sustainability

MDPI

Article

The Impact on Ecosystem Services and the Satisfaction Therewith of Community Forest Management in Northern Thailand

Siriluck Thammanu [1], Hee Han [2,*], E. M. B. P. Ekanayake [3], Yoonkoo Jung [4] and Joosang Chung [5,6,*]

1 Royal Forest Department, Bangkok 10900, Thailand; luckpp60@hotmail.com
2 Department of Forest Policy and Economics, National Institute of Forest Science, Seoul 02455, Korea
3 Department of Forest Conservation, Sampathpaya, Battaramulla 10120, Sri Lanka; epiumali@yahoo.com
4 Department of Forest Sciences, Seoul National University, Seoul 08826, Korea; yk6911@gmail.com
5 Department of Agriculture, Forestry and Bioresources, Seoul National University, Seoul 08826, Korea
6 Research Institute of Agriculture and Life Sciences, Seoul National University, Seoul 08826, Korea
* Correspondence: heehan@korea.kr (H.H.); jschung@snu.ac.kr (J.C.); Tel.: +82-10-3914-2838 (H.H.); +82-2-880-4764 (J.C.)

Abstract: Forest ecosystems provide myriad services that are beneficial to local livelihoods. Successful community forest management (CFM) enhances the provision, overall benefit, and effectiveness of the regulation of ecosystem services and contributes to forest conservation efforts. The study area was a deciduous forest in the Ban Mae Chiang Rai Lum Community Forest, which is located in Pa Mae Phrik National Forest Reserve in Thailand's northern province of Lampang. A systematic sampling of the forest area was conducted, and survey plots were established. A field survey documented 197 plant species from 62 families. A questionnaire that focused on CFM engagement behavior and ecosystem service satisfaction levels was used to interview household representatives. The study found that levels of engagement and the effectiveness of forest management were directly related; increased CFM effectiveness leads to improved ecosystem services. Participation in CFM can improve ecosystem services and enhance livelihoods. Specifically, participation in decision making, forest fire management, check dam construction, benefit sharing, and in forming effective forest regulations positively impacted ecosystem services. In contrast, employing forest patrols adversely affected those services. This knowledge is useful for identifying policies and practices that can maximize ecosystem services to enhance livelihoods and safeguard the forest's vitality.

Keywords: forest conservation; participatory decision making; deciduous forests; non-timber forest products; questionnaire

Citation: Thammanu, S.; Han, H.; Ekanayake, E.M.B.P.; Jung, Y.; Chung, J. The Impact on Ecosystem Services and the Satisfaction Therewith of Community Forest Management in Northern Thailand. *Sustainability* **2021**, *13*, 13474. https://doi.org/10.3390/su132313474

Academic Editor: Pablo Peri

Received: 2 October 2021
Accepted: 2 December 2021
Published: 6 December 2021

1. Introduction

A forest ecosystem is a source of timber, economic benefits, and biological diversity, and as such provides a range of services that include environmental and recreational functions [1,2]. These ecosystem services have been defined by the Millennium Ecosystem Assessment (2005) as the benefits people receive from an ecosystem, including provisioning (e.g., food, fresh water, wood, fiber, fuel, genetic resources), regulating (e.g., climate, floods, disease, water flow), and cultural services (e.g., aesthetics, spirituality, recreation, ecotourism) [3]. Many studies have revealed that these ecosystem services result from effective forest management [2,4,5]. Thus, the efficiency of forest management can influence the existence, quality and viability of these benefits and can, therefore, concomitantly be linked to human well-being.

Thailand is an ASEAN country richly endowed with forests that cover 31.64% of its total area [6]. The forests are vital to the country as approximately 23 million people live near national forest reserve areas and depend on their ecosystem benefits for subsistence and income opportunities [7]. They continue to play a significant role in economic, social,

and environmental development despite the fact that their viability and effectiveness are under increasing pressure. Deciduous forests, including mixed deciduous and dry dipterocarp, are exceptionally important in Thailand. They cover 18.26% of the nation's forest area [8], and they provide the most valuable timber and non-timber forest products (NTFPs) for remote rural communities to access to supplement their livelihoods [9–13].

Mirroring a 1985 forest policy declaration, the 12th National Economic and Social Development Plan (2017–2021) reiterated Thailand's goal of maintaining a minimum of 40% of the country's total area as forests with 25% of them for conservation forests and 15% for economic forests [14,15]. In spite of this, Thailand still faces significant issues regarding the depletion of its natural forest resources. Accelerated deforestation has been fueled by commercial logging and the heightened need of a burgeoning population for agricultural land [16]. Forest encroachment and illegal logging continue to pose serious threats to the forests and to those who rely on them. This is particularly true in the north of Thailand where the highest degree of illegal activity and forest conversion rates have been reported [17]. Illegal logging has a wide-reaching and detrimental impact on the economy, the environment, and the local residents. Collectively, these developments have been the impetus that underlies the increased community management of forests throughout Asia [18].

Community forest management (CFM) is a method of sustainable forest resource management that provides a wide range of social, economic, and environmental benefits [19]. CFM's efficacy is multi-faceted. It can address encroachment by encouraging people in the community to collaborate with the government to preserve, restore, and develop forests [20,21]. It serves as a vehicle by which community organizations are supported and developed. It also advances the 2017 constitutional mandates of the Kingdom of Thailand which empowers local communities to participate in the management, maintenance, and utilization of natural resources and the environment [22]. Overall, CFM is an important component of an operational framework. It provides local communities the opportunity to participate in sustainable forest management, conservation, and decision making regarding the utilization of natural resources in conjunction with relevant and applicable laws and regulations.

The provisioning, regulatory, and cultural ecosystem functions provided by forest resources are reflected in the biodiversity and the NTFPs that can be utilized for income supplementation and daily consumption [10,13,23–28]. As a result of a greater appreciation and awareness of the importance of the forest and its resources, emphasis has been placed on local involvement in management while promoting responsible utilization of NTFPs and conservation of resources. Previous studies have demonstrated that success or failure of CFM can depend on a forest's unique features and levels of CFM participation [29–31]. This information is useful for identifying forest management policies that are more effective at addressing local needs, improving forest conditions, and enhancing ecosystem services.

The recently enacted Community Forest Act B.E. 2562 (2019) formally codified and established the authority for local decision making. This has incentivized participation, expanded local control and created new opportunities to implement and benefit from successful management [32]. During the twenty years prior to 2021, 15,337 community forest projects were established in 17,442 Thailand villages, encompassing 1.2 million hectares [33], including the study area. The Ban Mae Chiang Rai Lum Community Forest has been officially registered as a community forest and managed as such in collaboration with the Royal Forest Department (RFD). Protracted illegal logging, encroachment, and damage to forest viability, which are issues faced by community forests throughout Thailand, served as the collective impetus for continuously implementing CFM in the study area since 2008.

Many studies have investigated the various drivers of participation in forest management; however, there is a lack of relevant data regarding the impact CFM can have on the crucial ecosystem services provided by the forest [34,35]. Such knowledge can be helpful in promoting and expanding the role of local people in managing forest resources [36] and

in positively impacting ecosystem services in Thailand. Our study would help to provide information necessary to improve ecosystem service benefits through CFM.

Therefore, the objectives of this study were to (1) assess the ecological characteristics of a deciduous forest contained in a community forest, (2) identify a community's forest management practices and the ecosystem services they provide, and (3) determine the relationship between these practices and services in order to inform more sustainable community forest management.

Several previous studies have indicated that CFM positively impacts ecosystem services such as climate regulation, carbon sequestration, hydrological services, pollination, and the provision of habitats [37–39]. In addition, the utilization of NTFPs was found to be closely related to participation in CFM [40]. Similarly, greater participation resulted in more effective forest management [41,42]. These findings are consistent with other studies [43–47]. Therefore, this study hypothesized that CFM is expected to improve ecosystem services. In addition, the effectiveness of CFM will reflect the engagement levels in the community forest. This increased engagement will subsequently improve the functional production systems of the forest and qualitatively and quantifiably develop provisioning, regulating, and cultural services.

2. Materials and Methods

2.1. Study Area

This study was conducted in the Ban Mae Chiang Rai Lum Community Forest (17°22′48″ N to 17°27′47″ N and 99°00′47″ E to 99°05′48″ E) which is part of the Pa Mae Phrik National Forest Reserve of Lampang Province in northern Thailand. The study area is one of the largest community forests in Thailand with an area of 3925 ha. It ranges in altitude from 140 to 660 m and has been classified as a deciduous forest [48] (Figure 1).

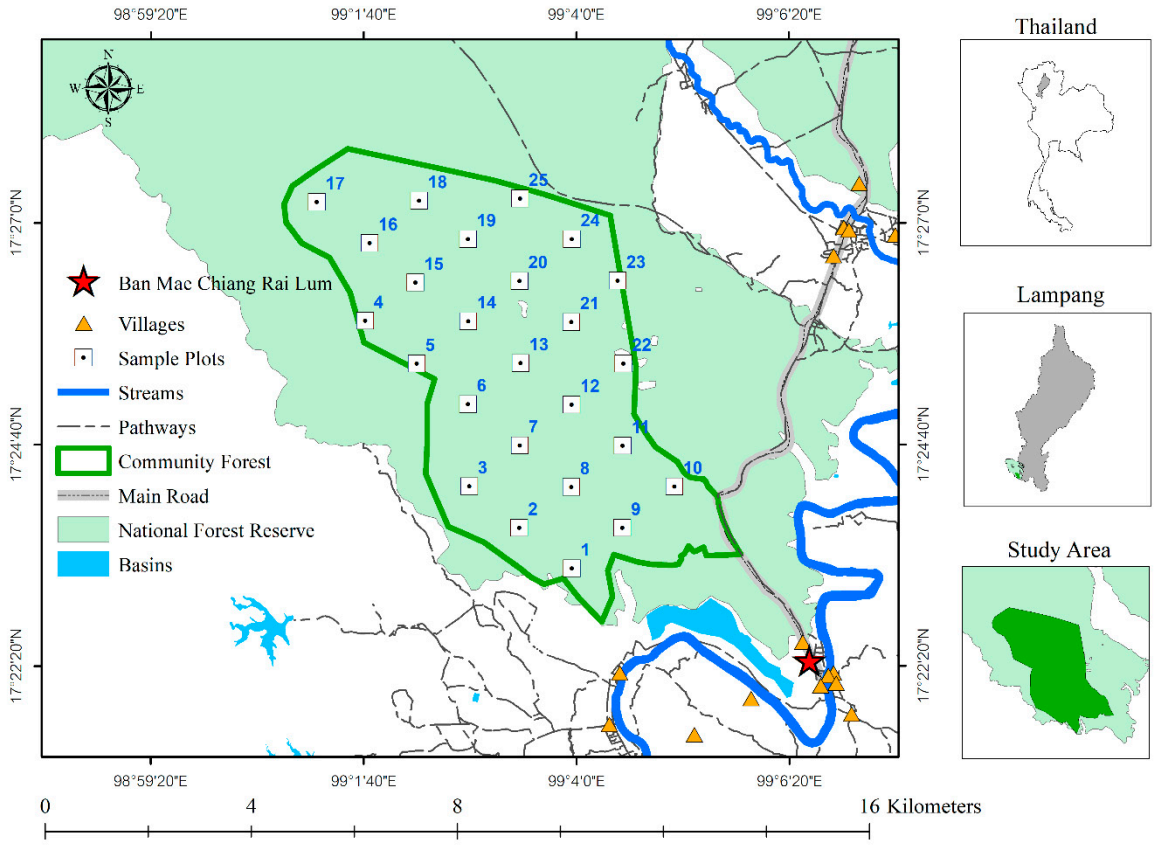


Figure 1. Location of the Ban Mae Chiang Rai Lum Community Forest in northern Thailand.

The study area experiences two distinct seasons: a wet season from April to October and a dry season from November to March. Drought conditions are common. According to the Thai Meteorological Department's 2018 data, temperatures ranged from 31.7 °C in January and November to 37.1 °C in March, while the mean annual temperature was 33.6 °C, relative humidity had a mean of 76.1%, and the mean rainfall was 1129.4 mm [49].

Forest resources in the study area have historically been under pressure and remain so as a result of illegal logging, deforestation, degradation, and the increasing demands for agricultural land from a growing population. This area also experiences periodic drought conditions which contribute to the need for corrective and remedial actions and policies to safeguard resources.

Since 2008, the study forest area has been collaboratively managed by local residents and the government in accordance with a community forest management program. CFM has proven to be an effective approach in supporting the livelihoods of nearby residents [50,51]. In spite of the longevity of CFM in this forest and throughout Thailand, minimal and insufficient data are available to effectively analyze the impact that CFM has on ecosystem service benefits and to determine what, if any, relationship there is between the two.

