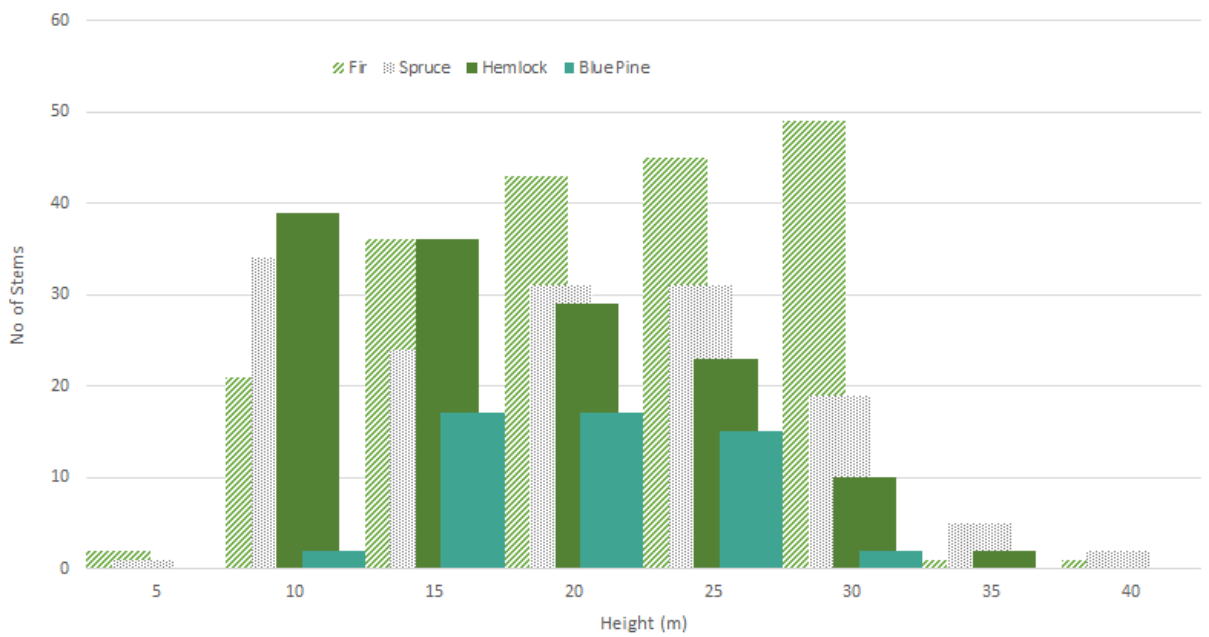


Figure 4 Height distribution and number of stems of Fir, Spruce, Hemlock, and blue pine in Bitekha FMU

b. Resource Access

i. Roads

Road infrastructure plays a crucial role in facilitating timber access and transportation from forested areas to processing facilities or markets. In Bhutan, where forests cover a significant portion of the country's land area, the construction and maintenance of roads in FMUs are important for sustainable forest management and the timber industry. Till date NRDCL has constructed around 751 Kms of road for timber, sand and stone extraction. Out of this, around 15 Kms is meant for sand and stone extraction purposes and the rest for timber activities. From the existing road network, 108 Kms is maintained by the Department of Roads, 174.41 is merged as farm road and 468.59 is maintained by NRDCL to carry out planned activities.

Many of these forest roads constructed by NRDCL for timber extraction in different regions are also planned to benefit the local communities, with positive socio-economic impacts to the local community. Such roads are maintained by NRDCL even after completion of operation. Owing to such obligations, the community expects new road construction and maintenance of inactive roads to make it smooth and pliable in all weather conditions, even if there are no commercial timber harvesting operations. Apart from the roads constructed by NRDCL, the company also contributes a certain amount annually towards maintenance of farm roads which are used for log transportation.

ii. Depots

Timber depots serve as central locations for the storage, processing, and distribution of timber harvested from forests. They play a crucial role in the timber supply chain and support sustainable forest management practices. A total of 30 depots have been established in Bhutan.

Table 3 Timber Depot and Location (Source: NRDCL, 2023)

SI No.	Depots & Location
1	Tshapey depot, Haa
2	Domtshangney Depot, Gidakom, Thimphu
3	Chelela Depot, Paro
4	Chunzom Depot, Paro
5	Ramtokto Depot, Thimphu
6	Khotokha Depot, Khotokha, Waangduephodrang
7	Gogona Depot, Khotokha, Wangduephodrang
8	Samthang, Depot, Samthang, Wangduephodrang
9	Tsirang Depot, Tsirang
10	Dagana Depot, Dagana

11	Chuteyganag Depot, Dawathang, Bumthang
12	Rabgang Depot, Karshong, Bumthang
13	Tang Depot, Rhodungla, Tang, Bumthang
14	Chendebji Depot, Chendebji, Trongsa
15	Homdor Depot, Zhemgang
16	Dhomkhar Depot, Uruk Sanitation, Chumey, Bumthang
17	Trongsa Depot, Trongsa
18	Menchugang Depot, Lingmithang, Monggar
19	Phawan Depot, Rongmanchu, Lhuentse
20	Korilla Depot, Monggar
21	Dongdechu Depot, Tashiyangste
22	Wamrong Depot, Wamrong, Trashigang
23	Khengzore Depot, Zhemgang
24	Samdrup Jongkhar Depot, Samdrupjongkhar
25	Nanglam depot, Nganglam, Pemagatshel
26	Buduney Depot, Samtse
27	Lhamoizingkha Depot, Sarpang
28	Ganglakha Depot, Gedu
29	Toorsa Depot, Phuntsholing
30	Gelephu depot, Gelephu, Sarpang



Figure 5 Rabgang Depot, Chumey, Bumthang

c. Available Technology

i. Harvesting

All commercial timber harvesting operations involves the utilization of fixed skyline cable cranes. This method employs a carefully planned and surveyed approach, where a narrow corridor is clear-felled to create an unobstructed pathway for the installation and operation of cable lines. The main objective is to ensure the safe and efficient establishment and functioning of the cable crane, adhering to technical requirements and conditions.

In a similar manner, utmost care is exercised during the felling of marked trees, ensuring they fall in the direction of the extraction corridor or the logging line opening. Once the felling is accomplished, the next step involves cross cutting the felled timber. To facilitate the transportation process, a long-distance cable crane is erected, enabling the lifting and conveyance of the timber to the nearest road head for subsequent transport to the nearby timber depot.

Additionally, various equipment such as skidders, mini-tower yarders, hydraulic loaders, and backhoe machines are employed in the dragging, loading, and movement of the timber. These tools are instrumental in transferring the timber from the extraction site to the closest road, as well as within the confines of the depot.

Some of the constraints of using cable cranes currently by NRDCL are as follows:

Terrain Limitations: Cable cranes are most effective in hilly or mountainous terrain, where they can be utilized for timber extraction from steep slopes. However, they may face challenges in extremely rugged or inaccessible terrains where setting up cable lines or anchoring points becomes difficult.

Limited Reach: Cable cranes have a limited reach and can only operate within a certain radius from the anchor points. This restricts their usage to specific areas and limits the coverage of timber harvesting operations. The cable cranes used in Bhutan are generally gravity systems and can have a logging range up to 1500 metres only.

Infrastructure Requirements: The installation and operation of cable cranes require the construction of strong anchor points and support structures. Building such infrastructure can be time-consuming and costly, especially in remote forested areas with limited access to transportation and resources.

Maintenance and Operation: Cable cranes require regular maintenance to ensure their optimal performance. The NRDCL or other operators need to allocate resources for maintenance activities such as cable inspection, tensioning, and replacement when necessary. Additionally, trained operators are required to operate cable cranes safely and efficiently.

Environmental Considerations: While cable cranes can be an environmentally friendly alternative to conventional timber extraction methods like bulldozers or skidders, they still have potential impacts on the surrounding environment. Care must be taken to minimize soil erosion, disturbance to flora and fauna, and other environmental concerns during cable crane operations.

Cost: The initial investment and ongoing operational costs associated with cable cranes can be significant. Procuring and maintaining cable crane equipment, constructing necessary infrastructure, training personnel, and conducting regular inspections and repairs can pose financial constraints.

Adoption of better timber harvesting technology and technique will increase efficiency in timber harvesting and enhance timber production without having to construct long distance forest roads in a particular area making it more viable to extract timber in an environment friendly manner. The existing equipment used by NRDCL is old and outdated.

