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Assessment on the Management Practices and Forest Conditions of Community Forests and State-Managed Forest in Highland Region: Case Study in Shan State, Myanmar

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Abstract: Forests are vital for sustainable livelihoods, environmental conservation, and poverty alleviation, yet they face growing threats from deforestation and forest degradation due to both direct and indirect causes. community forestry (CF), a promising approach for sustainable forest management, has been widely adopted in Myanmar to address socio-economic and environmental challenges. This study investigates the management practices, community rules, silvicultural operations, and forest conditions of community forests and state-managed forests in Nyaung Shwe Township, part of the Inle Lake watershed. Data from 58 systematically distributed sample plots were analyzed to assess species composition, diversity, and structural parameters. The results showed that community forests had higher species diversity, richness, and evenness compared to state-managed forests. Notably, *Shorea siamensis* emerged as the most ecologically significant species in both forest types. The diameter distribution revealed a dominance of mid-sized trees, indicating regeneration potential but also highlighting the challenges posed by annual forest fires and limited silvicultural engagement. Management practices in community forests emphasized conservation and local participation, though gaps in benefit-sharing mechanisms were noted. These findings underscore the importance of community forestry in promoting biodiversity and sustainable forest management while emphasizing the need for enhanced community engagement and institutional support.

1. Introduction

Forests and trees play a vital role in supporting sustainable livelihoods and combating hunger and poverty. However, deforestation and forest degradation continue to rise globally, driven by both direct factors such as over-logging, excessive resource use, and land-use changes, as well as indirect factors like poverty, hunger, and lack of financial resources [8]. In developing countries, communities rely heavily on ecosystem services provided by forests, whereas in developed countries, forests are often conserved for their environmental and recreational benefits [7]. In recent years, many countries in tropical Asia, including Myanmar, have actively adopted community forestry practices to restore the productivity of degraded forest lands and improve the well-being of local communities, including forest dwellers and those dependent on forests [18]. In Myanmar, forests and forestlands are state-owned and managed by the Forest Department (FD). Aligning with the global trend of decentralizing forest management, the Forest Department launched community forestry in 1995, following the issuance of the Community Forestry Instructions (CFI). This initiative marked a significant advancement in the forestry sector, addressing evolving socio-economic and environmental challenges. These programs also aim to enhance the livelihoods of local communities by empowering Forest User Groups (FUGs) to manage community forests more effectively, sustainably, and fairly. This initiative aligns with government policy to transfer the management of national forests to local communities. This study aimed to investigate management practices, community rules, and silvicultural practices in managing community forests and to assess the forest conditions of community-managed forests and state-managed forests. It includes an evaluation of the composition and structure of selected forest types, concluding with an analysis of their potential and prospects for future management. Understanding the detailed assessments of plant communities, particularly their species composition, structure, and natural regeneration of forests is essential in the present context and effective forest management and restoration plans [3].

2. Material and Method

2.1. Study Area

The study area covers four community forests from Nyaung Shwe Township which is part of the Inle lake watershed area and is facing environmental protection challenges. Figure *1* shows the locations of the study area.