2.2. Theoretical Framework and Variables

2.2.1. Research Framework

The protection of forest resources through CFM has been shown to be more effective than the non-CFM management efforts such as reducing deforestation and minimizing human disturbances [52,53]. In addition, it has been reported that carbon stock, forest cover, tree basal area, and tree stem density are more positively impacted in CFM areas when compared with non-CFM areas [52–54]. CFM is closely related to enhancing the provision, overall benefit, and effectiveness of ecosystem services [35,55]. Thus, CFM could potentially have a positive impact on forest conditions, satisfaction with CFM and the ecosystem services that the forest provides.

There are four components of CFM: (1) the level of participation in management efforts, (2) knowledge of regulations and opinions as to the levels of compliance with, and the effectiveness of, those regulations, (3) understanding and perception of CFM, and (4) the sharing of forest resource benefits [25,56–59]. Investigating these components can help us assess the effectiveness of CFM.

It has been found that the degree to which the households in the community participate in CFM vary, and the extent to which households avail themselves of the benefits of the forest's ecosystem services are likewise unique. Studies have also determined that participation in local CFM improves the effectiveness of forest resource management [36,53,60–62]. This, in turn, elevates the ecosystem service benefits thereby resulting in higher community satisfaction. Therefore, maximizing CFM participation can lead to enhanced ecosystem service benefits.

We, therefore, posit that effective CFM can improve (1) provisioning, (2) regulating, and (3) cultural services, the three primary ecosystem services, and ultimately enhance the benefits that accrue to the people of the community (Figure 2).

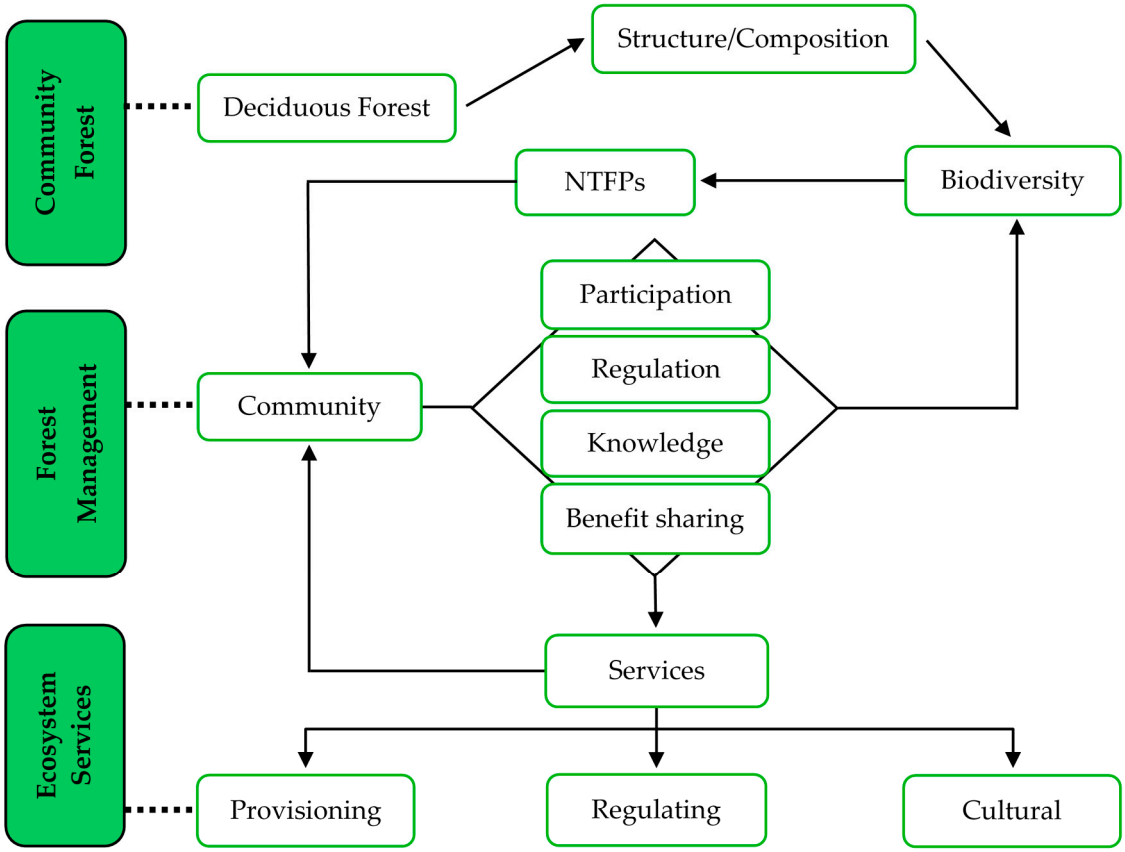


Figure 2. Conceptual framework of the relationship between CFM and ecosystem services.

2.2.2. Variables

The variables and description of factors on ecosystem services and CFM are shown in Table 1. Participation in CFM is multi-faceted. According to the FAO (2005), it is a process in which stakeholders influence policy formulation and investment choices [63]. They share control over development initiatives and management decisions and establish a necessary sense of ownership among their local communities. There are different methods and degrees of participation [64]. Appendix A details the question types, subject matter, and response options constituting the questionnaire. The Appendix A also provides a general explanation of the information-gathering methodology. Informed household representatives who were involved in forest management as active members, other supporters, or passive members were all interviewed [65]. Opinions as to the below-described ecosystem services and CFM factors were investigated:

Table 1. Variables and identifying characteristics of the impact of CFM factors on ecosystem services.

	Variables	Identifying Characteristics
Dependent Variables		
Ecosystem services	Provisioning services	Level of satisfaction with NTFPs as foods, medicinal plants, fuelwoods, fibers, extractives, including benefits from fresh water and biodiversity
	Regulating services	Level of satisfaction with the regulation of air, soil, pollination, wind storms, pests and disease, and water yield
	Cultural services	Level of satisfaction with the inherit culture, traditions, beliefs, religions, local wisdom, and recreation and ecotourism

Table 1. *Cont.*

	Variables	Identifying Characteristics
Independent Variables		
CFM	Decision-making process	Level of participation in planning forest management, such as determining regulations, assigning authority, and forest development activities
	Participation in forest activities	Level of participation in forest plantations, forest protection and weed control, forest patrol, forest fires control, forest surveys and alignment, building check dams, and cultural and traditional forest events
	Monitoring and evaluation activities	Level of follow-up on performance, presenting problems and obstacles, and finding solutions to CFM
	Household NTFP income	Income of a household from collecting and utilizing NTFPs in 2018 (in THB)
	Knowledge of forest regulations	Level of familiarity with community forest regulations
	Effective forest regulations	Opinion regarding the appropriateness and efficient enforceability of the community forest regulations
	Compliance with forest regulations	Level of compliance with community forest regulations
	Perception and understanding	Level of knowledge of CFM principles and sustainable forest management
	Benefit sharing	Level of satisfaction from sharing the benefits fairly and equitably of the community forest in environmental, social, and economic benefits

CFM = Community forest management, NTFPs = non-timber forest products, THB = Thai baht.

- Ecosystem services

Forest ecosystem services are the benefits from forest resources that directly affect people and provide support for the maintenance of other services. In line with the Millennium Ecosystem Assessment (2005), the satisfaction of the people with three of the community forest ecosystem services [3] was investigated as follows.

1. Provisioning services: the benefits that people obtain from food, medicine, fuelwoods, fibers, and extractives (e.g., resins, gums, oils, waxes, and chemicals), fresh water, and the biodiversity that reflects genetic resources.

2. Regulating services: the benefits that people receive from the regulation of ecosystem processes related to air, soil, pollination, windstorms, pests and disease, and water yield.

3. Cultural services: the benefits resulting from the support of culture, traditions, beliefs, religions, local wisdom, and recreation and ecotourism.

- Community forest management (CFM)

Involvement in forest management can lead to improved forest conditions that yield more abundant and beneficial forests. According to Cohen and Uphoff (1980), there are four levels of participation: decision making, implementation, evaluation, and benefiting [66].

1. Prompting involvement in decision-making processes is essential for improving forest management. Coulibaly-Lingani et al. (2011, 2014) found that the opportunity to engage in decision making is a primary incentive to participate in forest management in general which, in turn, is strongly correlated with enjoying forest-sourced economic benefits [45,67].

2. Forest activities are vital to improving conditions and enhancing ecosystem services for the benefit of those who rely on the forest for subsistence or income [68]. In Thailand, various measures are employed, including plantation, protection and weed control efforts, patrols, forest fire control, surveys and alignment, building check dams (structures that span streams with sandbags, or rock, branches, or other natural material to inhibit wa-

ter flow, retard erosion, and increase soil hydration), and cultural and traditional forest events [69,70].

3. Unfettered and unmonitored utilization of NTFPs can have a negative impact on species diversity as well as on the amount and variety of NTFPs [71,72]. Monitoring means the general, ongoing observation of the patterns of utilization of forest resources and the subsequent impact on species and forest health. In addition, it includes managing forest fires, being involved in forest activities and being knowledgeable of the effect of such utilization on forest resources.

4. The opportunity to utilize the forest for income prompts involvement in public forest programs and activities, which enhances forest management success and improves ecosystem services [36,73]. Thus, household income for 2018 from food, medicine, fuelwood, fiber, and extractive NTFPs was assessed as part of this study.

Successful forest management depends on additional factors that can impact community forests, such as:

5. Regulations are crucial tools for forest management and monitoring the utilization of resources [30,73]. Kongcharoen (2012) showed that communities can efficiently enforce their own regulations [74]. Community members have also viewed strict rules and regulations as inadequate [75]. In this study, we investigated residents' knowledge of forest regulations and asked their opinions regarding the effectiveness of and compliance with those regulations.

6. Perception, understanding, and knowledge of the principle of sustainable forest management also impact the effectiveness of CFM [50,75]. While it is true that any household can access forest resources and have an impact on the effectiveness of CFM, households with a better understanding of the importance of sustainability and more knowledge of the available resources and technologies can more effectively supplement their income by collecting and utilizing NTFPs [26,27]. This knowledge can increase interest in forest conservation [43–47].

7. Sharing forest benefits through transparent processes is also a component of successful CFM. Doing so fosters an environment that motivates relevant stakeholders to become more responsible in their use of natural resources to the benefit of community livelihoods in general [36,76].

2.3. Forest Field Survey

2.3.1. Data Collection

A field survey related to ecosystem services, species diversity, and NTFPs in the community forest was conducted from July to October 2018. The forest comprises 3925 ha. In line with the findings of ANSAB (2010), 0.1% of the total inventory was sampled [77]. Twenty-five sample plots measuring 40 × 40 m each were established using a systematic sampling method. In each plot, all plant species with a diameter at breast height (DBH) ≥4.5 cm were identified and measured in 10 × 10 m sub-quadrats. Within the 10 m sub-quadrats, saplings with a DBH <4.5 cm and a height >1.30 m were recorded in 4 × 4 m sub-quadrats, while seedlings were documented in 1 × 1 m sub-quadrats within each 4 m sub-quadrat. The sample plot locational information is shown in Figure 3.

2.3.2. Data Analysis

Plant species were categorized into their family, genera, and species. A comparison of unknown specimens was conducted with those in the Forest Herbarium of the Department of National Parks, Wildlife and Plant Conservation to classify species that were not initially identifiable [78]. In order to ascertain the ecological characteristics of the community forest, the number, density, and basal area of the trees were calculated.

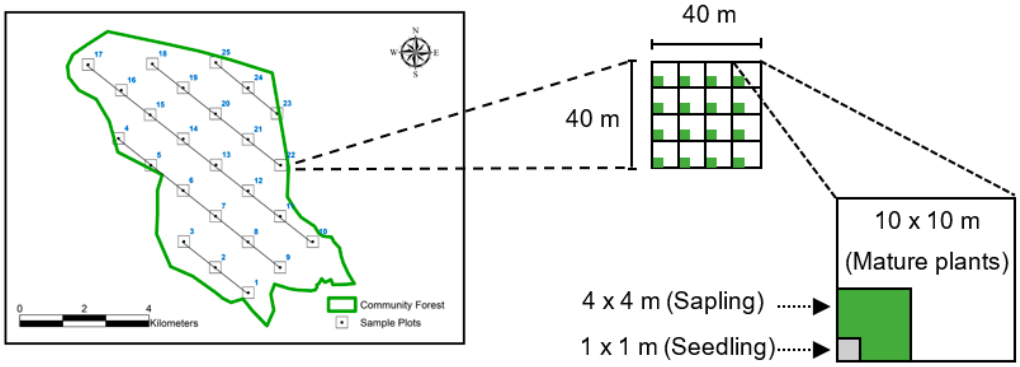


Figure 3. Map of sample plots in the study area.