Table 4 List of Machineries Available with NRDCL (Source: NRDCL, 2023)

Sl.#	Machine	Jakar	Zhonggar	Rinpung	P/ling	Sha Branch	Gelephu	IWPP*	Total	Remarks
1	Cable crane	6	2	5		1			14	
2	Mini cable			1					1	
3	Chainsaw (STHIL)	2	2	9	1		2	2	18	
4	Penz loader	3	2	3					8	
5	Telelogger	3	1	6				1	11	
6	Tractor Skidder			1					1	
7	Skidder			2					2	1-off-road
8	Pay loader		1			4	2		7	
9	Excavator		3		3	5	2		13	
10	Swing Yarder					1			1	
11	Backhoe	1	1	1			1		4	
12	Truck/Tipper		1			3			4	
13	Trailer					1			1	
14	Tractor	1	1	1		1			4	
15	DCM-Eicher							1	1	
16	Air compressor		1						1	
17	Joinery Machine Set		1						1	
18	Genset 125 kVA									
19	Sawmill		1					4	5	
20	Forklift							1	1	
	Total	16	17	29	4	16	7	9	98	

*IWPP : Integrated Wood Processing Plant, Ramtokto



Figure 7 Logging Site at Dawathang FMU, Bumthang



Figure 6 Skyline Cable Cranes at Dawathang FMU, Bumthang



Figure 8 Bell Tele Logger In Operation at Kharshong FMU, Bumthang

ii. Transportation

The common truck capacity for timber transportation in Bhutan is 10 cubic meters. Some of the challenges associated with the transportation of timber in Bhutan using trucks include:

1. **Road Conditions:** Bhutan's mountainous terrain and challenging road conditions pose significant challenges for timber transportation. Steep and narrow roads, inadequate road infrastructure, and difficult terrains can hinder the movement of trucks and increase the risk of accidents or delays.
2. **Seasonal Constraints:** Bhutan experiences monsoon seasons and harsh winter conditions that can further complicate timber transportation. Heavy rains can cause landslides and make roads impassable, while snowfall and icy conditions can restrict truck movements.
3. **Remote Locations:** Many forested areas in Bhutan are in remote or inaccessible regions. Transporting timber from these areas to processing facilities or markets requires navigating through challenging landscapes, which can increase logistical difficulties and transportation costs.
4. **Lack of Standardization:** The lack of standardized truck capacities and inconsistent regulations can pose challenges in ensuring efficient and safe timber transportation. In some cases, the size and weight restrictions imposed by road infrastructure and regulations may not align with the actual capacity requirements for timber transportation.
5. **Maintenance and Repair:** Maintaining a fleet of trucks for timber transportation requires regular maintenance, repair, and replacement of vehicles. Ensuring the availability of well-maintained trucks can be a challenge, especially in remote areas with limited access to repair facilities and spare parts.



Figure 9 Timber transportation by Trucks (10 m³ Capacity)



Figure 10 A Penz Loader at Chudzom Depot, Paro

iii. Sawing

Currently, records indicate a total of 136 sawmills and 6 integrated wood processing units spread across Bhutan. The maximum number of sawmills are concentrated in the Thimphu, Paro and Haa conifer forest belt. See Figure 11.

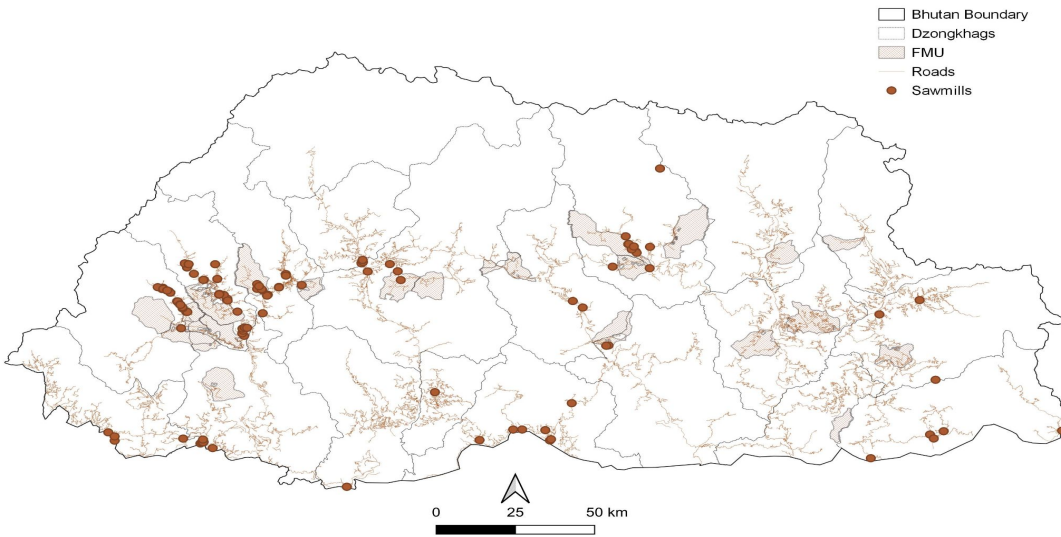


Figure 11 Map showing the location of sawmills in Bhutan (Data Source: DoFPS,2023)

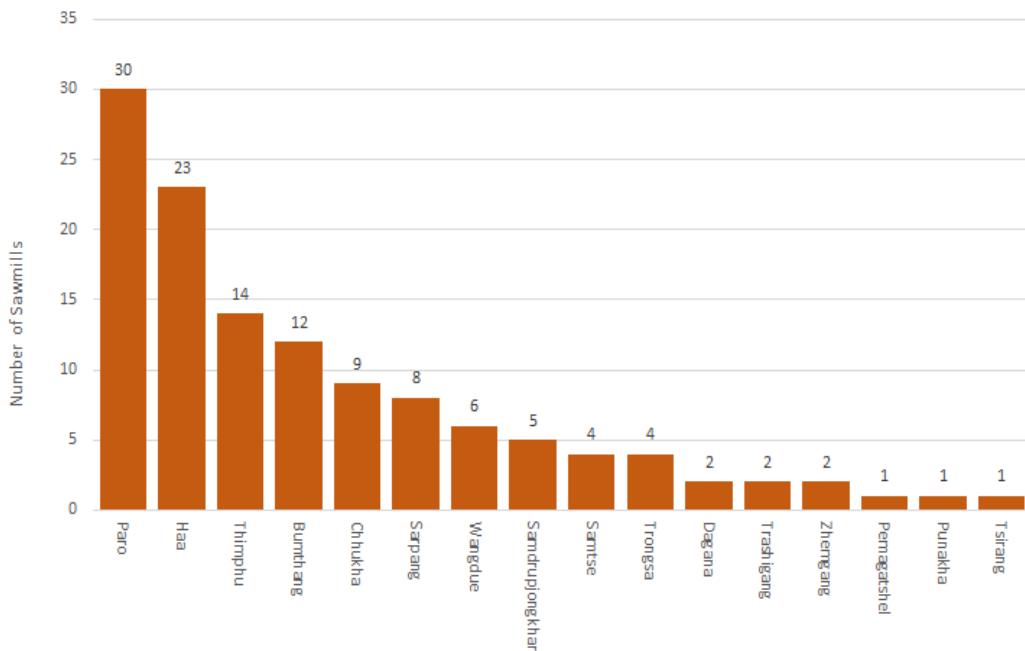


Figure 12 District wise distribution of Sawmills in Bhutan

Out of the total sawmills, 120 are stationary/fixed sawmills and 16 are mobile sawmills. These sawmills encompass a variety of types, including Indian sawmills, Wood-mizer, Timberking, Norwood, Mebor, Lucas, and Solee, which have been adopted by numerous sawmillers across the country.

The wood-based industries in Bhutan require approximately 588,000 cubic feet (cft) of raw materials monthly when operating at full capacity. However, the monthly timber production, including output from Forest Management Units, ad-hoc working sites, and privately registered lands, amounts to around 375,000 cft of logs. Consequently, there exists a substantial gap between the supply and demand of raw materials, resulting in many integrated wood industries operating below their full capacity. For instance, Ongdi Wood industry is currently functioning at only 20% of its capacity due to constraints in obtaining raw materials.

The sawing capacities of sawmills in Bhutan can vary significantly, depending on factors such as size, technology, and specific operations. Sawing capacity refers to the volume or quantity of timber that a sawmill can process or saw into various dimensions within a given time frame.

Sawmills in Bhutan exhibit a range of sizes and capacities, encompassing both small-scale and larger industrial operations. The sawing capacities can vary from a few cubic meters to several hundred cubic meters per day. The actual capacity is influenced by factors such as the type and efficiency of the sawing equipment, the workforce involved, and the operational practices employed.

iv. Post-processing & Storage

Post-processing and storage practices for timber are crucial to ensure the quality, preservation, and value of the harvested wood. These practices involve various activities and measures to prepare the timber for further use, prevent deterioration, and facilitate its long-term storage. Here are some common post-processing and storage practices for timber in Bhutan:

Seasoning: Seasoning, also known as drying, is a critical step in post-processing timber. It involves reducing the moisture content of freshly harvested wood to a level suitable for its intended use. Proper seasoning helps prevent warping, cracking, and fungal decay. Common methods of seasoning in Bhutan include air drying and kiln drying. Air drying involves stacking the timber in a well-ventilated area, allowing natural air circulation to gradually remove moisture. Kiln drying is a faster and controlled method that uses heat and airflow to accelerate the drying process. NRDC currently has seasoning capacity of **7250 cft** of timber per month which is very limited. Some of the seasoning equipment are non-functional and requires major maintenance (Table 5).

Grading and Sorting: After the timber is properly seasoned, it is graded and sorted based on various factors such as size, quality, and intended use. Grading involves assessing the strength, appearance, and other characteristics of the timber to determine its suitability for different applications. Sorting is done to categorise the timber based on dimensions and specifications, making it easier for customers to identify and select the desired pieces.