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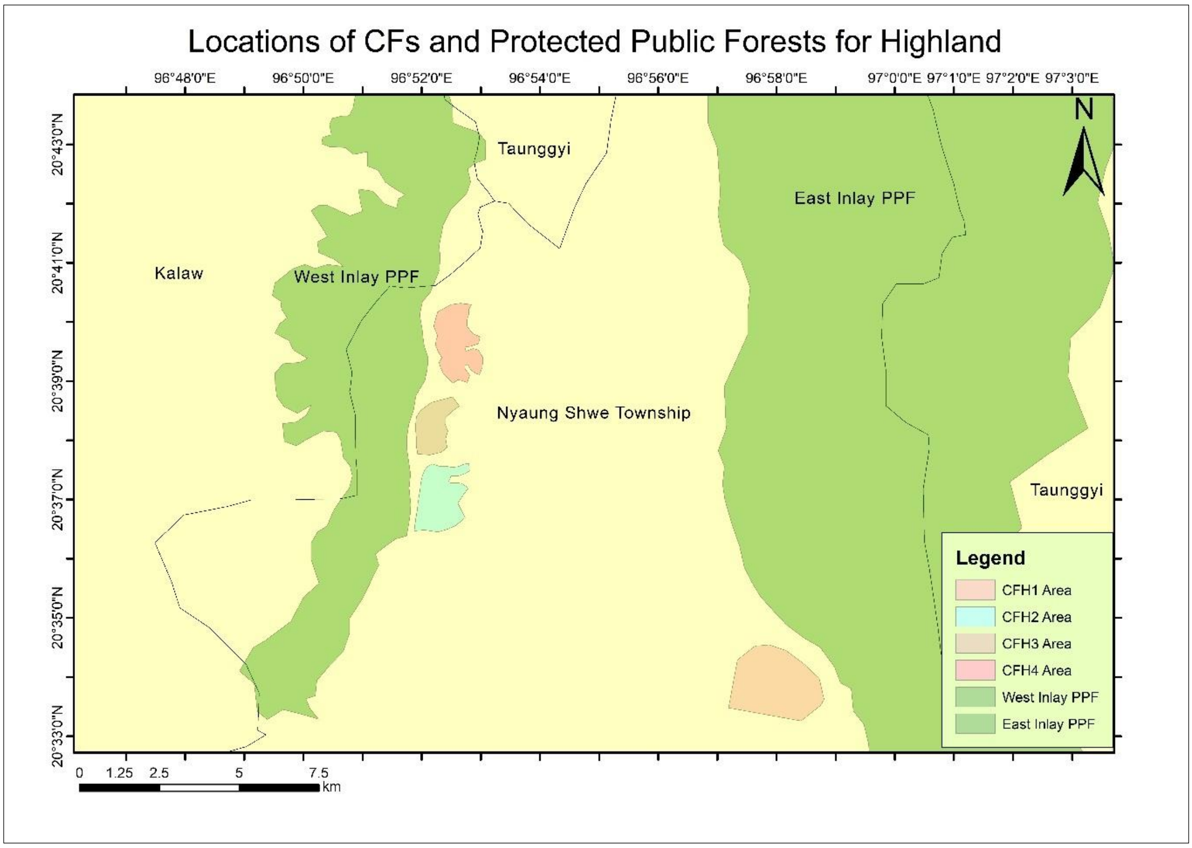

Figure 1 Location of CFs and Protected Public Forests in the Study Area

2.2. Data Collection

The data were collected in September, 2023. Total 58 sample plots (29 plots from CF sites and 29 plots from protected public forest) were established in two different managed forests. In each forest, sample plots with size of 2,500m^2 (50m x 50m) were systematically distributed. Each sample plot was subdivided into two sub-sample plots with size of 100m^2 (10m x 10m) and 25m^2 (5m x 5m). All trees with DBH greater than or equal to 5cm within 50m plot, saplings 3cm < DBH < 5cm within the 10m sub-plot and seedlings within 5 m plots were measured. Figure *2* and Figure *3* demonstrates the location of sample plots in CFs and Protected Public Forests in the study area.

2.3. Data Analysis

The diversity of plant species in the forest types was quantified using the Shanon (H) and Simpson species diversity indices. Important-Value-Index (IVI) combining three parameters (relative abundance, relative frequency and relative dominance) was used to compare the ecological significance of species. The collected data were analyzed by using Microsoft Excel and STATA software to analyze the data and show the results with simple descriptive statistics to summarize the vegetation parameters.