The importance value index (IVI) was used to determine the ecological importance of the tree species in each forest by calculating the following:

$$\text{IVI} = \text{R.D} + \text{R.F} + \text{R.D}_o \quad (1)$$

where R.D is the relative density of the tree species, and is equal to number of individuals of the species × 100/total number of quadrate studies; R.F is their relative frequency, calculated as the number of quadrates in which species occurred × 100/total number of quadrate studies; and R.D_o is their relative dominance, which is equal to the total basal area of species × 100/total basal area of all the species [79].

Additionally, tree DBH and height classes were investigated to identify trends in the density, growth, and regeneration of species. Shannon–Wiener indices (H') were also computed to determine the forest's biodiversity using this equation:

$$H' = -\sum_{i=1}^{s}(pi)(log_2 pi) \quad (2)$$

where s is number of species, and pi is the proportion of individuals found in the ith species.

NTFPs can be classified in many ways. They are classified by mode of utilization in Thailand. Biodiversity inventories usually group animals and plants according to the scientific names of their family and genera. Ethno-botanical studies classify according to local end uses (e.g., food, medicine, fuelwood, fiber, extractive). Foresters and forest-based assessments use groupings according to plant form and parts used (e.g., non-wood tree parts, fruit, herbs, climbers, shrubs, etc.) [80]. In this study, we grouped the NTFPs into five categories based on the general classification that has been applied in other studies in Thailand [12,13,81]. Accordingly, NTFPs were separated into food plants, medicinal plants, fuelwoods, fibers, and extractives.

2.4. Household Survey

2.4.1. Data Collection

A systematic sampling method was used to determine a representative number of households to be interviewed. Using proportional sampling and applying the formula proposed by Yamane (1967), a sample size was determined [82]. The formula utilized is:

$$n = N/\ (1 + Ne^2) \quad (3)$$

where n = the sample size to be estimated, N = the number of households, and e = the significance level (0.05).

It was determined that 159 of the 265 total households in the subject area community would provide sufficient sampling intensity for the interview portion of the study. The interviews utilized a pre-developed questionnaire that consisted of requests for specific demographic data, questions that provided multiple response choices (single/multiple

answers and for Likert scale application), and questions that presented opportunities for open-ended responses, as described in more detail as follows:

1. Socio-demographic information, such as gender, age, marital status, role in family, education level, household size, primary occupation, household income, and land ownership, was sought to understand the makeup of the community.

2. Information regarding household income from the harvest and utilization of these nine categories of NTFPs was obtained: food (edible plants, wild fruits, mushrooms, honey and insects, and small animals), medicinal plants, fuelwoods, fibers, and extractives [12,13,81].

3. Methods and degrees of engagement in CFM and satisfaction with ecosystem services and their benefits were determined through interviewee responses on a scale of 1–5 (5 = 'very high', 4 = 'high', 3 = 'moderate', 2 = 'low', and 1 = 'very low'), which were averaged and interpreted based on a five-point Likert scale.

Respondents were also asked to rate their levels of participation in decision making, forest activities, and monitoring and evaluation activities, as well as rate the effectiveness of regulations and the degree to which the community shares the accessible benefits, on the same 1–5 scale.

Levels of satisfaction with provisioning, regulating and cultural ecosystem services were determined in the same fashion.

2.4.2. Data Analysis

The net return from the utilization of the nine categories of NTFPs in 2018 was determined by subtracting the 'opportunity' and 'transportation' costs from the total income. The minimum daily wage in Thailand of THB 300 (USD 9.68) was used to calculate the economic value of the NTFPs that were harvested for subsistence or trade based on the time involved in doing so. In addition, transportation (fuel) costs were considered in a calculation of the net return:

$$\text{Net NTFPs Return } = \sum_{i=1}^{n} PiQ_i^h - \left(WL^h + Tc^h\right) \quad (4)$$

where, Pi = price of the good, i = category of NTFP, Q_i^h = quantity of goods collected by household h, W = wage rate, L^h = hours worked by households h, and Tc^h = transportation costs incurred by households h.

To determine the degree of effectiveness of CFM and levels of satisfaction with ecosystem services, averaged interviewee responses were interpreted based on the mean interval ranges on a five-point Likert scale. The scale was broken down into equal mean intervals of 0.80 in order to provide a weighted mean. The interval ranges were calculated by subtracting one from five (the minimum and the maximum length on the scale), or $5 - 1 = 4$, then dividing the resulting four by five, which is the greatest value on the scale, or $4/5$, for a result of 0.80. The intervals are interpreted as 'very high' = 5.00–4.21, 'high' = 4.20–3.41, 'moderate' = 3.40–2.61, 'low' = 2.60–1.81, and 'very low' = 1.80–1.00.

A chi-squared test of independent variables was used to determine the relationship between CFM factors and the ecosystem services.

A binary logistic regression analysis was used to understand how differently the various levels of participation in CFM affect ecosystem services. CFM and ecosystem service variables were coded as 1 if 'very high' and coded as 0 if otherwise, except for NTFP income variables which were coded as 1 if >5000 THB and 0 if otherwise. The impact of community forest management on ecosystem services was calculated using this equation:

$$ln\left(\frac{P}{1-P}\right) = \beta_o + \sum_{i=1}^{n} \beta_i X_i + \varepsilon \quad (5)$$

where, P = the probability of the event that $Y = 1$ (ecosystem services), β_o = the regression intercept, β_i = the regression coefficient of the ith CFM factor, X_i = the ith CFM factor influencing the ecosystem services, and ε = the random disturbance term.

All statistical calculations were performed using the Windows version of the R 4.1.1 (10 August 2021) program for datasets, graphics, and stats packages [83].

3. Results

3.1. Ecological Characteristics of the Community Forest

The field survey of the forest led to the identification of 18,567 plants of 197 species (129 mature tree, 99 sapling, and 141 seedling species), 144 genera, and 62 plant families with an average density of 966 trees ha^{-1} and an average basal area of 16.74 m^2 ha^{-1}. The ecological characteristics of the mature trees (DBH $\geq$ 4.5 cm) in the community forest are shown in Table 2.

Table 2. The ecological characteristics of Ban Mae Chiang Rai Lum Community Forest.

Ecological Characteristics	Mean ± Standard Deviation
Species	24.32 ± 6.87
Families	16.80 ± 3.09
Genera	20.04 ± 5.83
Density (trees/ha)	57.70 ± 15.81
Basal area (m^2/ha)	16.74 ± 3.99

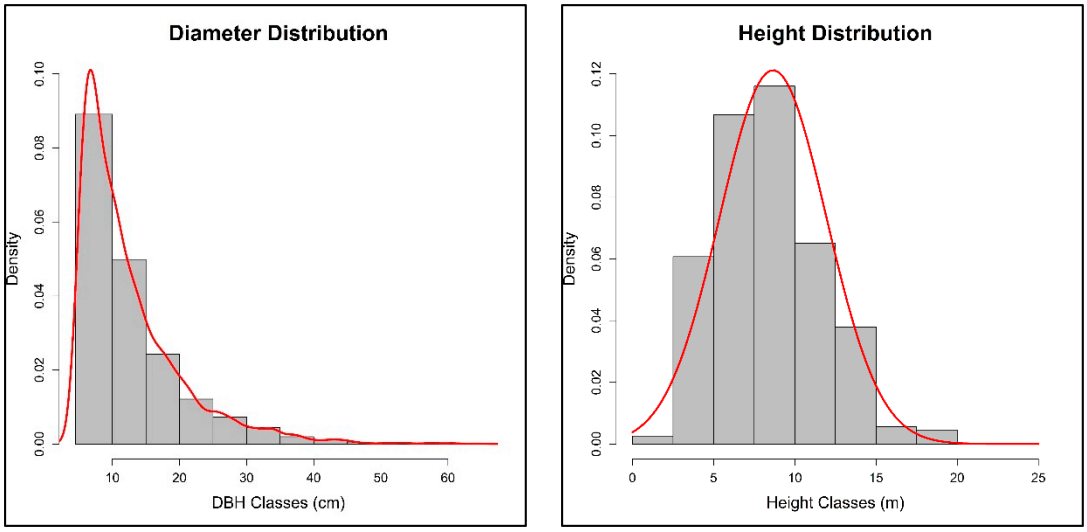
The importance value indices of the primary species in the community forest are shown in Table 3. *Shorea obtusa*, *Shorea siamensis*, *Xylia xylocarpa*, *Sindora siamensis*, and *Buchanania lanzan* were the five most significant species.

Table 3. The importance value indices of plant species in the community forest.

Ranking	Species	Family	R.D	R.F	$R.D_o$	IVI
			(%)	(%)	(%)	(%)
(1)	*Shorea obtusa*	Dipterocarpaceae	10.90	9.47	10.90	11.76
(2)	*Shorea siamensis*	Dipterocarpaceae	10.12	6.82	10.12	8.93
(3)	*Xylia xylocarpa*	Fabaceae	7.06	8.19	7.06	6.87
(4)	*Sindora siamensis*	Fabaceae	6.83	3.53	6.83	5.53
(5)	*Buchanania lanzan*	Anacardiaceae	0.86	1.52	0.86	5.29
(6)	*Terminalia mucronata*	Combretaceae	4.05	4.02	2.76	3.61
(7)	*Canarium subulatum*	Burseraceae	2.13	3.04	5.64	3.60
(8)	*Millettia brandisiana*	Fabaceae	3.50	2.36	3.12	2.99
(9)	*Dipterocarpus tuberculatus*	Dipterocarpaceae	2.39	2.50	3.30	2.73
(10)	*Ellipanthus tomentosus*	Connaraceae	3.06	3.88	0.89	2.61
	119 other species	62 other families	40.09	54.66	34.45	46.07

R.D = relative density, R.F = relative frequency, $R.D_o$ = relative dominance, IVI = importance value index.

Figure 4 below presents the distribution of mature trees in density ranges and height classes. Trees with a DBH <10 cm (49.02%) were the most abundant, followed by trees with a DBH of 10–20 cm (37.09%), 20–30 cm (9.70%), and >30 cm (4.19%). Overall, the DBH ranged from 4.50 to 64.34 cm with a mean of 11.53 ± 6.71cm.



(**a**) (**b**)

Figure 4. Distribution of trees according to: (**a**) DBH class and (**b**) height class within the community forest.

The range of the height classes of trees was 1.30–25.00 m with a mean height of 8.65 ± 3.29 m. Trees in the 5–10 m class (55.84%) had the highest density, followed in descending order by the 10–15 m class (25.75%), the 1.3–5 m class (15.84%), and the >15 m class (2.69%).

3.2. Species Biodiversity and Its NTFP Producing Contribution

The average diversity indices of the deciduous forest stands in the Ban Mae Chiang Rai Lum Community Forest were calculated to be 2.49 ± 0.28 (mature trees), 2.25 ± 0.32 (saplings), and 2.44 ± 0.43 (seedlings). Of the 197 NTFP-producing species found in the community forest, 160 have medicinal uses, 89 are used as food, 37 are used as extractives, 32 as fuelwoods, and 12 are used as fibers (Table 4).

Table 4. NTFPs of the Ban Mae Chiang Rai Lum Community Forest.

	Number of Species	Species and Type of NTFPs				
		Food Plants	Medicinal Plants	Fuelwoods	Fibers	Extractives
Tree	92	47	74	25	6	27
Shrub	53	23	49	7	1	10
Climber	25	9	17	-	3	-
Herb	21	8	18	-	1	-
Bamboo	1	1	1	-	-	-
Fern	3	1	1	-	1	-
Orchid	1	-	-	-	-	-
Palm	1	-	-	-	-	-
* Total	197	89	160	32	12	37

NTFPs = non-timber forest products. * Due to some plants being used for different NTFPs, the total number of species is not equal to the cumulative total of species used as NTFPs.

3.3. Socio-Demographics of Respondents

A composite of the household survey data is shown in Table 5. Respondents were between 26 and 86 years old, though they were primarily 30–60 years old (62.89%) and female (62.89%). The vast majority were married (72.33%) and the heads of their household (62.26%). Most had attained an elementary school education (67.92%). Smaller families (three members or less) were more common (57.86%) and farming (83.65%) was the primary occupation. More households (38.36%) reported an income range between THB 62,000–

124,000 (USD 2000–4000) than any other range of income. A large majority of respondents were landowners (88.05%).

Table 5. Respondent demographics.

Socio-Demographics	Groups	Households (%)
Gender	Female	100 (62.89)
	Male	59 (37.11)
Age (year)	<30	4 (2.52)
	30–60	100 (62.89)
	>60	55 (34.59)
Marital status	Single	44 (27.67)
	Married	115 (72.33)
Role in family	Head	99 (62.26)
	Member	60 (37.74)
Education level	Uneducated	2 (1.26)
	Primary school	108 (67.92)
	Secondary school	44 (27.67)
	Bachelor's degree	5 (3.15)
Household size (people)	1–3	92 (57.86)
	>3	67 (42.14)
Primary occupation	Farmer	133 (83.65)
	Off-farm	26 (16.35)
Household income (THB)	<62,000	56 (35.22)
	62,000–124,000	61 (38.36)
	>124,000	42 (26.42)
Land ownership	Yes	140 (88.05)
	No	19 (11.95)

USD 1 = THB 31 on 31 January 2018 as of Bank of Thailand.