Treatment: Timber treatment is sometimes required to enhance its durability and resistance to pests, insects, and decay. Treatment methods may include chemical treatments, such as pressure treatment or dip treatment, to protect the timber against pests and fungal attacks. The treatment process ensures that the timber remains robust and usable over an extended period, particularly for outdoor or exposed applications.

Bundling and Packaging: Once the timber has been processed and graded, it is typically bundled or packaged for storage or transportation. Bundling involves tying or strapping timber pieces together to create manageable units for ease of handling. Packaging may include covering the timber with protective materials such as plastic sheets or wrapping it in a secure manner to safeguard it from external elements during storage or transportation.

Storage: Proper storage facilities are essential to maintain the quality and integrity of timber. Storage areas should be dry, well-ventilated, and protected from moisture, direct sunlight, pests, and other potential hazards. Timber is often stacked in an orderly manner to prevent damage and promote air circulation. Depending on the quantity and length of storage, covered sheds or warehouses may be used to provide additional protection.

Inventory Management: Effective inventory management practices are crucial for timber storage. Maintaining accurate records of the types, quantities, and conditions of timber in storage enables efficient tracking and retrieval when needed. This helps prevent stock shortages, minimize waste, and facilitate timely supply to customers.



Figure 13 High Frequency Wood Dryer, Integrated Wood Processing Plant, NRDC, Ramtokto, Thimphu

Table 5 Seasoning Equipment and Capacities with NRDC as of April 2023

#	Equipment	Location	Capacity (cft)	Monthly cycle	Monthly capacity (Cft)	Yearly capacity (Cft)	Current Status
1	TechnoXL Kiln	Ramtokto	1500	1	1500	18000	Functional
2	WoodTECH Kiln	Ramtokto	1500	1.5	2250	27000	Functional
3	SAGA Dryer	Ramtokto	400	2.5	1000	12000	Non-Functional
4	SAGA Dryer	Langjophakha	400	2.5	1000	12000	Non-Functional
5	TechnoXL Kiln	Lingmethang	1500	1	1500	18000	Non-Functional
				Total	7250	87000	

d. Costing

The timber price (sawn and logs) in Bhutan is regulated through a Government Executive Order issued in 2007. This regulation ensures that timber and timber products remain accessible, available, and affordable to all Bhutanese citizens. The Natural Resources Pricing Committee (NRPC), established under the same executive order, is responsible for reviewing, revising, and approving the timber prices, except for special class timber.

Table 5 provides the current prices of logs and sawn timber, which are the direct outputs from the sawmills. The price regulation applies only to these specific products. The latest timber prices fixed by the NRPC were notified in July 2020. For A Class conifer logs, the price ranges from 164.5 to 169.02 Nu/Cft, while B Class conifer logs range from 157.5 to 162.02 Nu/Cft. The price range for A Class broadleaf log is 134.5 to 144.46 Nu/Cft, and for B Class broadleaf logs, it is 127.5 to 137.46 Nu/Cft. It's important to note that the prices of logs vary according to the districts (dzongkhags) in Bhutan, as listed in the specific table (Table 5).

Sawn timber prices are higher compared to logs in Bhutan. For A Class conifer sawn timber, prices range from 334.74 to 402.99 Nu/Cft, while B Class conifer sawn timber is priced between 323.74 and 391.99 Nu/Cft. A Class broadleaf sawn timber ranges from 334.06 to 354.06 Nu/Cft, and B Class broadleaf timber is priced between 321.23 and 341.23 Nu/Cft.

In terms of dzongkhags (districts), Thimphu, Paro, and Haa have relatively lower prices for both conifer and broadleaf timber, while Dagana, Sarpang, and Samdrupjongkhar exhibit higher prices (as listed in Table 6).

The regulation of timber prices aims to maintain fairness and affordability for Bhutanese citizens, ensuring the sustainable management of timber resources while supporting the country's development goals. This price distinction reflects the market dynamics and factors influencing the production and availability of

sawn timber in Bhutan. The differential pricing aims to balance affordability and sustainability while considering regional variations in demand and supply.

It's important to note that the pricing of Glue Laminated Timber (GLT) and Cross Laminated Timber (CLT) is not governed by the Natural Resources Pricing Committee (NRPC). The pricing for these types of timber is at the discretion of the National Resources Development Corporation Limited (NRDCL).

Table 6 Dzongkhag wise Selling price of Commercial Logs (Nu/Cft) (NRPC, July 2020)

Sl.No	Dzongkhag	Conifer		Broadleaf	
		A Class	B Class	A Class	B Class
1	Thimphu	168.79	161.79	138.79	131.79
2	Paro	168.79	161.79	138.79	131.79
3	Haa	168.79	161.79	138.79	131.79
4	Wangdue	165.30	158.30	135.30	128.30
5	Gasa	165.30	158.30	135.30	128.30
6	Punakha	165.30	158.30	135.30	128.30
7	Tsirang	165.30	158.30	135.30	128.30
8	Dagana	165.30	158.30	135.30	128.30
9	Bumthang	169.02	162.02	139.02	132.02
10	Trongsa	169.02	162.02	139.02	132.02
11	Zhemgang	169.02	162.02	139.02	132.02
12	Sarpang	169.02	162.02	139.02	132.02
13	Chhukha	165.30	158.30	144.46	137.46
14	Samtse	165.30	158.30	144.46	137.46
15	Monggar	164.50	157.50	134.50	127.50
16	Lhuentse	164.50	157.50	134.50	127.50
17	Trashiyangtse	164.50	157.50	134.50	127.50
18	Tashigang	164.50	157.50	134.50	127.50
19	Samdrupjongkhar	164.50	157.50	134.50	127.50
20	Pemagatshel	164.50	157.50	134.50	127.50

Table 7 Dzongkhag wise Selling rates of Sawn Timber (Nu./Cft) (NRPC, July 2020).

Sl.No	Dzongkhag	Conifer		Broadleaf	
		A Class	B Class	A Class	B Class
1	Thimphu	377.94	366.94	342.39	329.55
2	Paro	340.62	329.62	342.39	329.55
3	Haa	340.62	329.62	342.39	329.55
4	Wangdue	353.60	342.60	357.53	344.70
5	Gasa	353.60	342.60	357.53	344.70
6	Punakha	353.60	342.60	357.53	344.70
7	Tsirang	353.60	342.60	357.53	344.70
8	Dagana	353.60	342.60	357.53	344.70
9	Bumthang	340.98	329.98	342.81	329.98
10	Trongsa	340.98	329.98	342.81	329.98
11	Zhemgang	340.98	329.98	342.81	329.98
12	Sarpang	382.23	371.23	342.81	329.98
13	Chhukha	388.17	377.17	423.83	410.99
14	Samtse	388.17	377.17	423.83	410.99
15	Monggar	379.05	368.05	342.40	329.57
16	Lhuentse	379.05	368.05	342.40	329.57
17	Trashiyangtse	379.05	368.05	342.40	329.57
18	Tashigang	394.77	383.77	345.98	333.14
19	Samdrupjongkhar	394.77	383.77	342.40	329.57
20	Pemagatshel	394.77	383.77	342.40	329.57

Table 8 Selling price of Poles (Nu/Cft) (NRPC, July 2020)

Sl.No	Dzongkhag	Conifer		Broadleaf	
		A Class	B Class	A Class	B Class
1	Thimphu	128.79	121.79	98.79	91.79

2	Paro	128.79	121.79	98.79	91.79
3	Haa	128.79	121.79	98.79	91.79
4	Wangdue	125.30	118.30	95.30	88.30
5	Gasa	125.30	118.30	95.30	88.30
6	Punakha	125.30	118.30	95.30	88.30
7	Tsirang	125.30	118.30	95.30	88.30
8	Dagana	125.30	118.30	95.30	88.30
9	Bumthang	129.02	122.02	99.02	92.02
10	Trongsa	129.02	122.02	99.02	92.02
11	Zhemgang	129.02	122.02	99.02	92.02
12	Sarpang	129.02	122.02	99.02	92.02
13	Chhukha	125.30	118.30	104.46	97.46
14	Samtse	125.30	118.30	104.46	97.46
15	Monggar	124.50	117.50	94.50	87.50
16	Lhuentse	124.50	117.50	94.50	87.50
17	Trashiyangtse	124.50	117.50	94.50	87.50
18	Tashigang	124.50	117.50	94.50	87.50
19	Samdrupjongkhar	124.50	117.50	94.50	87.50
20	Pemagatshel	124.50	117.50	94.50	87.50