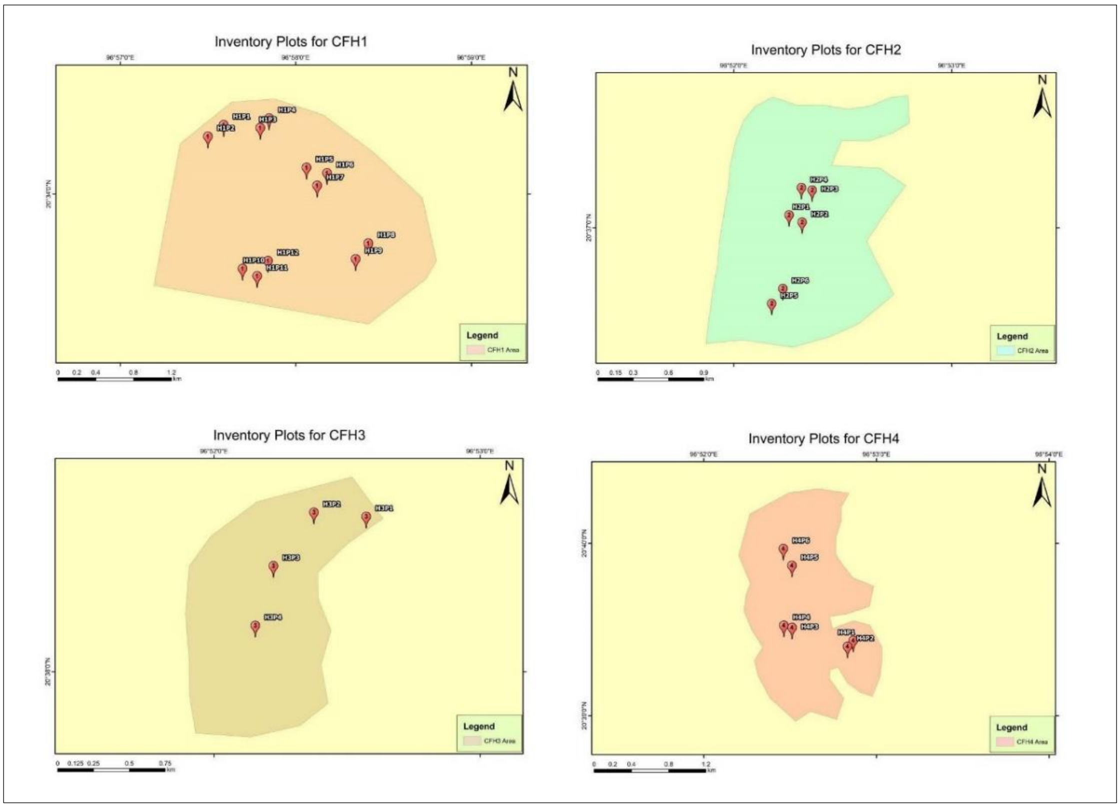

Figure 2 Locations of Inventory Plots in CFs in the Study Area

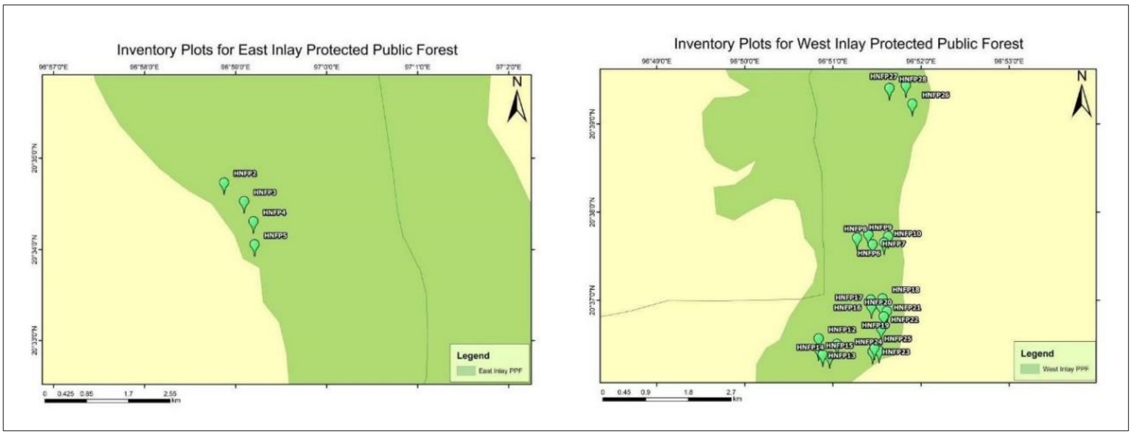

Figure 3 Locations of Inventory Plots in Inle Protected Public Forest in the Study Area

3. Results

3.1. Management Practices, Community Rules and Silvicultural Practices in Managing Community Forests

According to the statistical analysis results, the majority of Community Forest User Groups (CFUGs) households from all community forests from highland region managed their community forests as a group for conservation. There was a significant relationship in management practices between these four study community forests at 10% significance level according to the Chi-square test's result ($X^2 = 10.58$, $p = 0.013$*).