3.4. Utilization of Non-Timber Forest Products (NTFPs)

In this study, we categorized the 159 households into three groups based on the nature of their NTFP usage: (a) harvest and use (HAU), (b) non-harvest but use (NHBU), and (c) neither harvest nor use (NHNU).

Overall, 109 households (68.55%) harvested and utilized NTFPs. Figure 5 below shows that HAU households mostly utilized mushrooms (106 households, 66.67%), small animals (57 households, 35.85%), and wild fruits (74 households, 46.54%).

Households in the NHBU category relied on NTFPs but either collected or bought from other sources, including harvesters, sellers, or collectors of harvested NTFPs. They did not harvest the NTFPs themselves. Of the NTFPs that these households utilized, honey and insects were used by the most households (64.78%). Small animals (45.28%), mushrooms (32.70%), and wild fruit (23.27%) were also used but not harvested.

The vast majority of households did not harvest or use (NHNU) fibers (95.60%), fuelwoods (91.19%), medicinal plants (87.42%), or edible plants (59.75%). A small number of households neither relied on nor used wild fruits, honey and insects, small animals, or edible mushrooms.

More specific NTFP household harvest and usage details are provided in Table 6.

Table 6. Household harvest and usage of NTFPs.

NTFPs	Types	Uses	Components Used	Period of Collection (in Months)	Quantity per Household (Mean ± SD)	Price/Unit (THB)	Number of Households (%)
Apis dorsata	Insect	Food	Honey	March–May	8.00 ± 5.65 L	250	2 (1.26)
Adenia viridiflora	Climber	Food	Stem, leaf, shoot	March–June	12.10 ± 23.19 kg	20–100	14 (8.81)
Amanita spp.	Mushroom	Food	Whole	May–July	13.33 ± 16.20 kg	50–150	101(63.52)
Astraeus spp.	Mushroom	Food	Whole	March–June	5.22 ± 5.45 kg	400	11 (6.92)
Bauhinia strychnifolia	Climber	Fiber	Stem	April–June	4.00 ± 2.58 kg	40–100	4 (2.52)
Cantharellus sp.	Mushroom	Food	Whole	June–October	30 kg	20	1 (0.63)
Cycas siamensis	Shrub	Food, medicine	Fruit	July–August	35.83 ± 55.61 kg	100–200	3 (1.89)
Elephantopus scaber	Herb	Medicine	Root	March	2 kg	100	1 (0.63)
Eurycoma longifolia	Shrub	Medicine	Root	March–April	1.87 ± 1.12 kg	50–100	8 (5.03)
Irvingia Malayana	Tree	Food	Fruit	September–April	67.55 ± 59.10 kg	50–100	69 (43.40)
Kaloula pulchra *Glyphoglossus molossus*	Amphibian	Food	Whole	April–June	10.85 ± 8.79 kg	50–180	55 (34.59)
Leiolepis belliana	Reptile	Food	Whole	March–June	6.21 ± 5.93 kg	100–250	26 (16.35)
Melientha suavis	Shrub	Food	Stem, leaf, shoot	January–April	18.73 ± 23.70 kg	50–140	19 (11.95)
Momordica cochinchinensis	Climber	Food, medicine	Stem, leaf, fruit	March–August	5.50 ± 6.61 kg	20–100	7 (4.40)
Oecophylla smaragdina	Insect	Food	Eggs	March–April	9.71 ± 7.97 kg	250	14 (8.81)
Phyllanthus emblica	Tree	Food, medicine	Fruit	November–April	143.00 ± 178.17 kg	10	8 (5.03)
Russula sp.1	Mushroom	Food	Whole	June–October	14.57 ± 18.63 kg	20–100	14 (8.81)
Russula sp.2	Mushroom	Food	Whole	Whole year	11.41 ± 22.78 kg	100–150	73 (45.91)
Schleichera oleosa	Tree	Food	Fruit	June–August	24.00 ± 21.51 kg	10	3 (1.89)
Shorea spp.	Tree	Fuelwood	Trunk, branch	March–June	7.00 ± 7.07 m^3	100	5 (3.14)
Termitomyces spp.	Mushroom	Food	Whole	June–November	18.48 ± 21.84 kg	250–400	102 (64.15)
Thyrsostachys siamensis	Bamboo	Food, medicine	Shoot, leaf	April–August	36.87 ± 39.54 kg	10–30	8 (5.03)
Trevesia palmata	Shrub	Food	Flower	March–August	10.12 ± 10.84 kg	100–200	8 (5.03)

NTFPs = non-timber forest products, SD = standard deviation, THB = Thai baht, L = liter, kg = kilogram, m^3 = cubic meter. USD 1 = THB 31 on 31 January 2018 as of Bank of Thailand.

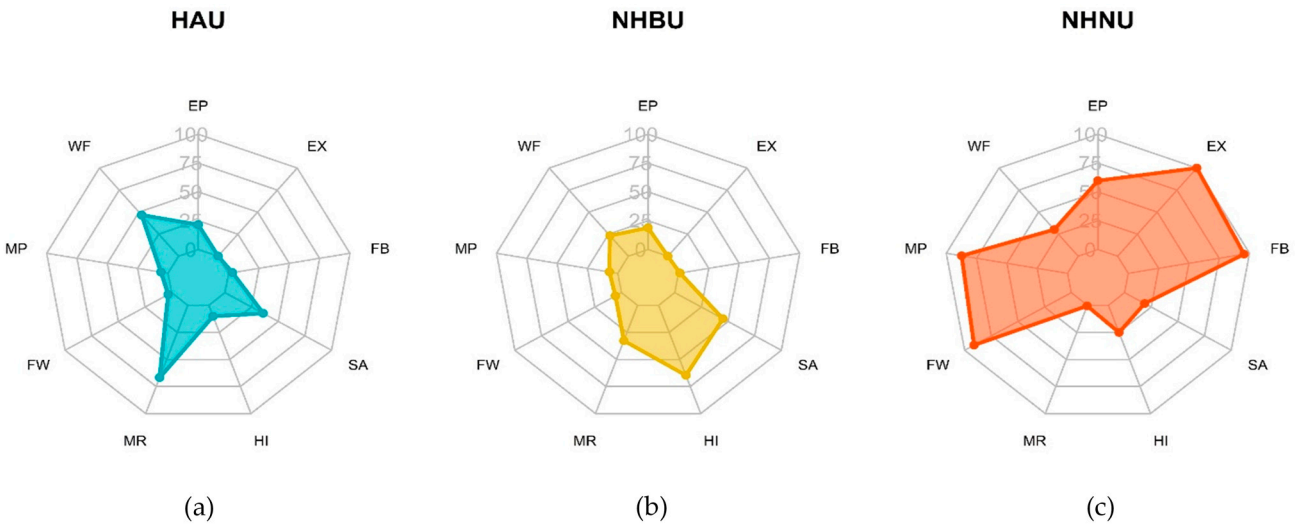
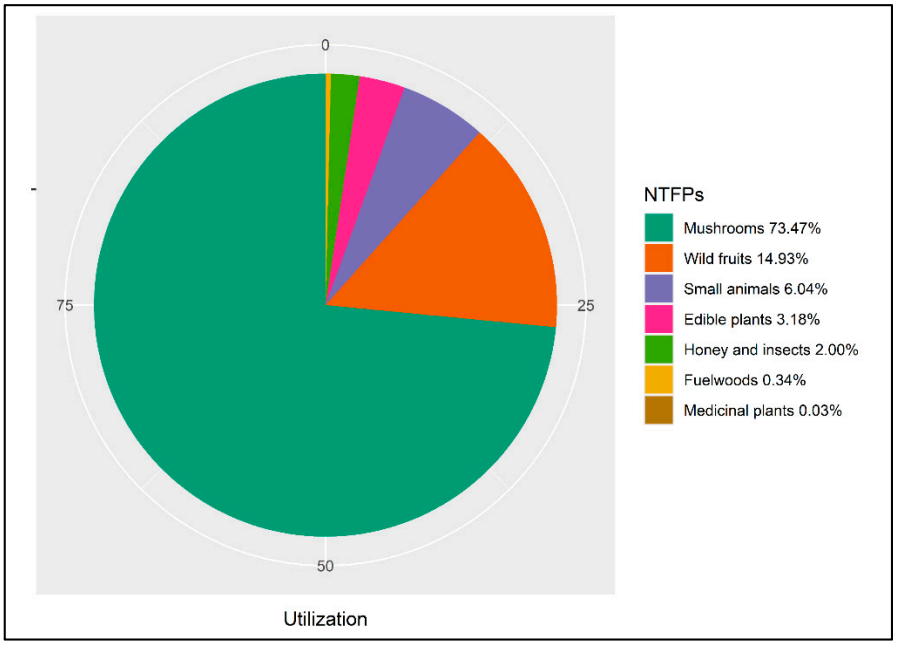


Figure 5. Harvest and utilization practices: (**a**) HAU—harvest and utilize, (**b**) NHBU—non-harvest but utilize, and (**c**) NHNU—neither harvest nor utilize. Utilization by household percentage of: EP = edible plants, WF = wild fruits, MP = medicinal plants, FW = fuelwoods, MR = mushrooms, HI = honey and insects, SA = small animals, FB = fiber, EX = extractives.

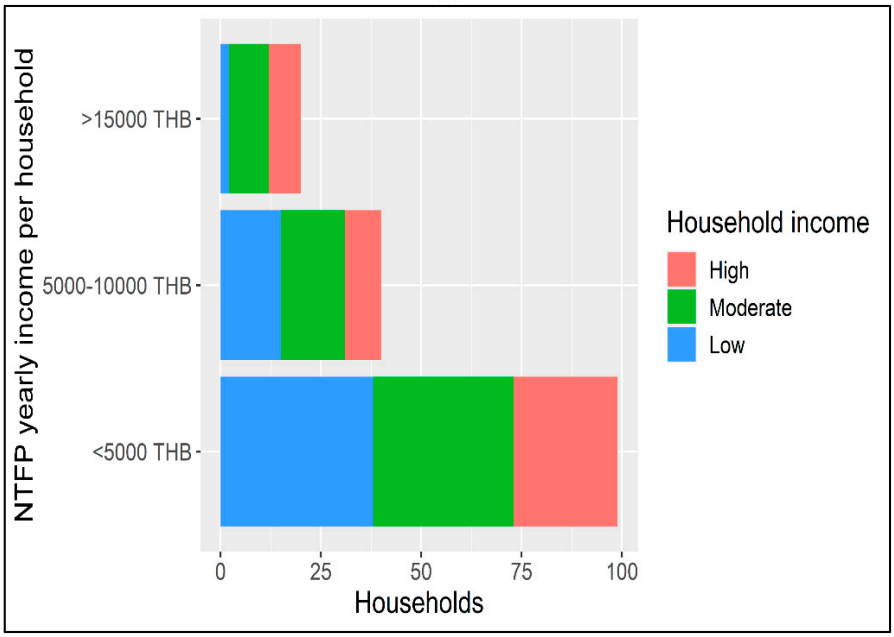
The total net return from NTFPs to the community was estimated at THB 1,871,117.30 (USD 60,358.62). Averaging the net return would yield THB 7060.82 (USD 227.77)/year to each household. When comparing income with the cost of collection, mushrooms provided the highest percentage of net return (73.47%) followed by wild fruits (14.93%), small animals (6.04%), and edible plants (3.18%).

Figure 6a shows a breakdown of the percentage of the returns for all of the primary NTFPs. Data regarding some other NTFPs, such as fibers or extractives, were not included as their value was insignificantly low or because they were not collected for household use.



(**a**)

Figure 6. *Cont.*



(**b**)

Figure 6. Utilization of NTFPs: (**a**) percentage of net returns and (**b**) NTFP income by household income.

Figure 6b shows a breakdown of NTFP income by the levels of other household income. Of the 159 surveyed households, 99 received less than THB 5000 (USD 156.25) per year. NTFPs tended to supplement the income of lower income households which lends support to the idea that rural livelihoods could financially benefit from NTFPs.

3.5. CFM and Participation Levels

Overall, people were engaged in CFM at a 'high' level (4.07 ± 0.42), and this engagement was demonstrated in many ways. Specifically, it was reflected in their perception and understanding of CFM and sustainable forest management (4.75 ± 0.29), their level of satisfaction with the sharing of benefits (4.61 ± 0.47), the effectiveness of forest regulations (4.27 ± 0.62) and compliance with forest regulations (4.82 ± 0.30), which were 'very high'. In addition, their knowledge of forest regulations (3.94 ± 0.69) and participation in forest activities (3.81 ± 0.81) were 'high'. However, involvement in decision-making processes (3.35 ± 0.91) and in monitoring and evaluation activities (3.03 ± 0.92) was 'moderate'. The percentages, levels, and forms of engagement in CFM are shown in Figure 7.