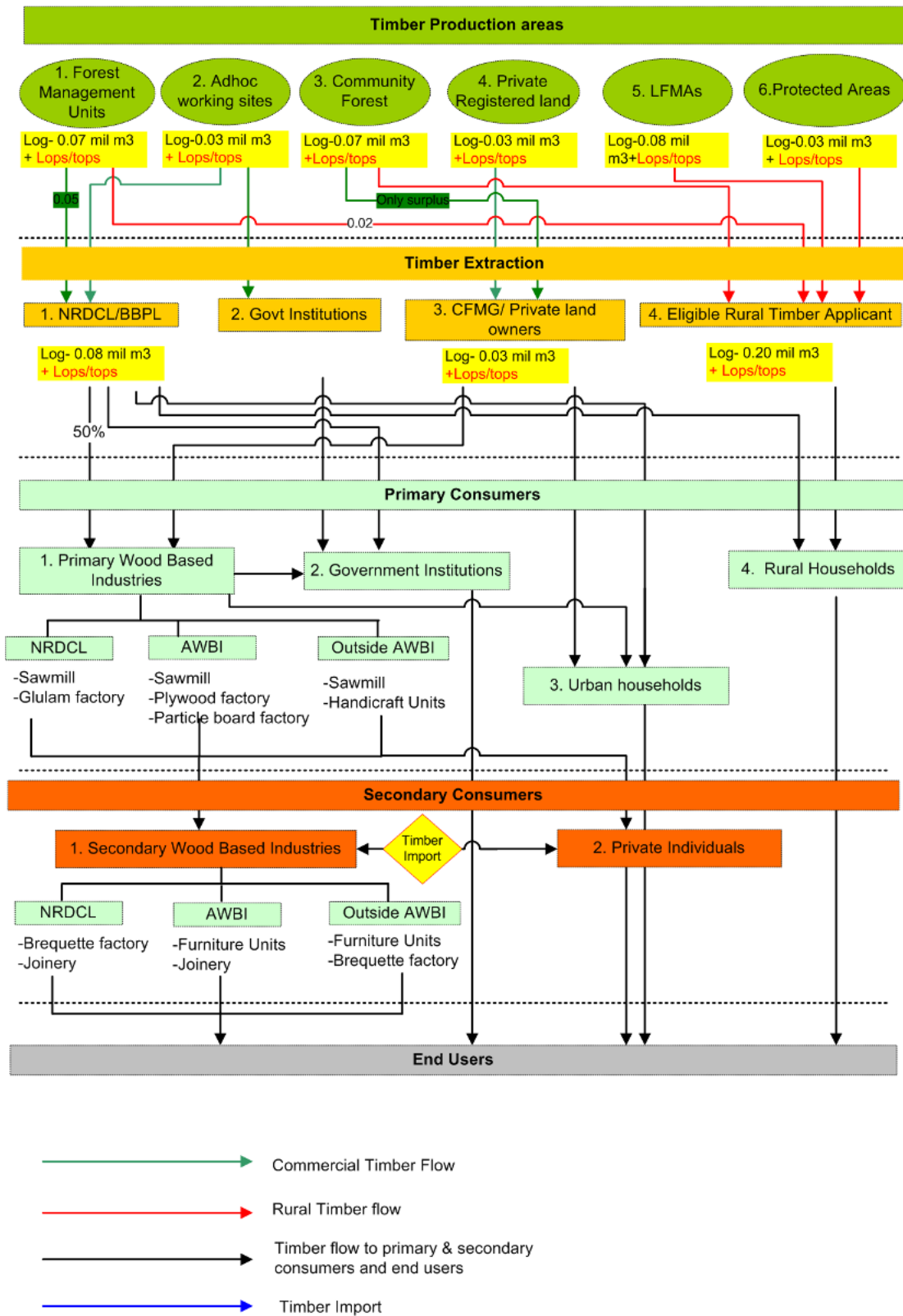


Figure 14 Timber Supply Chain (Values are Average of 5 years 2015-2019) (DoFPS 2020)

e. Resource Governance Issues

i. Policy & Legislations

For centuries, the people of Bhutan have coexisted harmoniously with their forests and environment. The forests were traditionally viewed as a shared resource, and individuals exercised their customary rights to utilize these resources. The *Thrimzhung Chenmo* of 1957 acknowledged the open access use of forest resources, with certain restrictions imposed on hunting and poaching activities.

However, the perception of forests as a common property led to unauthorized logging and encroachment on forest land, placing immense pressure on the forest ecosystem. Recognizing the significance of "protecting, conserving, and scientifically managing the forests of Bhutan," the Bhutan Forest Act (BFA) of 1969 was enacted by the National Assembly. This legislation marked a pivotal moment in the evolution of forestry practices in Bhutan.

Since then, a chronological progression of legal frameworks has shaped forestry and its practices in Bhutan. The following outlines the sequential development of these legal frameworks over time:

Bhutan Forest Act (1969)

The Bhutan Forest Act of 1969 played a significant role in the management of forest resources in Bhutan. The act encompassed the nationalization of land that lacked permanent heritable and transferable rights of use and occupancy, designating such land as forest. Additionally, the act outlined directives pertaining to forest rights, utilization, royalty rates, and penalties (FAO 2006).

A crucial provision of the act was the mandate that at least 60% of Bhutan's total land area should be always maintained as forested land for all times. This provision reflects the country's commitment to the conservation and preservation of its forests, ensuring the sustainability of forest resources and the associated benefits they provide to both the environment and society.

National Forest Policy (1974)

The National Forest Policy of 1974 stands as one of the earliest policies approved by the Bhutanese Government. It serves the dual purpose of conserving and protecting the forests to generate revenue for the country, aligning with the objectives of the National Economic Policy. Additionally, the policy emphasizes the need to always maintain a minimum forest cover of 60%. It explicitly states that measures will be undertaken to increase forest cover if it falls below the stipulated percentage, but the excess forest cover should never be compromised or sacrificed.

The policy's notable achievements include its emphasis on afforestation and discouragement of shifting cultivation practices. However, the passage of time and rapid socio-economic development necessitated a revision of the policy, leading to the drafting of a revised National Forest Policy in 1991. After extensive deliberation and refinement, the revised policy was finally passed in 2011.

The National Forest Policy of 2011 not only reinforced the objectives of forest conservation and revenue generation but also introduced clear definitions for National Parks and Wildlife Sanctuaries. It empowered the Department of Forests to establish rules and regulations governing these protected areas, thereby enhancing their management and conservation efforts.

Timber Pricing and Marketing Policy (1999)

In 1999, the Royal Government of Bhutan (RGoB) implemented a new timber pricing policy aimed at boosting timber supply and reducing prices in the market. As part of this policy, the export of timber, both in round and sawn form, was prohibited. Subsequently, in 2000, an additional ban on the export of semi-finished wood products was introduced. These policy measures had a direct influence on the quantity and pricing of timber within the market.

Forest and Nature Conservation Act (1995)

The National Forest Act 1953 was repealed and ratified in 1995. The Forest and Nature Conservation Act 1995 identified and outlined the requirement of management plan for production and protection of forest and wildlife. Emphasis was given to community and social forestry and encouraged the participation of community and private individuals. It also recognised the traditional and cultural rights of local people to access and use of forest resources.

Forest and Nature Conservation Rules (FNCR) 2000, revised 2003

The FNCR 2000, revised 2003 was approved and circulated to implement and exercise the power and duties vested by the FNCA 1995. The act defines the Forest Management Unit (FMU) and the requirement of forest management plan for FMU.

Forest and Nature Conservation Rules 2006

The Forest and Nature Conservation Rules (FNCR) 2006 was formulated to implement the provisions of the FNCA 1995. The FNCR 2006 issued authority and provisions for the preparation of management plans for FMUs, CF and NWFP groups.

Land Act of Bhutan (2007)

The Land Act of Bhutan, enacted in 2007, holds significant implications for tree ownership and land rights. Under this act, ownership of all trees, whether naturally grown or planted, within registered land is granted to the landowner. Additionally, the act includes provisions for leasing State Reserved Forest (SRF) land for various developmental purposes, including *tsamdros* (grazing land) and *sokshings* (collection forest). However, the rights to *tsamdros* and *sokshings* shall ultimately revert to the Government.

To ensure fairness, the traditional right holders of *tsamdros* and *sokshings* are given preference for leasing SRF land, provided they meet other criteria outlined in the act. This approach aims to protect and prioritize the rights of individuals with established customary claims to these specific resources. The management of *sokshings* and *tsamdros* is required to adhere to a management plan, ensuring sustainable practices and appropriate utilization of these areas.

Constitution of the Kingdom of Bhutan (2008)

The Constitution of the Kingdom of Bhutan, adopted in 2008, stands as one of the pioneering constitutions worldwide to incorporate an article dedicated to the environment. This constitutional provision underscores the importance of maintaining a minimum forest cover of 60% for perpetuity. Furthermore, the Constitution entrusts all Bhutanese citizens with the responsibility of protecting, conserving, and sustainably managing the State Reserved Forest (SRF) for the benefit of present and future generations.

National Forest Policy (2011)

The formulation of the National Forest Policy in 2011 was a response to the changing times and the evolving management practices of State Reserved Forest Lands in Bhutan. This policy was designed to ensure the sustainable management of Bhutan's forests and biodiversity for the well-being of its people, considering both social and economic considerations, while upholding the constitutional mandate of maintaining a minimum forest cover of 60%.

The National Forest Policy encompasses various management regimes to address different forest ecosystems and conservation needs. It also recognizes the significance of forest-based industries and emphasizes the importance of proper utilization and marketing practices. The policy aims to foster the development of the private sector and rural communities by promoting sustainable and responsible utilization of forest resources. By striking a balance between conservation efforts and the socio-economic needs of the country, the National Forest Policy aims to safeguard Bhutan's forests for future generations.