Table *1* shows the management practices of CFUG households' participation for each community forest. In the study area, the primary goal of managing community forests is to preserve the natural forest to ensure a reliable water supply for nearby villages. Access to drinking water is their main priority, as the villages lack other potable water sources. A stream flowing through the community forest is directly piped to a village water storage tank, from which all residents collect water at designated taps. To protect this vital resource, the management committees enforce strict rules, prohibiting illegal timber harvesting, unsustainable extraction of non-timber forest products (NTFPs), and encroachment into community forest areas. Community forest members and neighboring villagers are required to report any conflicts within the forest to the committees. First-time offenders, whether members or outsiders, are issued warnings for engaging in illegal activities in the forest. However, repeat offenders are required to pay a penalty as punishment for subsequent violations.

Table 1 Participation of Local People in Different Management Practices

Management Type		**CF Name**				**Total**
		CFH1	**CFH2**	**CFH3**	**CFH4**	
Managed Individually	Number	0	0	0	0	0
	% within CF name	0.00 %	0.00 %	0.00%	0.00%	0.00%
Managed by Group	Number	28	23	15	40	106
	% within CF name	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Managed both	Number	0	0	0	0	0
	% within CF name	0.00 %	0.00 %	0.00%	0.00%	0.00%
Total	**Number**	**28**	**23**	**15**	**40**	**106**
	% within CF name	**100.00 %**	**100.00 %**	**100.00 %**	**100.00 %**	**100.00 %**

*Chi-square value = 10.58, df =3, p = 0.013**
*Significance levels *, **, and *** are 10 %, 5%, and 1% respectively.*

Table 2, only regular meetings are held and neither financial nor benefit-sharing meetings are not held in this study area. Also in this study area, only regular meetings are held except H2 (Lwe-nyeint CF) and neither financial nor benefit-sharing meetings are not held. From this, it can be noted that these community forests are still lacking the benefit-sharing mechanism among CFUGs except CFH2. In CFH2 (Lwe-nyeint CF), the management committee and CFUG members held the benefit sharing meetings because they already developed the revolving fund from the community forests and this funding can support the management of community forests activities and livelihoods improvement of CFUGs and for village development.

Table 2 Frequency of Meetings by Management Committees

CF Name	**Frequency of Regular Meeting (per year)**	**Frequency of Financial Meeting (per year)**	**Frequency of Benefit Sharing Meetings (per year)**
CFH1	4	0	0
CFH2	3	0	1
CFH3	2	0	0
CFH4	1	0	0

Managing existing forests is another approach to community forestry in Myanmar. To meet the objectives of community forests, activities such as weeding, cutting climbers, boundary marking, forest guarding, and fire protection are essential. In highland regions, all CFUG households actively participate in conserving natural forests and are required to carry out silvicultural practices for sustainable forest management. These practices include weeding, pruning, boundary demarcation, forest guarding, fire protection, enrichment planting, gap planting, and climber cutting, as illustrated in *Figure 4*. Existing forest management focuses on areas within community forests not designated as plantations. CFUG households oversee these areas to prevent illegal activities, deter encroachments, and conserve forest resources. Participation in managing these forests is mandatory for all CFUG households. They are permitted to collect NTFPs from these areas for personal use and may also sell certain products, like bamboo shoots and mushrooms, on a small scale for commercial purposes.