3.6. Ecosystems Services and Satisfaction Levels

Overall, a 'very high' level of satisfaction was reported with the benefits the respondents received from general provisioning (4.21 ± 0.47), regulating (4.35 ± 0.40), and cultural services (4.60 ± 0.43) (Figure 8). The satisfaction level with the provisioning of food was 'very high' (4.75 ± 0.43). This was their highest satisfaction level and was followed by biodiversity (4.61 ± 0.62), fuelwoods (4.54 ± 0.65), medicinal plants (4.50 ± 0.57), and fibers (4.20 ± 0.78). Respondents had a 'high' level of satisfaction with the provision of fresh water (3.96 ± 0.82), while they were 'moderately' satisfied with the provision of extractives (2.91 ± 1.02). There was a 'very high' level of satisfaction with the air quality and climate regulation (4.77 ± 0.52), pollination (4.69 ± 0.52), soil erosion regulation (4.59 ± 0.56), and windstorm protection (4.28 ± 0.72). A 'high' level of satisfaction with pest and disease regulation (4.16 ± 0.67) and water regulation and purification (3.62 ± 0.70) were reported.

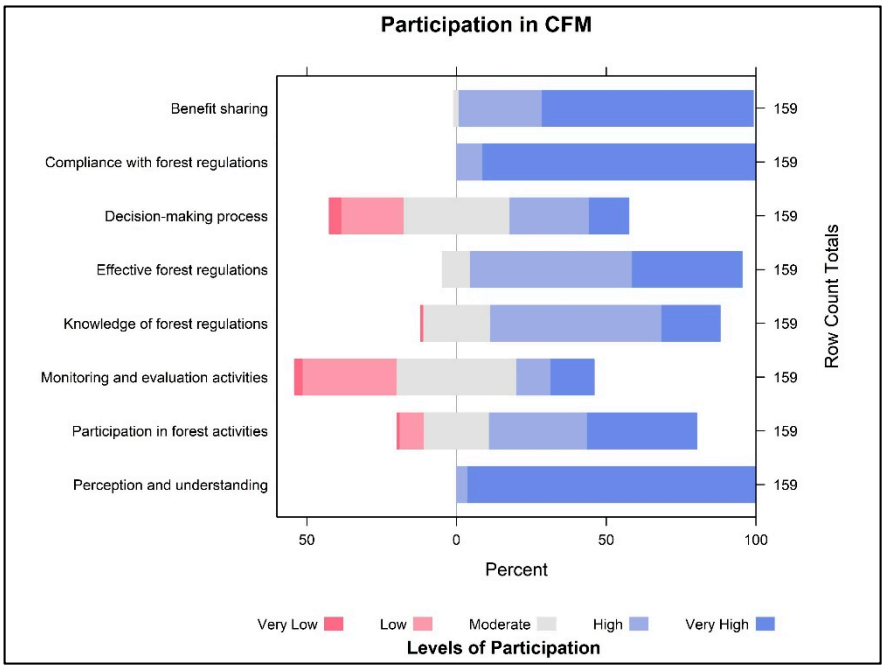


Figure 7. Participation in CFM and satisfaction levels.

Furthermore, a 'very high' level of satisfaction was reported with the cultural services that are related to traditions, beliefs, religions, and local wisdom (4.89 ± 0.36) as well as with the benefits from recreation and ecotourism (4.31 ± 0.74).

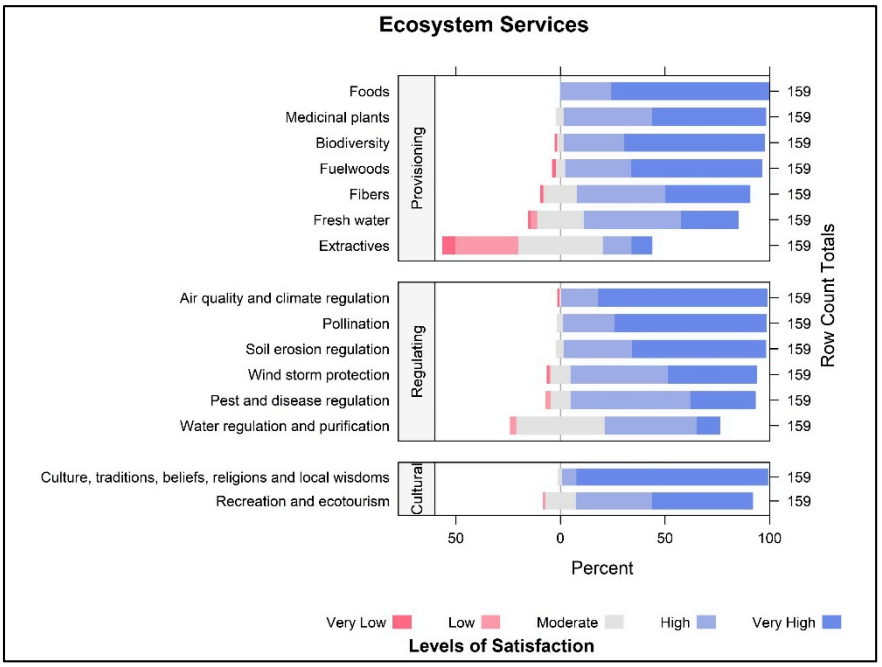


Figure 8. Satisfaction with ecosystem services.

3.7. The Nature of CFM Engagement and Ecosystem Services

A chi-squared test of independence was performed to examine the relationship between CFM and ecosystem services. There were apparent differences between the levels of participation in CFM and ecosystem services ($p < 0.05$, $p < 0.01$, and $p < 0.001$), suggesting that the levels of satisfaction with ecosystem services varied depending on CFM participation levels (Table 7).

Table 7. The influence of different CFM factors on ecosystem services.

CFM	Chi-Squared (χ^2)		
	Provisioning Services	**Regulating Services**	**Cultural Services**
Decision-making process	14.801	8.3957	3.0161
Forest plantation	16.952	11.464	3.3527
Forest protection and weed control	29.063 **	12.965	10.877
Forest patrol	30.281 **	25.888 **	9.8874
Prevention and control of forest fires	17.933	9.4879	8.7694
Forest survey and alignment	19.109	13.347	14.036
Building check dams	19.623	10.926	4.189
Participation in forest culture/tradition	22.730 **	21.406 **	31.622 ***
Monitoring and evaluation activities	8.305	4.915	4.281
NTFP income	0.768	2.843	1.811
Familiarity with forest regulations	20.006 *	5.860	6.564
Effective forest regulations	26.062 ***	15.722 **	10.675 *
Compliance with forest regulations	34.097 ***	19.342 ***	22.309 ***
Perception and understanding	25.456 ***	1.2811	10.641 **
Benefit sharing	79.434 ***	31.180 ***	36.465 ***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. CFM = community forest management, THB = Thai baht. USD 1 = THB 31 on 31 January 2018 as of Bank of Thailand.

3.8. Participation in CFM and the Impact on Ecosystem Services

The binary logistic regression results demonstrate the relationship between participation in CFM and satisfaction with ecosystem services (Table 8). Overall, the logit model with predictors showed that engagement in CFM strongly affects ecosystem services (Pseudo $R^2 = 0.457$, $p < 0.01$). Participation in CFM also had an effect on provisioning (Pseudo $R^2 = 0.408$, $p < 0.05$), regulating (Pseudo $R^2 = 0.359$, $p < 0.01$), and cultural services (Pseudo $R^2 = 0.272$, $p < 0.05$).

Table 8. Result of a binary logistic regression for variables predicting satisfaction with ecosystem services ($n = 159$).

Predictors	Ecosystem Services		
	Provisioning	**Regulating**	**Cultural**
(Intercept)	−19.344	−2.452	−1.175
Decision-making process	2.252 *	−1.478	-
Forest plantation	−0.171	0.010	-
Forest protection and weed control	−0.446	0.528	-
Forest patrol	0.098	−1.497 *	−2.158 **
Prevention and control of forest fires	−0.198	0.682	1.785 *
Forest survey and alignment	−1.381	2.232	−0.612
Building check dams	1.486 *	−0.232	−0.352
Participation in forest culture/tradition	0.187	0.205	−0.270
Monitoring and evaluation activities	−0.028	0.434	0.427
NTFP income (>5000 THB)	−0.583	0.270	0.316
Familiarity with forest regulations	−0.724	−0.574	−1.083
Effective forest regulations	0.960 *	1.171 *	1.325 *
Compliance with forest regulations	17.491	0.715	0.192
Perception and understanding	0.536	0.823	1.633
Benefit sharing	1.644 **	1.906 ***	2.090 **

Table 8. *Cont.*

Predictors	Ecosystem Services		
	Provisioning	Regulating	Cultural
Chi-square (χ^2)	27.1 *	34.3 **	21.7 *
Pseudo R^2 (Nagelkerke)	0.408	0.359	0.272
Log-likelihood	−80.892	−80.977	−65.988
Accuracy	0.723	0.773	0.817

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. NTFP = non-timber forest product, THB = Thai baht. USD 1 = THB 31 on 31 January 2018 as of Bank of Thailand.

Specifically, benefit sharing significantly and positively impacted regulating ($p < 0.001$), provisioning, and cultural services ($p < 0.01$), and effective forest regulations also had a strong positive relationship with these ecosystem services ($p < 0.001$). Involvement in the decision-making process and the building of check dams also had a positive relationship with provisioning services, while efforts to prevent and control forest fires had a positive effect on cultural services ($p < 0.05$). However, the implementation of forest patrols showed a negative correlation at $p < 0.05$ with regulating and at $p < 0.01$ with cultural services.

4. Discussion

4.1. Community Forest Provision of Ecosystem Services

The inventory of the Ban Mae Chiang Rai Lum Community Forest yielded a total of 18,567 plants that encompassed 197 species, 144 genera, and 62 plant families. We also identified 129 mature tree, 99 sapling and 141 seedling species. The number of species identified in this study was higher than those recorded in other studies in Thailand: 125 species were recorded in the Na Haeo Forest Reserve [84], 97 species in the Khok Bung Preu Forest [10], and 42 species in the Sakaerat Environmental Research Station [85]. Tables 2 and 3, displayed above, detail the ecological characteristics and outline the dominant species in the subject forest. The prominent and significant species are akin to those found in similar forests in Thailand [10,85–90]. The average diversity index of mature trees (H') was 2.49 ± 0.28, which is mid-range when compared with other deciduous forests in Thailand [90–92]. As for NTFPs, 160 of the 197 species have been classified as having medicinal uses, with 89 used as food, 37 as extractives, 32 as fuelwoods, and 12 species as fibers (Table 4). These findings are consistent with studies that have found that forest biodiversity can help people meet basic needs, generate income, and generally enhance their livelihoods [10,12,13,93,94].

Small-size class trees (DBH < 20 cm) were more abundant (Figure 4a). Tree density decreased as DBH increased, resulting in an inverted J-shaped graph [95–98]. This can reflect tree density, growth rate, and the successful regeneration of species, which are considered indicia of a healthy, stable, and strongly recruiting population [99–102]. In addition, Figure 4b reflects a normal distribution or bell-shaped curve of height classes, in which the tallest species reached the intermediate, middle-size class. This is consistent with Felfili (1997), wherein it was suggested that this pattern reflects a self-regenerating community [103]. Thus, the distribution of DBH and height classes in the community forest is a positive indicator of the future natural regeneration of tree species.

The forest is a source of food security; mushrooms, wild fruits, small animals, and edible plants were utilized to the greatest degree (Figure 6a). As in other studies, rural people depended on NTFPs for subsistence and income, with 68.55% of the households surveyed indicating that they had a reliance on NTFPs [23,27,28,104,105]. The minimal harvest and reliance on other NTFPs, such as extractives, fibers, fuelwoods, honey and insects, and medicinal plants (Figure 5), certainly contributed to the value of the harvested NTFPs being only 6.35% of the total annual income of the community. A multitude of factors could be determinants, however, such as high opportunity costs for extracting NTFPs, highly productive agricultural lands [50,106], food security [107], and higher wages as a laborer or profits from business [72].

The reasons that households or a community in general would or would not harvest and utilize NTFPs are varied and idiosyncratic, as are the economic factors that dictate price and value, supply and demand, and the efficacy of harvesting. In 2018, the Thai government raised the minimum wage. This incentivized seeking off-farm employment opportunities which could reduce the reliance on NTFPs.

A comparison of the NTFPs that are actually utilized (Figure 5 and Table 6) with the forest's potential to supply NTFPs (Figure 4 and Table 4) indicates that usage of various plant species could be greater. This suggests at least the possibility of increased dependence on a wider variety and larger amount of NTFPs in the event that other opportunities become limited [28]. An untapped potential for greater income exists, which highlights the importance of enhancing forest biodiversity to ensure an expanded and ongoing supply of NTFPs. In addition, lower income households were likely to obtain a greater relative income from NTFPs than higher income households (Figure 6b), illustrating the forest's role in improving rural livelihoods [46,105,108].