Forest and Nature Conservation Rules and Regulations (2017)

Various amendments to the FNCR 2003 have been done over the year due to changing times and to implement the NFP 2011. Further, a separate amendment to the FNCRR 2003 due to the adoption of the revised rule for the rural timber allotment as part of the Government to citizen services was implemented. Therefore, the FNCRR 2017 was a compilation of all such amendments and to implement provisions of the NFP 2011.

Forest and Nature Conservation Bill (2021)

The Forest and Nature Conservation Act of 1995 is under revision and aims to address the need for updated legislation in line with current environmental priorities. The Forest and Nature Conservation Bill seeks to protect Bhutan's rich flora and fauna while promoting ecologically balanced development and ensuring equitable access to forest resources.

The revised bill recognizes the importance of enhancing the capacity of forests to mitigate and adapt to climate change, as well as supporting socio-economic activities. It considers the need for alignment with existing national legislations, including the Constitution, Penal Code, and acts such as Land, Mines and Minerals, and Water Acts. Furthermore, the bill ensures compliance with international commitments and obligations.

This amendment process also incorporates provisions from the National Forest Policy of 2011, aiming to implement its objectives effectively. By revising the Forest and Nature Conservation Act, Bhutan seeks to

uphold its constitutional requirement of maintaining a minimum forest cover of 60% for the long-term preservation and sustainable management of its forests.

These legal frameworks have played a crucial role in shaping Bhutan's approach to forestry and guiding sustainable forest management practices. They reflect the country's commitment to balancing environmental conservation with the socio-economic well-being of its people.

ii. Planning

Over the years, Forest Management Planning in Bhutan has undergone significant advancements since the establishment of the first working scheme in 1963-64 by the working plan division. This division has gradually evolved into the Forest Resources Management Division, and currently, it is known as the Forest Resources Planning and Management Division (FRPMD). The FRPMD plays a crucial role in providing technical support for sustainable forest management programs across the country.

Initially, the working plan division prepared management plans for Forest Management Units (FMUs) and forwarded them to field divisions for implementation within their respective jurisdictions. However, in 2015, the Department decentralized the preparation of management plans by enhancing the capacity of field offices. This led to the transfer of responsibility for management plan preparation to the respective divisions.

The FMUs are managed according to written management plans that adhere to the provisions outlined in the "Forest Management Code of Bhutan" in 2004 and the revised "Forest and Nature Conservation Code of Best Management Practices of Bhutan - 2021". These plans consider factors such as the growing stock and prescribe the annual allowable cut for both rural and commercial timber.

The Forests Resource Potential Assessment Report (FRPA) 2013, identifies potential areas for production forest. The creation of an FMU involves a series of processes, starting from reconnaissance surveys and culminating in the implementation of the management plan. The overall framework for this process is illustrated in the Figure 15 below:

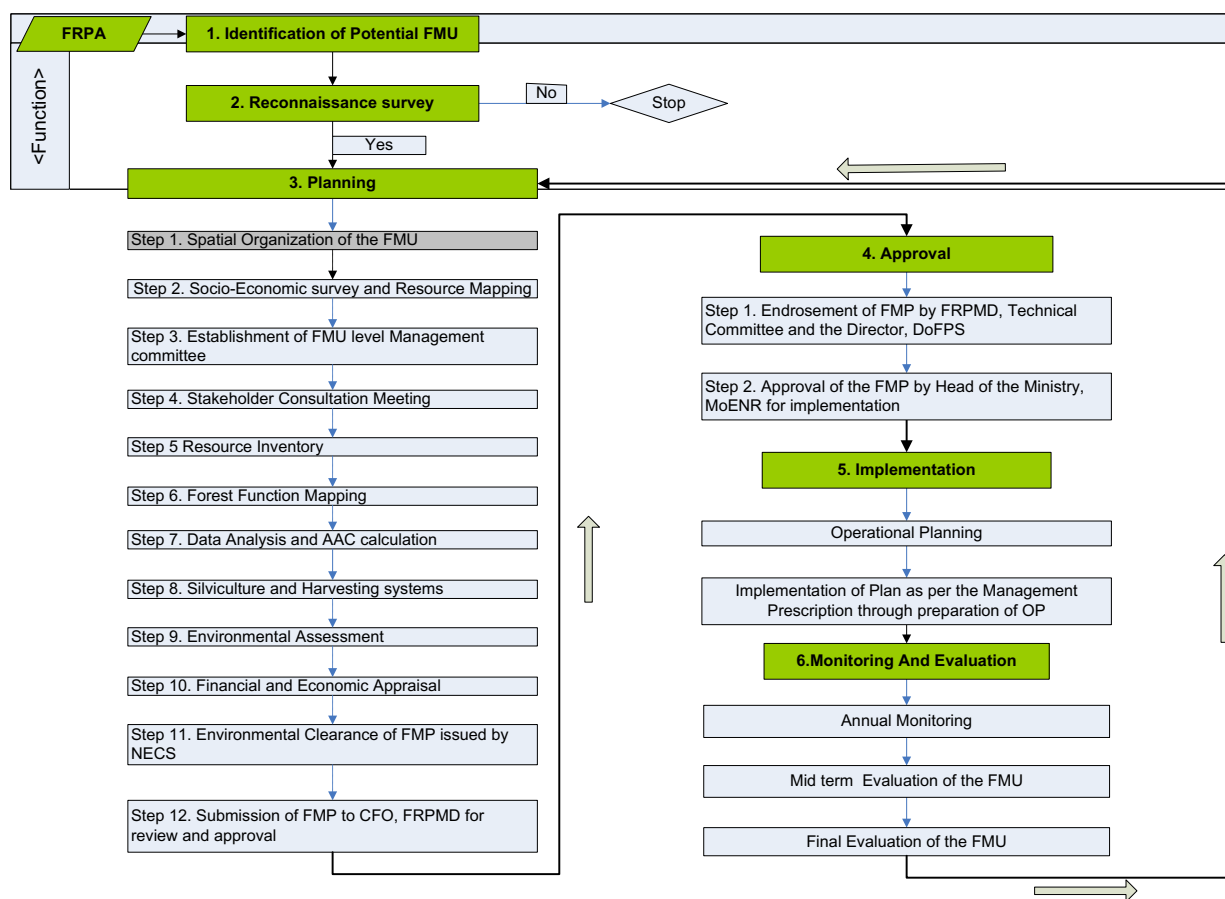


Figure 15 The FMU Planning Process (Forest and Nature Conservation Code of Best Management Practices of Bhutan 2021)

The Forest Management Unit (FMU) planning process in Bhutan involves a series of steps to develop comprehensive plans for sustainable forest management. The following is an outline of the FMU planning process:

Stakeholder Engagement: The planning process begins with the engagement of relevant stakeholders, including local communities, government agencies, non-governmental organizations (NGOs), and other key actors. This participatory approach ensures the inclusion of diverse perspectives and promotes collaborative decision-making.

Assessment of Forest Resources: The FMU planning process involves conducting a detailed assessment of forest resources within the designated unit. This includes inventorying and mapping the forest cover, identifying key species, assessing biodiversity, and evaluating the ecological values and potential threats to the forests.

Identification of Objectives and Strategies: Based on the assessment of forest resources, the next step is to establish clear objectives for the FMU. These objectives may include sustainable timber production, conservation of biodiversity, protection of watershed areas, provision of ecosystem services, and socio-economic development. Strategies and action plans are then formulated to achieve these objectives.

Formulation of Forest Management Plan (FMP): The Forest Management Plan (FMP) is developed based on the identified objectives and strategies. The FMP outlines the specific activities, guidelines, and management interventions required to achieve sustainable forest management within the FMU. It

includes provisions for timber harvesting, reforestation, fire management, wildlife conservation, community engagement, and monitoring and evaluation.

Environmental Impact Assessment (EIA): An Environmental Impact Assessment (EIA) is conducted to evaluate the potential environmental and social impacts of the proposed activities outlined in the FMP. The EIA ensures that the planned interventions are environmentally sound and socially responsible, considering factors such as biodiversity, water resources, soil quality, and local communities.

Approval and Implementation: Once the FMP and EIA are completed, they are submitted for review and approval by relevant government agencies responsible for forest management. Upon approval, the FMP is implemented, and the planned activities are carried out within the FMU.

Monitoring and Evaluation: Monitoring and evaluation mechanisms are established to assess the progress and effectiveness of the implemented activities. Regular monitoring helps track changes in forest conditions, evaluate the achievement of objectives, and identify areas for improvement. This information is used to update and revise the FMP as needed.

Adaptive Management/Review: The FMU planning process in Bhutan emphasizes adaptive management, which involves incorporating new information and knowledge into the planning and management cycle. Adaptive management allows for flexibility and adjustment of strategies and actions based on the results of monitoring and evaluation, emerging challenges, and changing socio-economic and environmental conditions.