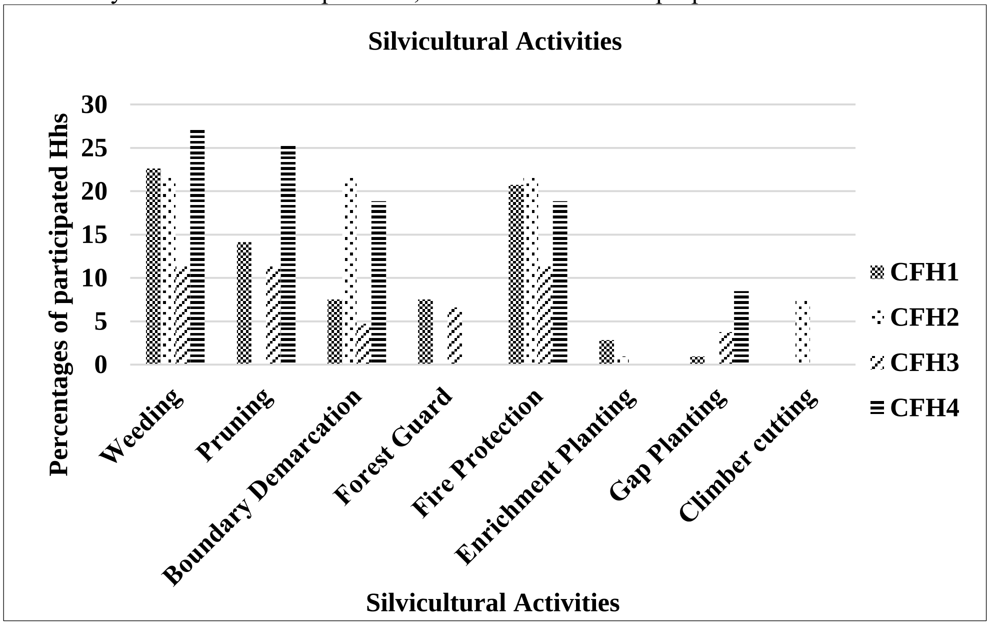

Figure 4 Silviculture Operations conducted by Management Committees

3.2. Vegetation Parameters

Different parameters were analyzed for the vegetation analysis of both community forests and protected public forest. In this study, 42 tree species were identified and recorded from 29 sample plots of the community forests and 39 tree species were recorded from 29 sample plots of protected public forests. *Shorea siamensis, Dalbergia cultrate, Grewia rothii, Bombax ceiba, Melanorrhoea usitata* were the common tree species in both community forests and protected public forests. As shown in

Table *3*, the findings indicated that the community forest encompasses a higher number of species (42) and individuals (2434) compared to the protected public forest (39 species and 2280 individuals). This distinction may reflect community-managed practices that encourage species diversity through sustainable use and conservation initiatives. Community involvement may also lead to greater conservation efforts and protection of various species, as local users are invested in the health and sustainability of their environment. The Shannon-Weiner Diversity Index for the community forest is higher (2.69) than that of the protected public forest (2.55). This index measures the entropy or uncertainty in predicting the species of a randomly chosen individual from the data set. A higher value suggests a more diverse and stable ecosystem. The Simpson's Diversity Index is also higher in the community forest (7.58) versus the protected public forest (6.57). This index measures the probability that two randomly selected individuals belong to the same species. A higher value indicates greater diversity. The species evenness is slightly higher in the community forest (0.72) than in the protected public forest (0.69). Evenness indicates how uniformly individuals are distributed across the different species; higher values suggest a more balanced distribution. The species richness is greater in the community forest (5.26) in comparison to the protected public forest (4.91). Species richness reflects the number of different species present, further supporting the conclusion that the community forest has higher diversity.

Table 3 Descriptive statistics of vegetation parameters in Community Forests and Protected Public Forests

S.N.	Parameters	Community Forest	Reserved Forest
1	Number of Species	42	39
2	Number of Individual Trees	2434	2280
3	Shannon-Weiner Diversity Index (H′)	2.69	2.55
4	Simpson's Diversity Index (D)	7.58	6.57
5	Species Eveness (E)	0.72	0.69

6	Species Richness (R)	5.26	4.91

Abundance, Dominance, Frequency and Important-Value-Index (IVI) of Both Forests Table *4* and *Table 5* describe the species wise relative density, relative frequency, relative dominance, relative abundance of the lists of 10 species based on their Important-Value-Index range for CF and Protected Public Forests. The most dominant tree species in both CF and Public Protected Forest were *Shorea siamensis* based on their IVI and *Xylia xylocarpa* had the lowest IVI. It can be noted that only few species were most abundance and had high frequency values in the investigated forests but most of species are comparatively causal. *Shorea siamensis* was found to be the most abundance species with the high frequency values and it indicated that there has favorable site condition for the development of this species.