Deciduous forests provide important services to remote, rural communities and cover nearly 20% of total forest areas in Thailand [8]. Consequently, the potential to provide ecosystem services in support of rural livelihoods is expansive.

4.2. Participation in CFM and Satisfaction with Ecosystem Services

The level of participation in CFM was 'high' (Figure 7), which translated into effective forest management. Similarly, there was a 'very high' level of satisfaction with ecosystem services (Figure 8). These results demonstrate a link between participation, improved forest conditions, enhanced ecosystem services, and elevated satisfaction. Thus, participation in CFM can positively impact ecosystem services [2,5].

Partially in response to historical and protracted encroachment, illegal logging, and the resulting damage to the viability of the forest, CFM has been implemented in Ban Mae Chiang Rai Lum since 2008. Collaborative management efforts between the government and local residents became more focused on forest plantations, fire protection and patrol, and the utilization of check dams. As a result, the community forest showed signs of restoration, and the damage caused by years of deforestation and degradation has been mitigated [109]. Plant density, growth rates, and the regeneration of plant species in the community forest increased in the study area under CFM. In addition, when compared with deciduous forests in northern Thailand that have been the focus of other studies, the species diversity in this study area was higher than forest areas under government management [110,111]. The evidence suggests that the community forest sector, through successful management, can play a role in improving ecosystem services [35].

Contrary observations have been made [112–114], but in this study the level of satisfaction with provisioning services was lower than that of the other services. Though mushroom harvesting was engaged in the most, the relatively minimal utilization of the other provisioning services (e.g., fibers, fuelwoods, medicinal plants, and edible plants) reduced the overall satisfaction with provisioning services.

To an indeterminable extent, the low incomes from NTFPs are indicative of a lack of significant dependence on the forest, and this lack of reliance could be the reason for the reported satisfaction levels. There are many possible explanations for a lack of dependence on NTFPs. For instance, a study conducted in Tanzania by Mushi et al. (2020) highlighted that households with few members, a high level of income, and greater available arable land are less willing to depend on NTFPs [106]. Nonetheless, the utilization of provisioning services should be promoted, for higher levels of satisfaction will lead to greater participation, more effective CFM, and enhanced services.

Table 7 details how the different types and levels of CFM participation, including forest activities, knowledge of forest management, benefit sharing, and forest regulation, were related to provisioning, regulating, and cultural ecosystem services. Relationships between demographics and social forestry involvement can be identified. Efforts to develop effective management practices can be informed by understanding these relationships.

4.3. Impact of CFM on Ecosystem Services

Table 8 shows the CFM factors that impacted the ecosystem services of the community forest in Ban Mae Chiang Rai Lum. These factors had both negative and positive effects on the forest benefits. This information can be used to identify suitable forest management policies to be implemented in this area.

Benefit sharing and effective forest regulations had a significant, positive relationship with provisioning, regulating, and cultural ecosystem services. The people work together socially, utilize forest resources as they deem appropriate, and acknowledge everyone's right to do so. They feel a sense of fairness when working and enjoying the fruits of their labor equitably. Sharing benefits in this fashion serves to incentivize collaboration and is critical to improving forest conditions. Enjoying revenue and sharing benefits from forest products are good incentives to collaborate [43–47]. Further investigation may establish a clearer link between the transparent sharing of forest products with greater participation in management and enhanced biodiversity.

Effective forest regulations play a vital role in enhancing the provision and overall benefit of ecosystem services. In the study area, ecosystem services similarly depend on the effectiveness of regulations. In Thailand, there was no specific legislation regarding CFM prior to 2019; however, forest management practices and policies were permitted so long as community regulations did not conflict with the overarching forest laws. Residents opined that the effectiveness of forest regulations was 'very high' (Figure 7). This can, therefore, be a powerful tool with which to manage the community forest and can contribute to more effective CFM management [30,57,73,74].

Engagement in decision-making processes positively impacts provisioning services. Deciding on strategies and process matters is a vital component of overall involvement and is a basic right of local people [45,115]. Engagement in making public forest management activity decisions can result in more effective management and increase economic benefits [116]. Thus, decision making can lead directly to improved provisioning services and concomitant benefits. However, this study also found that engagement in decision making was at a 'moderate' level, suggesting that it had a limited impact on species conservation and utilization (Figure 7). In analyzing the same area as this study, Thammanu et al. (2021) found that the rate of above-ground carbon sequestration would decrease from 2028–2038 under CFM when compared with the previous decade [109]. This highlights the importance of a long-term focus on all aspects of management participation to maximize the positive impact on ecosystem services for the sustained viability of the forest and its resources.

Fires are part of the fabric of daily living in Thailand. They are frequent during the dry season in deciduous forests, including mixed deciduous and dry dipterocarp forests [117,118]. They are employed for site preparation, disease and pest control, and to harvest NTFPs, but they are also used illicitly for logging, hunting, and shifting cultivation [119–123]. Regardless of their purpose, fires are a considerable forest management problem as they are all potential causes of large-scale forest fires. The RFD reported 3158 cases of forest fires in 2020 which damaged 10,100 ha, 90% of which occurred in the northern region of the country [6]. Addressing the problem through participation in fire prevention activities and integrated management efforts has a positive effect on cultural services.

Management efforts that are combined with various religious rituals that reflect deep-seeded beliefs have been widely adopted to address and manage forest fires in northern Thailand. Buddhism is a strong cohesive force in every aspect of life in Thailand, and its spiritual tenets are called upon to help protect and safeguard the forests [57,124,125].

The 'Tod Pa Bah' Buddhist robe-offering ceremony provides an opportunity for the people of the community to make merit and to donate funds for conservation efforts. 'Suep Chata Pa' is a rite to boost the spirit and the morale of the people and prolong the life of the forest, while 'Buod Pa' is a tree ordination ceremony that is seen as a deterrent to illegal deforestation. In addition, many fire management strategies that are based on traditional knowledge and local wisdom are used to prevent and control forest fires [126,127], such

as determining proper timing, size, and routes of firebreak lines, selecting suitable tree species to plant in drought areas to increase soil moisture, or employing specific techniques to extinguish fires using minimal water. Combined with proven management, prevention, and control strategies, these rituals provide opportunities to participate in ways that have a beneficial impact on ecosystem services.

Deciduous forests are classified as 'tropical dry forests' which suffer prolonged drought conditions for 5–6 months. During these dry periods, forest fires are a prime cause of damage [117,118]. Fire disturbances have crucial effects on the dynamics and regeneration of tree species in deciduous forests in Thailand [86,128]. In a study on this same area, tree species and distribution were found to be closely related to soil moisture and distance to streams [48]. Building check dams was required to ensure species diversity and safeguard NTFP supplies, thereby exemplifying their impact on provisioning services. Consequently, participation in building check dams is likely to have a positive effect on provisioning services.

Forest patrols are a powerful tool to control deforestation [129]. Communities establish groups to patrol for fires, encroachment, over-exploitation, or other problematic conditions. In this study, forest patrols negatively impacted regulating and cultural services. Though somewhat surprising at first glance, this could actually be a genuine reflection of the social capital of the remote, rural communities.

The norms, values, and attitudes that pre-dispose people to cooperate, trust, and reciprocate with an obligation to support the common rules, a network, or group constitutes social capital [130]. Along with traditions and longstanding ways of life, this social capital is extremely important within a community [57,131] and is one of the variables that work in favor of a community self-organizing to manage resources in pursuit of sustainability.

According to Ostrom (1990, 2009), self-organization and engagement in efforts to achieve sustainability in a complex social ecological system (SES), such as a forest, can be influenced by the natural capital of the system (size, resource mobility, resource importance, predictability, and productivity), human capital (number of resource users, leadership, and knowledge of the system), and the moral and ethical standards of social capital [132,133]. Social capital can incentivize engagement and collective action to organize effective rules to manage the forest for the benefit of people's livelihoods and community forest improvement [134,135]

In this study, we found inherent conflicts between patrol groups and those who use fires contrary to law or custom. These conflicts can lead to behaviors that are counterproductive to the very reason for the patrols. Incidents have been reported where fires have been intentionally set merely in retaliation to these groups and their conservation efforts [4,58]. Such disunity can compromise and militate against efforts to improve regulating and cultural ecosystem services.

Fires have an adverse effect on air and water quality, soil properties, and other forest ecosystem conditions [136–138]. Worldwide, the vulnerability of tropical dry deciduous forests to fires is greater than any other forest type [139]. Thus, the use of fire against forest patrols or for other illicit purposes exacerbates a naturally occurring problem and negatively impacts regulating services. Furthermore, improperly conducted patrols resulted in diminished trust in community forest projects [140]. A lack of trust in projects can lead to unwillingness to participate and would serve as a formidable obstacle to collaborative forest management. Thus, the promotion of proper patrols that can reduce conflict is needed. Furthermore, education, training, and increasing awareness of the importance of conservation and CFM are vital to reducing conflicts and securing a common goal within a community, because obtaining and sharing knowledge is an important factor in encouraging the self-governance of forest resources [132,133].

The number of community forest projects has increased rapidly and steadily since 1987. Presently, there are more than 15,000 existing CFM projects in Thailand [33]. This is evidence that government policies are effective at promoting collaboration and engagement in forest

management through CFM. This expansion of CFM provides optimism for a brighter future for local livelihoods and conservation efforts. There are limitations, however.

According to Ostrom (1990, 2019), it is difficult to find simple explanations as to why complex social–ecological systems deteriorate or solutions for how they can be improved. As was once the theory, no longer is it simply assumed that government mandated solutions are required; no longer is it simply assumed that people will not invest time and energy into protecting resources. Social scientists have found that, in some instances, government policies adversely impact resources, while the reasons that people self-organize are becoming more identifiable. Perhaps a balance can be found [132,133].

CFM in Thailand is presently regulated by the recently promulgated Community Forest Act B.E. 2562 (2019) [32]. This government mandate helps people self-organize by providing more opportunities to participate in decision making, use forest resources, get involved in conservation efforts, and contribute to overall forest management. CFM provides a forum to share knowledge, develop leadership, collectively develop rules, expand the number of resource users, and protect the productivity of the forest. These are all variables that contribute to energizing people to use their time and effort to achieve sustainability [132,133].

Unfortunately, this law also prohibits the implementation of CFM in vast swaths of protected forest areas such as national parks, wildlife sanctuaries, and non-hunting areas. Prohibiting CFM in these areas retains the obstacles to enhancing involvement and denies the local residents the opportunities created by effective CFM. This is an issue that needs to be addressed.

5. Conclusions

The deciduous community forest of Ban Mae Chiang Rai Lum is exceptionally biodiverse with the potential to provide additional and more beneficial ecosystem service contributions to local livelihoods. In addition, a comparison of the degree of existing species diversity and low level of utilization suggests that a wider variety and greater amount of NTFPs can be safely utilized and their overall benefit to those who rely on them expanded.

The community forest provides significant food security. Mushrooms, wild fruits, small animals, and edible plants are abundant. NTFPs provide more supplemental income to lower-income households which suggests that the forest has the capacity to improve rural livelihoods. A comparison of the forest conditions and the actual income from utilized NTFPs indicates that there is significantly greater income and benefit potential. To tap into this potential, the focus should be on promoting increased extraction and utilization of NTFPs by all households to supplement incomes.

There are relationships between different CFM factors and ecosystem services, the underlying behavior of the community in engaging in CFM, and their impact on ecosystem services. Moreover, our study provided evidence that CFM can improve provisioning, regulating, and cultural ecosystem services. Knowledge of these relationships can inform suitable strategies for this area and serve as an example of how to promote self-management of local forest resources toward sustainable CFM. However, employing forest patrols adversely affected regulating and cultural services, which lends credence to widespread beliefs that improving social capital through decentralized management (CFM) is important for improving forest ecosystem services and enhancing livelihoods.

This study, however, did not address opinions or levels of satisfaction regarding forest size, plant density, topography, the distance between the community and the forest, or other forest features. Future research could provide useful information regarding the relationship of these factors to effective forest management.

Author Contributions: Conceptualization, S.T. and J.C.; methodology, S.T., J.C. and H.H.; formal analysis, S.T.; writing—original draft preparation, S.T.; writing—review and editing, H.H., J.C., E.M.B.P.E. and Y.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by SEARCA-ASRF under the ASEAN-Swiss Partnership on Social Forestry and Climate Change and the R&D Program for Forest Science Technology (Project No. 2018113C10-2020-BB01) of the Korea Forestry Promotion Institute, Korea Forest Service.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is not publicly available. Access to the data may be granted upon request directed to the corresponding author.