Table 9 Steps for FMU Planning

1. Identification of potential FMU					
Activity	Objective	Output	Lead agency	Collaborators	Comments
Identification of potential FMU area	To identify potential FMU based on FRPA results	Potential FMU area identified	DFO	FRPMD	FRPA results must be referred
2. Reconnaissance Survey					
Activity	Objective	Output	Lead agency	Collaborators	Comments
Reconnaissance Survey	To carry out preliminary assessment of the identified FMU area	Decision on establishment of FMU based on reconnaissance survey report	DFO	FRPMD	Socio-economic survey (SES), Initial Environmental Examination (IEE), Reconnaissance Forest Inventory (RFI), Economic Feasibility Study (EFS).

3. Planning						
Steps	Activity	Objective	Output	Lead agency	Collaborators	Comments
1	Spatial Organization of the FMU	To finalize the FMU area. To establish or review block, compartment & sub-compartments	Exclude managed area and Private Forests. Map of block, compartment & sub-compartment boundaries	DFO	NRDCL or any other authorized agency	
2	Socio-Economic Survey (SES) and Resource Use Mapping	To provide information on the local use of the forest area	Participatory resource use map and social information on stakeholders	DFO	LG	
3	Establishment of FMU-level forest management committee	To agree on the composition and role of the FMU-level forest management committee	a. List of committee members b. Agreed ToRs for FMU-level forest management committee	DFO	NRDCL	The committee needs to ensure that all stakeholder groups are represented. Commitment of members is needed to ensure their involvement in planning steps.
4	Stakeholder consultation meeting	To take on board the interest of stakeholders in FMP and decide how their interests can best be represented	Local Government / Public endorsement	DFO	NRDCL/ LG	Emphasis on institutional representation of all stakeholder groups including local government. Representatives must have local knowledge of the FMU.
5	Forest function mapping	To segregate the FMU area into protection, non-production and production zones. restrictions	Prepared map showing zones and sub-zones based on forest functions	DFO	NRDCL/LG	Revisions of plans should include review and update of forest function mapping

6	Resource Inventory	To collect and map the forest resource data	Generate Forest Inventory report	DFO / FRMD	DFO / FRMD	Start one year before new plan is due to begin
7	Data analysis, and Annual Allowable Cut (AAC) calculation	To assess the growing stock of the FMU To determine the AAC of the FMU	Determine the Volume per ha and other parameters. Estimate of the AAC	DFO	FRPMD	Zones determined by their primary management objective
8	Silvicultural & Harvesting systems	To determine appropriate silvicultural and harvesting strategies and systems for the FMU	Appropriate silvicultural and harvesting systems recommended.	DFO	NRDCL	
9	Environmental assessment	To identify environmental issues, potential impacts & mitigating measures	Environmental statement as integral part of FMP	DFO	LG, Dzongkhag Environment Officer (DEO)	FMP (with integral environmental statement) to be approved by NECS (i.e. environmental clearance granted)
10	Financial & economic appraisal	To identify factors affecting supply and demand, to assess cash flow & financial viability, to undertake cost-benefit analysis including consideration of non-market costs and benefits	Statement of factors affecting supply & demand for forest products in FMU & implications for forest management. 10-year cash flow forecast. Long-term cost-benefit analysis. Statement of non-market costs & benefits & implications for forest management.	DFO	NRDCL	

11	Environmental clearance of FMP by NECS	To obtain environmental clearance for all proposed activities in FMP	Environmental clearance obtained from NECS	FRPMD	NECS	
4. Approval						
Steps	Activity	Objective	Output	Lead agency	Collaborators	Comments
1	Endorsement of FMP by FRPMD, Technical Advisory Committee (TAC) and the Head of Department	To ensure that the plan is consistent with the technical standards and other legal provisions as enshrined in Acts, Policies and Rules.	FMP technically reviewed and endorsed by FRPMD, TAC and the Head of Department.	FRPMD	DFO	
2	Approval of FMP by the Head of the Ministry	Approve the FMP for Implementation	FMP approved for implementation.	FRPMD	DFO	
5. Implementation						
	Activity	Objective	Output	Lead agency	Collaborators	Comments
1	Preparation of OP	To prioritise activities for the two-year rolling plan based on FMP	OP prepared.	DFO	FRPMD, NRDC	
2	Implementation of OP	To implement the activities prescribed in the OP	OP implemented.	DFO	NRDC	
6. Monitoring and Evaluation						

	Activity	Objective	Output	Lead agency	Collaborators	Comments
1	Annual Monitoring of FMU by Unit Incharge	To annually monitor the implementation of FMU activities	1. Physical and Financial Form 1 to 3. 2. Environmental Form 4 to 10 3. Physical, Financial and Environmental Summary form 11	FMU	NRDCL	
2	Annual Monitoring of FMU by DFO	To annually monitor the implementation of FMU activities	Annual Monitoring Form A	DFO	NRDCL	
3	Annual Monitoring by FRMD	To monitor the implementation of FMU activities	Review and monitor the progress of the implementation of the OP	FRPMD	DFO, NRDCL	
4	Mid-Term Evaluation	To review progress against FMP objectives and amend the FMP if required	Mid-Term evaluation report along with due observations and recommendations	FRPMD	DFO, NRDCL	
5	Final Evaluation	To review progress against FMP objectives	Final Evaluation Report	FRPMD	DFO, NRDCL	

Source: Forest and Nature Conservation Code of Best Management Practices of Bhutan, 2021

iii. Implementation

Field actors and arrangement

In Bhutan, the implementation of Forest Management Plans (FMPs) involves the collaboration and coordination of various field actors. These field actors play essential roles in executing the planned activities and ensuring the effective implementation of the FMPs. The Divisional Forest Offices (DFO) shall prepare the management plan with technical support from Forests Resources Planning and Management Division (FRPMD). The FMP is a holistic sustainable forest management plan prepared in consultation with the Local Government (LG) and other relevant stakeholders. The implementation of FMU activities should

be based on an annual Operational plan approved by the Department of Forests and Park Services (DoFPS). The following are key field actors and their implementation arrangements:

Forest Department (FD): The Forest Department is the primary government agency responsible for forest management in Bhutan. It plays a crucial role in overseeing and coordinating the implementation of FMPs. The FD provides technical guidance, sets policies, and monitors the activities carried out within the Forest Management Units (FMUs).

Divisional Forest Offices: Divisional Forest Office, under the Forest Department, are stationed in the field to facilitate the implementation of FMPs. They are responsible for overseeing the day-to-day management activities, coordinating with local communities, and ensuring compliance with the planned interventions. Divisional Forest Offices also provide technical expertise and support to field staff and stakeholders.

Local Communities: Local communities residing in and around the FMUs play a vital role in the implementation of FMPs. They actively participate in community forestry programs, sustainable harvesting activities, and conservation efforts. Their involvement includes the protection of forest resources, participation in reforestation activities, and engaging in alternative livelihood initiatives. The FMPs often incorporate provisions for community-based forest management and the sharing of benefits derived from sustainable forest practices.

Forest Management Units (FMUs): FMUs are designated areas within Bhutan's forest landscapes that have specific management objectives and plans. FMUs serve as implementation units for FMPs, where the planned activities are executed. They are responsible for carrying out timber harvesting, reforestation, biodiversity conservation, and other management interventions as outlined in the FMPs.

Authorised Agency (NRDCL): The Natural Resources Development Corporation Limited (NRDCL) or any other authorised agency shall ensure that the activities are implemented as per the prescription of the Operational Plan and the management plan.

Research Institutions and Experts: Research institutions and experts contribute to the implementation of FMPs through scientific research, data collection, and analysis. They provide technical guidance, conduct studies on forest ecology, biodiversity, and socio-economic aspects. Their research findings inform the decision-making processes and help improve the effectiveness of FMP implementation.

The implementation arrangement for FMPs in Bhutan involves a collaborative approach, where field actors work together to ensure the successful execution of planned activities. Through their collective efforts, sustainable forest management objectives are achieved, and the conservation of biodiversity and socio-economic well-being are promoted within the FMUs.

Some of the most important roles of the key actors in the management planning and implementation process are provided in Table 9.

Table 10 Roles and responsibilities of key actors

Offices	Roles and Responsibilities
FRPMD	<ul style="list-style-type: none"> • Conduct Forest Resources Potential Assessment (FRPA) • Provide technical support for the conduct of Reconnaissance Survey (RS). • Provide technical support for the conduct of resource inventory. • Provide technical support for forest function mapping. • Conduct cold and hot check during forest resource inventory. • Review the FMP prepared by the field offices and process for approval from the Ministry. • Process for Environmental Clearance (EC) from National Environment Commission Secretariat (NECS). • Review and approve the operational plan (OP) prepared by the field offices. • Monitor and evaluate the implementation of FMU activities.
CFO	<ul style="list-style-type: none"> • In coordination with FRPMD, identify new potential FMU areas recommended by the FRPA 2013. • Prepare the FMP following the steps detailed out in the <i>Forests and Nature Conservation Code of Best Management Practices of Bhutan</i>. • Coordinate the formation of and participate in FMU-level management committee meetings and discussions (CFO acts as chairman of the committee). • Prepare and ensure the implementation of OP. • Regulate and monitor the implementation of the FMPs. • Report on progress in implementing activities within OP (annually through an FMU annual monitoring report).
Authorised agency	<ul style="list-style-type: none"> • Participate in preparation of FMP and OP. • Implement the FMP and OP activities. • Fund the FMU implementation activities. • Participate in FMU-level forest management committee meetings. • Carry out afforestation and reforestation.
LG	<ul style="list-style-type: none"> • Participate in the planning and implementation of social and extension-oriented activities. • Participate in FMU-level forest management committee meetings as representatives of local stakeholders.