Table 4 Species wise Relative density, Relative frequency, Relative dominance, Relative abundance and Importance Value Index in CF

Species	**No. of Tree**	**Relative Frequency %**	**Relative Dominance %**	**IVI**
Shorea siamensis (Kurz.) Miq.	766	31.47	79.90	111.37
Dalbergia cultrata Grah.	295	12.12	9.57	21.69
Melanorrhoea usitata Wall.	114	4.68	1.62	6.30
Bombax ceiba L.	133	5.46	1.43	6.90
Lannea wodier (Roxb.) Adelb.	76	3.12	1.08	4.21
Sterculia guttata Roxb.	97	3.99	0.92	4.90
Grewia rothii DC.	137	5.63	0.82	6.45
Berrya ammonilla Roxb.	113	4.64	0.79	5.44
Lagerstroemia venusta Wall.	75	3.08	0.78	3.86
Xylia xylocarpa (Roxb.) Taub.	55	2.26	0.54	2.80

Table 5 Species wise Relative density, Relative frequency, Relative dominance, Relative abundance and Importance Value Index in Protected Public Forests

Species	**No. of Tree**	**Relative frequency %**	**Relative Dominance %**	**IVI**
Shorea siamensis (Kurz.) Miq.	779	34.17	76.49	110.66
Dalbergia cultrata Grah.	310	13.60	12.11	25.71
Melanorrhoea usitata Wall.	131	5.75	2.16	7.91
Bombax ceiba L.	114	5.00	1.64	6.64
Grewia rothii DC.	103	4.52	1.34	5.85
Lannea wodier (Roxb.) Adelb.	102	4.47	1.31	5.79
Berrya ammonilla Roxb.	94	4.12	1.11	5.24
Sterculia guttata Roxb.	90	3.95	1.02	4.97
Lagerstroemia venusta Wall.	75	3.29	0.71	4.00
Xylia xylocarpa (Roxb.) Taub.	68	2.98	0.58	3.57

3.3. Diameter Frequency Class and Distribution of Individuals by Height Class

In community forest, there has the maximum number of trees in diameter class of (31-40) cm which attributes 471 tree individuals as shown in Figure *5*. Similarly, protected public forest has the maximum number of trees in diameter class of (31-40) cm which accounts for 445 individuals Figure *6*. This suggests that both forests are robust in terms of medium-sized trees, which are typically classified as pole/post stage.