Acknowledgments: Special thanks are extended to the Asian Forest Cooperation Organization (AFoCO) and the Royal Forest Department (RFD) for the opportunity to pursue this project and to the village leaders and people of Ban Mae Chiang Rai Lum, but for whose assistance this research would not have been possible.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Preliminary Community Survey

Before interviewing household representatives, multiple investigative visits over a year were made to the study area community in order to ascertain the organizational and procedural framework, activities, governance and enforcement practices, and other relevant aspects of community forest management in the study area. The following were identified:

- The existence of a governing forest management committee, members of which are all local people from the village;
- Monthly meetings between the village heads, the community forest committee, and all households regarding village issues, including forest management;
- Every household in the village is required to send a representative to the monthly meeting;
- Input is solicited from everyone in attendance regarding forest plans, activities, regulations, enforcement of regulations, and all aspects of management;
- The existence of a patrol group that meets regularly and is responsible for the enforcement of regulations;
- Issues salient to the local people regarding the forest and ecosystem services.

Information garnered from the investigative visits was then used to develop the interview questionnaire for the data gathering process.

Appendix A.2. Summary of Interview Procedures and Questionnaire

- The following is a translation of the questions used by the primary author to gather data during the interview process. The primary author is of Thai nationality and all interviewees were also of Thai nationality. No translation of the questions was required during the data gathering process. No author of non-Thai nationality was involved in the interviews.
- The following list of questions attempts to accurately convey the meaning of the questions posed to the interviewees. The meaning of much of the Thai vocabulary in the original questionnaire, particularly technical vernacular, does not translate directly or easily into English.
- Interviews were conducted without prior arrangement with the interviewees. Interviewees self-selected who would represent their household. Representatives were over the age of 18 and were household members who could report the demographics and the involvement in CFM, if any, of the household.
- Names of the interviewees were kept confidential.
- One interview of each representative was conducted.
- The interviews were not recorded as no open-ended questions or questions seeking opinions were asked.

Table A1. Variables and identifying characteristics of the impact of CFM factors on ecosystem services.

Variables	Related Questions	Answer Options
• Ecosystem services	○ How satisfied are you with the following provisioning services?	
	- Foods	From 1 to 5 to plot on a Likert scale
	- Medicinal plants	From 1 to 5 to plot on a Likert scale
	- Fuelwoods	From 1 to 5 to plot on a Likert scale
	- Fibers	From 1 to 5 to plot on a Likert scale
	- Extractives	From 1 to 5 to plot on a Likert scale
	- Fresh water	From 1 to 5 to plot on a Likert scale
	- Biodiversity	From 1 to 5 to plot on a Likert scale
	○ How satisfied are you with following regulating services?	
	- Air quality and climate regulation	From 1 to 5 to plot on a Likert scale
	- Soil erosion control	From 1 to 5 to plot on a Likert scale
	- Pollination	From 1 to 5 to plot on a Likert scale
	- Windstorm protection	From 1 to 5 to plot on a Likert scale
	- Pest and disease control	From 1 to 5 to plot on a Likert scale
	- Water regulation and purification	From 1 to 5 to plot on a Likert scale
	○ How satisfied are you with following cultural services?	
	- Preservation of inherit culture, traditions, beliefs, religions, and local wisdom	From 1 to 5 to plot on a Likert scale
	- Recreation and ecotourism	From 1 to 5 to plot on a Likert scale
• Decision making	○ How would you describe the frequency of your involvement in attending community forest planning meetings or activities?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in helping to determine community forest regulations?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in helping to determine the authority, structure, or management of the community forest committee?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in helping to determine community forest development activities?	From 1 to 5 to plot on a Likert scale
• Forest activities	○ How would you describe the frequency of your involvement in forest plantation events?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in forest protection and weed control activities?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in forest patrols?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in forest fire control efforts?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in forest surveys and alignment?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in building check dams?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in cultural or traditional forest events?	From 1 to 5 to plot on a Likert scale
• Monitoring and evaluation activities	○ How would you describe the frequency of your involvement in following up on the performance of community forest management activities, efforts, or plans?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in identifying problems or obstacles faced by community forest management?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the frequency of your involvement in finding solutions to community forest management problems?	From 1 to 5 to plot on a Likert scale
• Non-timber forest products (NTFPs)	○ Has your household harvested NTFPs of any kind from the community forest during the past year?	Yes/No
	○ If yes, what did you harvest?	Species
	○ Regarding NTFPs and your family, please indicate the nature of your harvest and utilization practice	Harvested and utilized/Did not harvest but utilized/Did not harvest or utilize
	○ When, by month, did you harvest?	Month (Jan–Dec)

Table A1. *Cont.*

Variables	Related Questions	Answer Options
	○ How many times did you harvest during the year?	No. of times
	○ On average, how much time did you spend on each harvesting event?	Hours
	○ How much did you harvest?	Units (liter, kilogram, cubic meter)
	○ If sold, what is an estimate of the price of what you harvested?	THB
	○ Approximately how much did you spend on transportation during each harvesting event?	THB
• Regulation	○ How would you describe your overall level of knowledge of community forest regulations?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the level of appropriateness of the community forest regulations?	From 1 to 5 to plot on a Likert scale
	○ How would you describe the level of how efficiently enforceable the community forest regulations are?	From 1 to 5 to plot on a Likert scale
	○ How would you rate your compliance with the following community forest regulations?	
	- Obtain permission from the community forest committee before cutting trees	From 1 to 5 to plot on a Likert scale
	- Do not take possession, utilize, construct, or expand the agricultural area in a community forest	From 1 to 5 to plot on a Likert scale
	- Do not dig or remove soil, stones, or sand	From 1 to 5 to plot on a Likert scale
	- No hunting	From 1 to 5 to plot on a Likert scale
	- Do not set fires in the community forest	From 1 to 5 to plot on a Likert scale
	- Do not collect NTFPs to sell as an occupation (such as charcoal)	From 1 to 5 to plot on a Likert scale
• Knowledge	○ A community forest is a forest from which local people can profit from forest products to meet their basic needs, and local people have the right to make decisions to manage their forest resources for sustainable forest management [141]	True/False
	○ Community forest management is the decentralization of forest resource management, it transfers forest management power from the government to a local community [142]	True/False
	○ Utilization of resources, community rules, community organizations and support from external organizations are factors key to the success of the management of the community forest [56]	True/False
	○ Community forests provide environmental benefits, social benefits, and economic benefits by enhancing income, especially of the poor [19,143]	True/False
	○ The Thai government has said that local communities should have the right to participate in the management, maintenance, preservation, and use of the natural resources and environment, including biological diversity, in a balanced, sustainable manner [22]	True/False
	○ Experts have said that under the concept of sustainable forest resource management, the average harvest must not exceed the forest's productivity capacity. This will ensure the present and future availability of resources [144,145]	True/False
	○ People can access NTFPs from a natural forest for subsistence, but commercial harvesting of NTFPs needs permission from the government [146]	True/False
	○ There is no nationwide law controlling community forests in Thailand. Forest management is controlled by related forest laws which should be consistent with local regulations [147]	True/False
	○ Setting forest fires for harvesting NTFPs may affect soil fertility, change the forest composition, and decrease ecosystem productivity [148]	True/False
	○ Sharing the benefits from the biodiversity of community forests is fair and equitable [149]	True/False
• Benefit sharing	○ How satisfied are you with the sharing of environmental benefits from the community forest?	From 1 to 5 to plot on a Likert scale
	○ How satisfied are you with the sharing of social benefits from the community forest?	From 1 to 5 to plot on a Likert scale
	○ How satisfied are you with the sharing of economic benefits from the community forest?	From 1 to 5 to plot on a Likert scale

References

1. Brockerhoff, E.G.; Barbaro, L.; Castagneyrol, B.; Forrester, D.I.; Gardiner, B.; González-Olabarria, J.R.; Layver, P.O.; Meurisse, N.; Oxbrough, A.; Taki, H.; et al. Forest biodiversity, ecosystem functioning and the provision of ecosystem services. *Biodivers. Conserv.* **2017**, *26*, 3005–3035. [CrossRef]
2. Pukkala, T. Which type of forest management provides most ecosystem services? *For. Ecosyst.* **2016**, *3*, 9. [CrossRef]
3. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005.
4. Rudra, A.K. Forest management for enhancing ecosystem services in the climate change scenario of Bangladesh. *Energy Environ. Eng.* **2016**, *4*, 21–29. [CrossRef]
5. Sing, L.; Metzger, M.J.; Paterson, J.S.; Ray, D. A review of the effects of forest management intensity on ecosystem services for northern European temperate forests with a focus on the UK. *Forestry* **2018**, *91*, 151–164. [CrossRef]
6. RFD. Forestry Statistics Data 2020. Available online: http://forestinfo.forest.go.th/Content.aspx?id=10400 (accessed on 1 September 2021).
7. Wichawuthipong, J. *Community Forest*; RFD: Bangkok, Thailand, 2005.
8. RFD. *Executive Summary*; RFD: Bangkok, Thailand, 2019.
9. Kutintara, U. Structure of the Dry Dipterocarp Forest. Ph.D. Thesis, Colorado State University, Fort Collins, CO, USA, 1975.
10. Kabir, E.; Webb, E.L. Saving a forest: The composition and structure of a deciduous forest under community management in northeast Thailand. *Nat. Hist. Bull. Siam Soc.* **2006**, *54*, 239–260.
11. Thammanu, S.; Zhang, C. The growing stock and sustainable utilization of White Bamboo, *Bambusa membranacea* (Munro) C.M.A. Stapleton & N.H. Xia in the natural mixed deciduous forest with Teak in Thailand: A case study of Huay Mae Hin Community Forest, Ngao District, Lampang Province. *Int. J. Sci.* **2014**, *3*, 23–30.
12. Larpkerna, P.; Eriksen, M.H.; Waiboonya, P. Diversity anduses of tree species in the deciduous dipterocarp forest, Mae Chaem District, Chiang Mai Province, northern Thailand. *NUJST* **2017**, *25*, 43–55.
13. Mianmit, N.; Jintana, V.; Sunthornhao, P.; Kanhasin, P.; Takeda, S. Contribution of NTFPs to local livelihood: A case studyof Nong Sai Sub-district of Nang Rong District under Buriram Province in northeast Thailand. *J. Agrofor. Environ.* **2017**, *11*, 123–128.
14. NESDB. *The 12th National Economic and Social Development Plan (2017–2021)*; NESDB: Bangkok, Thailand, 2017.
15. Thai Government. *National Forest Policy*; Royal Thai Government Gazette: Bangkok, Thailand, 1985.
16. TFSMP. *Thai Forestry Sector Master Plan, Subsectoral Plan for People and Forestry Environment*; Ministry of Agriculture and Cooperatives, and FINNIDA: Bangkok, Thailand, 1993; Volume 5.
17. Lakanavichian, S. Impacts and effectiveness of logging bans in natural forests: Thailand. In *Forests out of Bounds: Impacts and Effectiveness of Logging Bans in Natural Forests in Asia-Pacific*; Durst, P.B., Waggener, T.R., Enters, T., Cheng, T.L., Eds.; FAO: Bangkok, Thailand, 2001.
18. Rosander, M.N. *Illegal Logging: Current Issues and Opportunities for SENSA/SIDA Engagement in Southeast Asia*; RECOFTC: Bangkok, Thailand, 2008.
19. RECOFTC. *Sharing the Wealth, Improving the Distribution of Benefits and Costs from Community Forestry: Policy and Legal Frameworks, Synthesis of Discussions at the Second Community Forestry Forum*; RECOFTC: Bangkok, Thailand; FAO: Bangkok, Thailand; SNV: Bangkok, Thailand, 2007.
20. White, A.; Martin, A. *Who Owns the World's Forests? Forest Tenure and Public Forests in Transition*; Center for International Environmental Law: Washington, DC, USA, 2002.
21. Bhusal, P.; Paudel, N.S.; Adhikary, A.; Karki, J.; Bhandari, K. Halting forest encroachment in Terai: What role for community forestry? *J. For. Livelihood* **2018**, *16*, 15–34. [CrossRef]
22. Thai Government. *Constitution of the Kingdom of Thailand B.E. 2560*; Royal Thai Government Gazette: Bangkok, Thailand, 2017.
23. Delang, C.O. Indigenous systems of forest classification: Understanding land use pattern and the role of NTFPs in shifting cultivators' subsistence economies. *Environ. Manag.* **2006**, *37*, 470–486. [CrossRef]
24. Pagdee, A. Community forest management in threat, the case from Dong Keng Community Forest, Khon Kaen Province, Thailand. *KKURJ* **2006**, *11*, 25–38.
25. Salam, M.A.; Noguchi, T.; Pothitan, R. Community forestmanagement in Thailand: Current situation and dynamics in the context of sustainable development. *New For.* **2006**, *31*, 273–291. [CrossRef]
26. Apipoonyanon, C.; Kuwornu, J.K.M.; Szabo, S.; Shrestha, R.P. Factors influencing household participation in communityforest management: Evidence from Udon Thani Province, Thailand. *J. Sustain. For.* **2020**, *39*, 184–206. [CrossRef]
27. Wimolsakcharoen, W.; Dumrongrojwatthana, P.; Trébuil, G. Production of non-timber forest products (NTFPs) and diversity of harvesters' practices and decision-making processes in northern Thailand community forests. *Bois. For. Trop.* **2020**, *343*, 39–52. [CrossRef]
28. Ormbsby, A.; Felardo, J.; Musci, R. Multiple values from the forest: Contribution of non timber forest products to livelihoods of local communities in northeastern Thailand. *Environ. Dev. Sustain.* **2021**, *23*, 1–10. [CrossRef]
29. Agrawal, A.; Chhatre, A. Explaining success on the commons: Community forest governance in the Indian Himalaya. *World Dev.* **2006**, *31*, 149–166. [CrossRef]