Source: *Forest and Nature Conservation Code of Best Management Practices of Bhutan, 2021*

Harvest timings and Procedures

The harvesting of timber is based on the approved Forest Management Plan (FMP) for the FMU. The FMP outlines the objectives, strategies, and guidelines for sustainable forest management, including timber harvesting. For the Annual Harvesting operations, the respective Divisional Forest Offices prepare the annual operation plans and submit them to the Forest Resources Planning and Management Division. The FRPMD reviews the Operational plan and puts up the final reviewed Operational Plan of the respective

FMUs to the Technical Advisory Committee of the Department of Forests and Park Services for administrative approval. The approved operational plans are handed over to NRDCL by January every year and NRDCL must begin the harvesting of timber and complete all harvesting and timber extraction operations by December based on the annual set target and the objectives and ecological considerations outlined in the FMP.

During the harvesting process, sustainable logging practices and techniques are employed to minimize environmental impacts. These practices may include directional felling to reduce damage to surrounding trees, ensuring minimal soil disturbance, and employing proper skidding and transportation methods to minimize soil erosion.

Monitoring and enforcement mechanisms are in place to oversee timber harvesting operations. Forest officials conduct regular inspections to ensure compliance with harvesting guidelines, environmental regulations, and adherence to the FMP. Non-compliance may result in penalties or revocation of harvesting permits.

After timber harvesting is completed, post-harvest activities are carried out, including log transportation, processing, and marketing. These activities are often regulated to ensure the traceability and legality of harvested timber and to maximize value-added processing within Bhutan.

f. Socio-Economic Issues

Sourcing timber in Bhutan may face several socio-economic issues that need to be addressed for sustainable and responsible practices. These issues include:

Limited Market Access: Bhutan's landlocked location and limited infrastructure can pose challenges in accessing international markets for timber products. Limited market access can affect the profitability and economic viability of timber sourcing operations.

Dependence on Timber as a Revenue Source: Bhutan relies on timber as a significant revenue source, and any changes in timber sourcing practices or market demand can impact the country's economy. Diversification of revenue sources is necessary to reduce dependence on timber and promote sustainable economic development.

Poverty and Livelihoods: Timber sourcing often occurs in rural areas where communities depend on forests for their livelihoods. Changes in timber sourcing practices can affect local employment opportunities, potentially leading to unemployment and increased poverty levels. Sustainable timber sourcing should consider strategies for creating alternative livelihood options for affected communities.

Limited Technological Capacity: The timber industry in Bhutan may face challenges in terms of technological capacity and infrastructure for efficient and sustainable timber processing. Investing in technology and capacity-building initiatives can improve productivity, reduce waste, and enhance the value chain.

Illegal Logging and Governance: Illegal logging remains a concern in Bhutan, undermining sustainable timber sourcing efforts. Weak governance, lack of enforcement mechanisms, and corruption can

contribute to illegal logging activities. Strengthening governance structures, promoting transparency, and implementing effective regulatory frameworks are essential to combat illegal logging.

Social Equity and Benefit Sharing: Timber sourcing should prioritise social equity by ensuring fair and equitable benefit-sharing mechanisms for local communities, including indigenous and marginalised groups. Effective community engagement, participatory decision-making processes, and transparent benefit-sharing agreements can help address social equity issues.

Cultural Considerations: Bhutan has a rich cultural heritage deeply intertwined with forests. Timber sourcing practices should respect and preserve cultural values and traditions associated with forests. Involving local communities in decision-making processes and incorporating traditional knowledge can help maintain cultural integrity.

Environmental Impacts: Unsustainable timber sourcing practices can lead to deforestation, habitat loss, and environmental degradation. Balancing economic interests with environmental conservation is crucial to ensure the long-term sustainability of timber sourcing. Implementing sustainable forestry practices, promoting reforestation efforts, and protecting ecologically sensitive areas are essential.

Addressing these socio-economic issues requires a multi-stakeholder approach involving government agencies, local communities, industry stakeholders, and civil society organisations. Collaborative efforts can lead to sustainable timber sourcing practices that promote economic development, poverty reduction, social equity, and environmental conservation in Bhutan.

g. Ecological Issues

Sourcing timber in Bhutan can have significant ecological implications that need to be carefully considered and managed. The following are key ecological issues associated with timber sourcing:

Deforestation: Unsustainable logging practices can lead to deforestation, which results in the permanent loss of forest cover and associated biodiversity. Deforestation disrupts ecosystems, reduces habitat availability for wildlife, and contributes to the loss of valuable ecosystem services.

Habitat Loss and Fragmentation: Timber sourcing activities, especially if not properly planned and managed, can lead to habitat loss and fragmentation. Clear-cutting or improper logging practices can destroy or fragment habitats, making them less suitable for various plant and animal species. This can result in the loss of biodiversity and negatively impact ecological balance.

Soil Erosion and Degradation: Improper logging practices, such as removing vegetation cover without adequate soil protection measures, can result in soil erosion and degradation. Soil erosion can lead to reduced soil fertility, loss of nutrients, increased sedimentation in water bodies, and adverse impacts on aquatic ecosystems.

Disruption of Forest Hydrology: Forests play a crucial role in regulating water flow, maintaining water quality, and preventing soil erosion. Unsustainable timber sourcing practices can disrupt forest hydrology, leading to altered water availability, increased runoff, and potential water pollution.

Loss of Carbon Sequestration Capacity: Forests are essential in sequestering carbon dioxide from the atmosphere, helping mitigate climate change. Deforestation or unsustainable logging can result in the release of stored carbon, contributing to greenhouse gas emissions and climate change.

Impacts on Non-wood Forest Products: Timber sourcing activities can impact non-wood forest products (NWFPs), such as medicinal plants, fruits, and mushrooms, which have ecological and socio-economic value. Overexploitation or habitat destruction can lead to a decline in the availability and diversity of NWFPs, affecting local communities' livelihoods and cultural practices.

Biodiversity Conservation: Bhutan is known for its rich biodiversity and unique ecosystems. Unsustainable timber sourcing can threaten the biodiversity of forests by reducing species diversity, disrupting ecological processes, and affecting the survival of vulnerable and endangered species.

Invasive Species Introduction: Timber sourcing activities can inadvertently introduce invasive plant species or pests, which can negatively impact native ecosystems. Invasive species can outcompete native flora and fauna, leading to ecosystem imbalances and reduced biodiversity.

To address these ecological issues, sustainable forestry practices should be employed, including selective logging, reforestation efforts, protection of ecologically sensitive areas, and the use of environmentally friendly logging techniques. It is crucial to implement proper land-use planning, adhere to forest management regulations, and promote ecosystem-based approaches to timber sourcing. Additionally, monitoring programs and environmental impact assessments can help identify and mitigate potential ecological risks associated with timber sourcing activities.

h. Implications on Climate & Carbon Neutrality

Timber harvesting, while providing economic benefits, can have implications for climate change and Bhutan's goal of carbon neutrality. Here are some implications to consider:

Carbon Sequestration: Forests play a vital role in carbon sequestration by absorbing carbon dioxide from the atmosphere and storing it in trees and soils. Timber harvesting reduces the overall capacity of forests to sequester carbon, leading to a decrease in the carbon sink. This can impact Bhutan's efforts to maintain a carbon-neutral status.

Deforestation and Forest Degradation: Unsustainable timber harvesting practices, such as clear-cutting or excessive logging, can lead to deforestation and forest degradation. These activities result in the loss of forest cover, biodiversity, and ecosystem services. Deforestation contributes to increased carbon emissions as the stored carbon in trees and soils is released into the atmosphere.

Loss of Habitat and Biodiversity: Timber harvesting can result in the destruction of wildlife habitats and biodiversity loss. Forest ecosystems provide critical habitats for numerous plant and animal species. Disrupting these ecosystems through timber harvesting can lead to the decline or displacement of species, impacting the overall ecological balance and resilience.

Forest Regeneration and Resilience: Sustainable timber harvesting practices should prioritise forest regeneration and resilience. Proper silvicultural techniques, such as selective logging and promoting

natural regeneration, can aid in maintaining the ecological functions of forests. Ensuring adequate regeneration is crucial for the long-term carbon sequestration capacity and sustainability of Bhutan's forests.

Climate Change Mitigation Potential: Well-managed forests have the potential to contribute to climate change mitigation efforts. Sustainable timber harvesting, coupled with robust reforestation and afforestation programs, can maintain, or enhance the overall carbon sequestration potential of Bhutan's forests. By focusing on sustainable practices, Bhutan can optimize its forest's ability to mitigate climate change impacts.