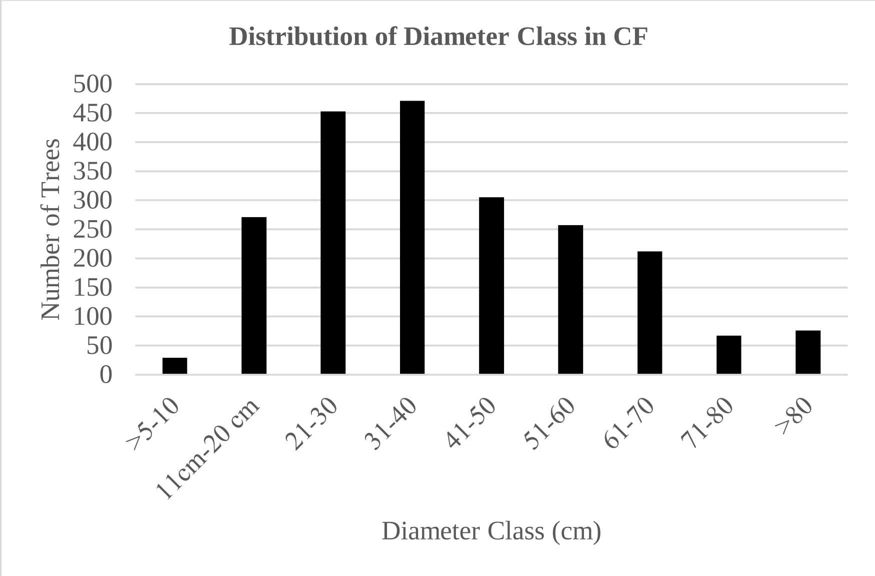

Figure 5 Distribution of Diameter Class in Community Forests

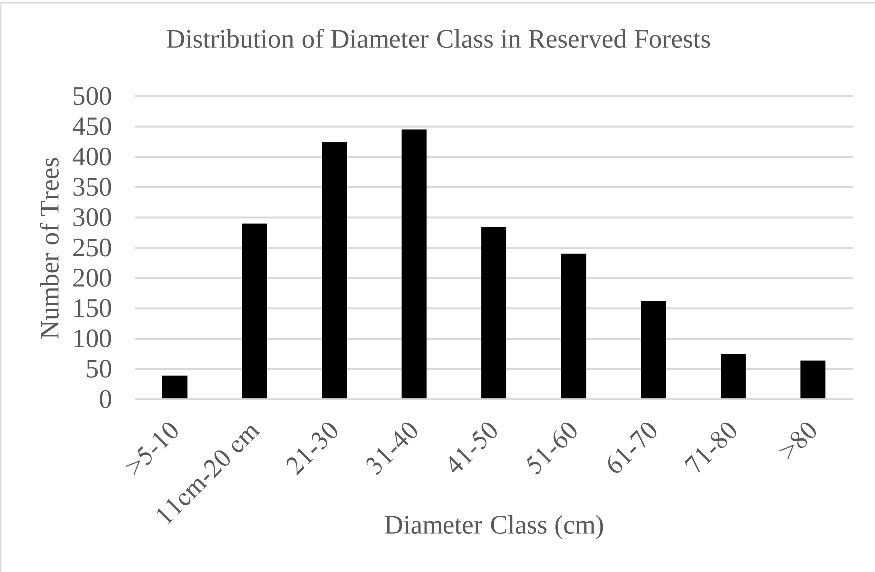

Figure 6 Distribution of Diameter Class in Protected Public Forests

About 22 percent of the tree species have the DBH range 31-40 cm in both community forest and protected public forest, which shows that both have more pole/post stages trees. The species distribution in both forests primarily consists of small-sized trees with a diameter range of >5-20 cm. In both forests, there is less percentage of trees with a diameter exceeding 60 cm as shown in Table *6*. The majority of tree species in both forests fall into the smaller diameter classes, particularly 5-20 cm. In the community forest, trees measuring between 11-20 cm account for 12.66%, while in the protected public forest, they account for 14.34%. This indicates a healthy regeneration potential, as younger trees are critical for sustaining forest ecosystems over time. The percentage of trees exceeding 60 cm in diameter is relatively low in both forests. For instance, the classes above 60 cm comprise only 25.45% of trees in the community forest and 22.38% in the protected public forest. These figures suggest that there may be fewer mature or old-growth trees, which can have implications for biodiversity, habitat complexity, and ecosystem services. The distribution of diameter classes between community forests and protected public forest is quite similar. While there are slight variations in the number of individuals per diameter class, the overall trends are consistent, underscoring comparable tree demographics and growth patterns. The significant presence of trees in the 31-40 cm class reveals that both forests may be experiencing a phase of development where younger trees are transitioning to maturity. This stage is crucial for forest health, biodiversity, and carbon sequestration. The dominance of smaller and medium-sized trees highlights the resilience of these forest ecosystems, suggesting that they are capable of regenerating and sustaining themselves if managed properly.