To mitigate these implications and maintain carbon neutrality, Bhutan should prioritize sustainable forest management practices, enforce strict regulations on timber harvesting, promote reforestation and afforestation efforts, and integrate forest conservation with climate change mitigation strategies. This requires a balanced approach that considers economic needs, biodiversity conservation, and climate change mitigation goals.

5. General Recommendations

a. Accessing the Resource

Forest Management Planning: Strengthen the capacity of forestry officials to develop comprehensive forest management plans that outline sustainable timber harvesting objectives, strategies, and guidelines. These plans should consider factors such as timber volume, species composition, regeneration capacity, and ecological sensitivity to ensure responsible and balanced timber extraction.

Harvesting Permits and Regulations: Strictly implement the timber harvesting practices as per the established permitting system that regulates timber harvesting activities. Issue permits based on sustainable yield calculations, ensuring that the harvesting levels do not exceed the forest's capacity for regeneration. Implement strict enforcement mechanisms to prevent illegal logging and enforce compliance with harvesting regulations.

Access Roads and Infrastructure: Develop well-planned and properly constructed access roads to facilitate timber extraction while minimizing environmental damage. Design road networks that consider topography, soil erosion prevention measures, and the use of appropriate engineering techniques to minimize impacts on forest ecosystems.

Harvesting Techniques and Practices: Promote sustainable harvesting techniques such as selective logging, where only specific trees are targeted for extraction, minimizing disturbance to the overall forest structure. Encourage reduced-impact logging practices that employ methods to minimize soil disturbance, protect waterways, and preserve the habitat of sensitive species.

Monitoring and Compliance: Strengthen monitoring and enforcement to ensure compliance with timber harvesting regulations. Regularly monitor harvesting activities, including log transportation, to detect and prevent illegal practices. Utilize technology such as GPS tracking systems and aerial surveillance (UAVs) to monitor logging activities.

Stakeholder Engagement: Involve local communities, forest users, and relevant stakeholders in the timber harvesting process. Encourage their participation in decision-making and seek their input on

sustainable harvesting practices and the allocation of timber resources. Promote transparency and accountability in the timber access and allocation process.

Capacity Building: Provide training and capacity-building programs for forest officials, timber harvesters, and local communities involved in timber harvesting activities. Train them in sustainable harvesting techniques, safety protocols, and the importance of responsible timber extraction. Foster knowledge exchange and learning opportunities among stakeholders.

Environmental Impact Assessment: Conduct comprehensive environmental impact assessments prior to timber harvesting activities. Assess the potential ecological, social, and economic impacts of logging and develop mitigation measures to minimize negative effects. Ensure compliance with environmental regulations and standards.

Reforestation and Rehabilitation: Implement reforestation and rehabilitation programs in harvested areas to restore forest cover and promote ecosystem recovery. Prioritize the use of native tree species and implement appropriate silvicultural practices to enhance the success of regeneration efforts.

Collaboration and Research: Foster collaboration with research institutions, industry experts, and international partners to enhance knowledge and research on sustainable timber harvesting practices. Invest in research initiatives that focus on improving timber harvesting techniques, forest regeneration, and the development of innovative and sustainable timber utilization methods.

b. Technology Enhancement

When it comes to technology enhancement for timber harvesting from Forest Management Units (FMUs) in Bhutan, several recommendations can be made to improve efficiency, sustainability, and environmental impact. Here are some suggestions:

Remote Sensing and Satellite Imagery: Utilize remote sensing techniques and satellite imagery to assess forest health, identify potential areas for timber harvesting, and monitor forest cover change. This can provide valuable insights for sustainable timber management.

Timber Inventory and Monitoring: Adopt advanced inventory techniques such as LiDAR (Light Detection and Ranging) and drones to accurately estimate timber volume and quality. Regular monitoring can help in tracking forest growth, identifying diseased trees, and optimizing harvest schedules.

Forest Harvesting Equipment: Introduce modern and efficient machinery for timber harvesting, such as mechanized harvesters and forwarders. These can improve productivity, minimize damage to the forest floor, and reduce the need for manual labor. The production forests in nearby areas have decreased over the years and to get access to timber from far flung areas requires either a longer length approach road or powerful, long distance skyline cable. As some of the logging machines are too old, it is recommended to purchase new all-terrain cable cranes and improved version log loaders to enhance the efficiency of timber harvesting activities.

Sustainable Logging Practices: Encourage the use of environmentally friendly logging techniques, such as selective logging and reduced-impact logging. These methods minimize the ecological impact by targeting specific trees for extraction while preserving the overall forest structure and biodiversity.

Training and Capacity Building: Provide training programs to forest officials and workers on the operation and maintenance of modern equipment, sustainable harvesting practices, and safety protocols. This can enhance skills, promote responsible logging, and reduce accidents.

Research and Development: Support research initiatives to develop innovative technologies for timber harvesting. This could include exploring alternative materials for logging infrastructure, bio-based fuels for machinery, or advanced tracking systems to monitor harvested timber from FMUs.

c. Sustaining Bhutan's Forests

Sustaining Bhutan's forests is crucial for maintaining biodiversity, mitigating climate change, and supporting the well-being of local communities. Here are some recommendations for promoting forest sustainability in Bhutan:

Strengthen Forest Governance: Enhance the governance framework for forest management by implementing clear policies, laws, and regulations that protect forests and support sustainable practices. Ensure effective enforcement and monitoring mechanisms to prevent illegal logging and encroachment.

Sustainable Forest Harvesting Practices: Encourage the adoption of sustainable harvesting practices, such as selective logging and reduced-impact logging, which minimize damage to the forest ecosystem. Implement strict regulations on logging methods, timber extraction, and transportation to ensure responsible practices are followed.

Reforestation and Afforestation: Implement large-scale reforestation and afforestation programs to restore degraded areas and expand forest cover. Focus on planting native tree species that are well-suited to local conditions and promote biodiversity. Incentivize individuals and communities to participate in tree planting activities.

Forest Fire Management: Develop comprehensive forest fire management strategies that include prevention, early detection, and rapid response mechanisms. Invest in firebreaks, firefighting equipment, and training programs for forest personnel. Raise awareness among communities about fire safety measures and the risks associated with forest fires.

Conservation Education and Awareness: Conduct awareness campaigns and educational programs to highlight the importance of forests, biodiversity, and sustainable forest management. Educate local communities, schools, and the public about the ecological, economic, and social benefits of forests, fostering a sense of stewardship.

Ecosystem Services and Payments for Environmental Services (PES): Explore mechanisms to recognize and incentivize the ecosystem services provided by forests. Consider implementing PES programs where forest-dependent communities and landowners receive financial or other benefits for conserving forests, protecting watersheds, or sequestering carbon.

Research and Monitoring: Support scientific research and monitoring initiatives to gather data on forest health, biodiversity, carbon sequestration, and ecosystem dynamics. This knowledge can inform evidence-based decision-making and adaptive management strategies.

International Cooperation: Collaborate with international organizations, neighbouring countries, and the global community to share experiences, expertise, and resources for sustainable forest

management. Engage in international initiatives related to forest conservation, climate change, and biodiversity conservation.

d. Advocacy, Technology Transfer & Capacity Building

Training and Capacity Building: Provide training programs to forest officials and workers on the operation and maintenance of modern equipment, sustainable harvesting practices, and safety protocols. This can enhance skills, promote responsible logging, and reduce accidents.

Research and Development: Support research initiatives to develop innovative technologies for timber harvesting. This could include exploring alternative materials for logging infrastructure, bio-based fuels for machinery, or advanced tracking systems to monitor harvested timber from FMUs to end-users.

Collaboration and Knowledge Sharing: Foster partnerships and collaborations with international organizations, neighbouring countries, and industry experts to exchange knowledge and best practices in sustainable timber harvesting. This can help Bhutan leverage global expertise and stay updated with the latest technological advancements.

Policy and Regulatory Framework: Develop and enforce policies that promote sustainable forest management and encourage the adoption of technology in timber harvesting. Provide incentives for FMUs to invest in modern equipment and practices that align with environmental and social objectives.

Public Awareness and Engagement: Conduct awareness campaigns to educate local communities, stakeholders, and the public about the importance of sustainable timber harvesting and the role of technology in achieving it. Strengthen community participation in forest management processes.

6. Specific Recommendations

- The requirement of 2010 m³ (~70982.48 cft) for the current project can be met and sourced sustainably from the following FMUs:
 - Khotokha FMU -AAC (2023): 9800 m³
 - Selela FMU -AAC (2023) : 9230 m³
 - Gidakom FMU -AAC (2023): 7400 m³
- Raw timber for the project can be processed in the Integrated Wood Processing Plant of the NRDCL at Ramtokto, or a new depot could be built to process timber for the project. The current log-log sawing capacity of the NRDCL Sawmill at Ramtokto is 1600 cft/day.
- Given current NRPC prices, raw materials for the project will cost about Nu. 26 million.
- Given that all timber is sourced from sustainably managed forests as per prescribed 'forest management codes' there will be no negative impact of Bhutan's status as a carbon neutral country.
- However, to build standards, foster technological innovation, and ensure forest ecological resilience and sustainability, it may be worth instituting a forest certification scheme across Bhutan's forest production landscapes.

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