Table 6 Percentage distribution of tree diameter at breast height

Sr.No.	Diameter Class (cm)	Community Forest		Reserved Forest	
		No. of Individuals	Percentage	No. of Individuals	Percentage
1	>5-10	29	1.35	39	1.93
2	11cm-20 cm	271	12.66	290	14.34
3	21-30	453	21.16	424	20.96
4	31-40	471	22.00	445	22.00
5	41-50	305	14.25	284	14.04
6	51-60	257	12.00	240	11.86
7	61-70	212	9.90	162	8.01
8	71-80	67	3.13	75	3.71
	>80	76	3.55	64	3.16

4. Discussion

CFUG households in this region managed their community forests collectively for conservation and participated actively in meetings, although some lacked established benefit-sharing mechanisms. Common rules enforced to prevent illegal extraction and promote sustainable practices were outlined. However, the observation that only a minority of CFUG households were involved in silvicultural practices points to a gap in engagement and highlights the need for greater outreach and extension services. Existing research also indicates that extension services are pivotal in motivating community members to participate in sustainable practices [4]. Various activities including weeding, boundary demarcation, and fire protection were conducted by CFUGs to manage community forests sustainably. Furthermore, some silvicultural activities such as weeding, climbers cutting, boundary demarcation, forest guarding and fire protecting must be operated by CFUG households which participated in existing forests management to achieve the objectives of community forests, which is also consistent with silvicultural activities implemented in existing evidence in Nepal [17]. When local communities understand the benefits they derive from forest products and services, they are more likely to adjust their resource and land use practices and dedicate time and effort to forest conservation. With appropriate support and incentives, communities have the capacity and willingness to manage forests and woodland resources sustainably and promote biodiversity [10].

The results of the forest inventory data of different forest management types revealed that *Shorea siamensis Dalbergia cultrate*, *Grewia rothii, Bombax ceiba, Melanorrhoea usitata* were the common tree species in both community forests and reserved forests. Its high density, frequency, and Importance Value Index (IVI) in both forest types highlight its ecological adaptability and competitive advantage in these forest ecosystems. *Shorea siamensis* is the most common had highest density, frequency and IVI in both types of forests and it had good regeneration potential suggesting that this species is capable of sustaining its population under current forest conditions. In the study area, soil conditions are not conducive to healthy tree growth due to the shallow depth of topsoil and the presence of rocky and stony substrates in some areas. These findings align with previous studies that emphasize *Shorea siamensis* as a characteristic species in tropical dry forests due to its drought resistance and ability to thrive in nutrient-poor soils [16]. Similar studies have reported that effective natural regeneration often reflects favorable conditions, such as the availability of seed sources, minimal disturbances, and suitable microsites for germination [5]. The diameter class distribution patterns for both forest types were in the form of bell-shaped distribution. This type of distribution suggests that the majority of trees are concentrated in the middle diameter classes (21 - 40 cm), with fewer trees in both smaller and larger diameter classes. curve, indicating the adequate representation of small trees in the lower diameter classes. In the study area, annual forest fire frequently damages the natural regeneration during the dry summer season and as a consequence, it causes a large gap between the number of regeneration and sustainable growth of forest for long term. Such distributions are commonly associated with forests that have experienced selective logging, natural disturbances, or specific management interventions, which favor mid-sized trees [6]. The similarity in species composition and diameter distribution patterns between community forests and state-managed forests suggests that both management types are maintaining key ecological functions. However, slight differences in regeneration potential or diameter class representation may reflect varying degrees of human intervention, forest fire, operating silvicultural activities or forest protection measures. Previous research has shown that community-managed forests often have improved regeneration due to local stewardship and the involvement of Forest User Groups [7].

5. Conclusion

This finding serves as a valuable indicator for determining more effective approaches to managing community forests, as well as for monitoring and evaluating the effectiveness of forest conservation in the future. This study highlights the significant role of community forestry in enhancing biodiversity, improving forest conditions, and promoting sustainable resource management. However, challenges such as inadequate benefit-sharing mechanisms, limited silvicultural activities, and the impact of forest fires on regeneration persist. Addressing these issues requires targeted interventions, including improved community outreach, capacity building, and support for sustainable practices. The similarity in species composition and structural characteristics between community forests and state-managed forests suggests that both management strategies support the preservation of ecological functions, though they differ in the extent of community participation and the benefits provided. This study reinforces the potential of community forestry as a viable strategy for forest conservation and livelihood enhancement, calling for stronger institutional frameworks to support its long-term success.

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