30. Pagdee, A.; Kim, Y.; Daugherty, P.J. What makes community forest management successful: A meta-study from community forests throughout the world. *Soc. Nat. Resour.* **2006**, *19*, 33–52. [CrossRef]
31. Ekanayake, E.M.B.P.; Cirella, G.T.; Xie, Y. Impacts of community forestry on forest condition: Evidence from Sri Lanka's intermediate zone. *PLoS ONE* **2020**, *15*, e0239405. [CrossRef]
32. Thai Government. *Community Forest Act, B.E. 2562*; Royal Thai Government Gazette: Bangkok, Thailand, 2019.
33. RFD. Community Forest Project Approval between 2000-Present. Available online: http://www.forest.go.th/community-extension/2017/02/02/ (accessed on 15 August 2021).
34. Charnley, S.; Poe, M.R. Community forestry in theory and practice: Where are we now? *Annu. Rev. Anthropol.* **2007**, *36*, 301–336. [CrossRef]
35. Paudyal, K.; Baral, H.; Lowell, K.; Keenan, R.J. Ecosystem services from community-based forestry in Nepal: Realising local and global benefits. *Land Use Policy* **2017**, *63*, 342–355. [CrossRef]
36. Musyoki, J.K.; Mugwe, J.; Mutundu, K.; Muchiri, M. Factors influencing level of participation of community forest associations in management forests in Kenya. *J. Sustain. For.* **2016**, *35*, 205–216. [CrossRef]
37. Chowdhary, C.; Rajendra, K.C. Biodiversity and Ecosystem Services: Neglected aspects of the community forestry systems in Nepal. In Proceedings of the Mainstreaming the Biodiversity and Ecosystem Services into Community Forestry in Nepal; DoF, FECOFUN and BCN, Kathmandu, Nepal, 4–5 August 2015.
38. Liang, J.; Crowther, T.W.; Picard, N.; Wiser, S.; Zhou, M.R.; Alberti, G.; Schulze, E.-D.; McGuire, A.D.; Bozzato, F.; Pretzsch, H.; et al. Positive biodiversity-productivity relationship predominant in global forests. *Science* **2016**, *354*, aaf8957. [CrossRef]
39. Mori, A.S.; Isbell, F.; Fujii, S.; Makoto, K.; Matsuoka, S.; Osono, T. Low multifunctional redundancy of soil fungal diversity at multiple scales. *Ecol. Lett.* **2016**, *19*, 249–259. [CrossRef] [PubMed]
40. Gebreegziabher, Z.; Mekonnen, A.; Gebremedhin, B.; Beyene, A.D. Determinants of success of community forestry: Empirical evidence from Ethiopia. World Development. *World Dev.* **2021**, *138*, 105206. [CrossRef]
41. Chirenje, L.; Richard, A.; Emmanuel, G.; Musamba, B. Local communities' participation in decision-making processes through planning and budgeting in African countries. *Chin. J. Popul. Resour. Environ.* **2013**, *11*, 10–16. [CrossRef]
42. Chou, P. The role of non-timber forest products in creating incentives for forest conservation: A case study of Phnom Prich Wildlife Sanctuary, Cambodia. *Resources* **2018**, *7*, 41. [CrossRef]
43. Lise, W. Factors influencing people's participation in forest management in India. *Ecol. Econ.* **2000**, *34*, 379–392. [CrossRef]
44. Jumbe, C.B.L.; Angelsen, A. Forest dependence and participation in CPR management: Empirical evidence from forest co-management in Malawi. *Ecol. Econ.* **2007**, *62*, 661–672. [CrossRef]
45. Coulibaly-Lingani, P.; Savadogo, P.; Tigabu, M.; Oden, P.C. Factors influencing people's participation in the forest management program in Burkina Faso, West Africa. *For. Policy Econ.* **2011**, *13*, 292–302. [CrossRef]
46. Tugume, P.; Buyinza, M.; Namaalwa, J.K.; Kakudidi, E.; Mucunguzi, P.; Kalema, J.; Kamatenesi, M. Socio-economic predictors of dependence on non-timber forest products: Lessons fromMabira Central Forest Reserve Communities. *JAES* **2015**, *4*, 195–214. [CrossRef]
47. Soe, K.T.; Youn, Y. Perceptions of forest-dependent communities toward participation in forest conservation: A case study in Bago Yoma, South-Central Myanmar. *For. Policy Econ.* **2019**, *100*, 129–141. [CrossRef]
48. Thammanu, S.; Marod, D.; Han, H.; Bhusal, N.; Asanok, L.; Ketdee, P.; Gaewsingha, N.; Lee, S.; Chung, J. The influence of environmental factors on species composition and distribution in a community forest in northern Thailand. *J. For. Res.* **2021**, *32*, 649–662. [CrossRef]
49. Thai Meteorological Department. *Daily Meteorology*; Northern Meteorological Center: Bangkok, Thailand, 2018.
50. Ekanayake, E.M.B.P.; Xie, Y.; Ahmad, S. Rural residents' participation intention in community forestry-challenge and prospect of community forestry in Sri Lanka. *Forests* **2021**, *12*, 1050. [CrossRef]
51. Poudel, N.R.; Fuwa, N.; Otsuka, K. The impacts of a community forestry program on forest conditions, management intensity and revenue generation in the Dang district of Nepal. *Environ. Dev. Econ.* **2015**, *20*, 259–281. [CrossRef]
52. Turyahabwe, N.; Tumusiime, D.M.; Byakagaba, P.; Tumwebaze, S.B. Impact of collaborative forest management on forest status and local perceptions of contribution to livelihoods in Uganda. *J. Sustain. Dev.* **2013**, *6*, 36–46. [CrossRef]
53. Wood, A.; Tolera, M.; Snell, M.; O'Hara, P.; Hailu, P. Community forest management (CFM) in south-west Ethiopia: Maintaining forests, biodiversity and carbon stocks to support wild coffee conservation. *Glob. Environ. Chang.* **2019**, *59*, 101980. [CrossRef]
54. Bowler, D.; Buyung-Ali, L.; Healey, J.R.; Jones, J.P.G.; Knight, T.; Pullin, A.S. The evidence base for community forest management as a mechanism for supplying global environmental benefits and improving local welfare. *CEE Rev.* **2010**, *48*, 8–11.
55. Måren, I.E.; Bhattarai, K.R.; Chaudhary, R.P. Forest ecosystem services and biodiversity in contrasting Himalayan forest management systems. *Environ. Conserv.* **2014**, *4*, 73–83. [CrossRef]
56. Pragtong, K. *Community Forestry in Thailand*; RFD: Bangkok, Thailand, 1995.
57. Sritanatorn, P. Sustainable Community Forest Management in Local Development: Community Practice, People Participation and the Success of Forest Conservation. Doctoral Dissertation, National Institute of Development Administration, Bangkok, Thailand, 2009.
58. Sunderlin, W.D. Poverty alleviation through community forestry in Cambodia, Laos, and Vietnam: An assessment of the potential. *For. Policy Econ.* **2006**, *8*, 386–396. [CrossRef]

59. Negi, S.; Pham, T.T.; Karky, B.; Garcia, C. Role of community and user attributes in collective action: Case study of community-based forest management in Nepal. *Forests* **2018**, *9*, 136. [CrossRef]
60. Dolisca, F.; Carter, D.R.; McDaniel, J.M.; Shannon, D.A.; Jolly, C.M. Factors influencing farmers' participation in forestry managementprog rams: A case study from Haiti. *For. Ecol. Manag.* **2006**, *236*, 324–331. [CrossRef]
61. Islam, K.K.; Rahman, G.M.M.; Fujiwara, T.; Sato, N. People's participation in forest conservation and livelihoods improvement: Experience from a forestry project in Bangladesh. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2013**, *9*, 30–43. [CrossRef]
62. Tadesse, S.; Woldetsadik, M.; Senbeta, F. Forest users' level of participation in a participatory forest management program in southwestern Ethiopia. *For. Sci. Technol.* **2017**, *13*, 164–173. [CrossRef]
63. FAO. *Global Forest Resources Assessment: Progress towards Sustainable Forest Management*; FAO: Rome, Italy, 2005.
64. Hoffman, S.M.; High-Pippert, A. From private lives to collective action: Recruitment and participation incentives for a community energy program. *Energy Policy* **2010**, *38*, 7567–7574. [CrossRef]
65. Dasgupta, P.; Southerton, D.; Ulph, A.; Ulph, D. Consumer behaviour with environmental and social externalities: Implications for analysis and policy. *Environ. Resour. Econ.* **2016**, *65*, 191–226. [CrossRef]
66. Cohen, J.M.; Uphoff, N. Participation's place in rural development: Seeking clearity through specificity. *World Dev.* **1980**, *8*, 213–235. [CrossRef]
67. Coulibaly-Lingani, P.; Tigubu, M.; Savadogo, P.; Oden, P.C. Participatory forest management in Burkina Faso: Members' perception of performance. *J. For. Res.* **2014**, *25*, 637–646. [CrossRef]
68. Santika, T.; Wilson, K.A.; Budiharta, S.; Kusworo, A.; Meijaard, E.; Law, E.A.; Friedman, R.; Hutabarat, J.A.; Indrawan, T.P.; John, F.A.V.; et al. Heterogeneous impacts of community forestry on forest conservation and poverty alleviation: Evidence from Indonesia. *People Nat.* **2019**, *1*, 204–219. [CrossRef]
69. Janekarnkij, P. Payment for ecosystem services (Pes) as tool for Mae Lao Watershed Conservation. *ARE Work. Pap.* **2014**, *2557/2*, 1–14.
70. Thammanu, S. The Growing Stock and Sustainable Utilization of White Bamboo (*Bambusa membranacea*) and Community Forest Management in the Natural Mixed Deciduous Forest with Teak in Thailand: A Case Study of Huay Mae Hin Community Forest, Ngao District, Lampang Province. Master's Thesis, Beijing Forestry University, Beijing, China, 2014.
71. Ndangalasi, H.J.; Bitariho, R.; Dovie, D.B.K. Harvesting of non-timber forest products and implications for conservation in two montane forests of East Africa. *Biol. Conserv.* **2007**, *134*, 242–250. [CrossRef]
72. Thammanu, S.; Han, H.; Marod, D.; Zang, L.; Jung, Y.; Soe, K.T.; Onprom, S.; Chung, J. Non-timber forest product utilization under community forest. *For Sci. Technol.* **2021**, *17*, 1–15.
73. Bridhikitti, A.; Khadka, B. Assessing factors to successful management for small-scale community forest under threat of urban growth: In a case of Ban Na Kham Noi Community Forest, Mukdahan, Thailand. *J. Sustain. For.* **2020**, *39*, 167–183. [CrossRef]
74. Kongcharoen, N. Community Forest Management in Northern Thailand. Doctoral Dissertation, University of Victoria, Victoria, BC, Canada, 2012.
75. Poung-ngamchuen, J.; Rungkawat, N.; Trirat, S.S.; Chaichawwong, J. Development of indicators affecting sustainability of community forest management in upper northern Thailand. *IJSSH* **2017**, *7*, 172–178. [CrossRef]
76. Phalla, C. *Benefit Sharing in the Yak Loam Lake Eco-Tourism Project Ratanakiri, Cambodia, Proceedings of A Fair Share? Experiences in Benefit Sharing from Community-Managed Resources in Asia, Bangkok, Thailand, 1 January 2007*; Mahanty, S., Burslem, K., Lee, E., Eds.; RECOFTC: Bangkok, Thailand; WWF: Bangkok, Thailand; SNV: Bangkok, Thailand, 2007; pp. 27–36.
77. ANSAB. *Participatory Inventory of Non-Timber Forest Products*; ANSAB: Kathmandu, Nepal, 2010.
78. DNP. *Thai Plant Names Tem Smittinand*; Forest Herbarium: Bangkok, Thailand, 2014.
79. Curtis, J.T.; McIntosh, R.P. An upland forest continuum in the Prairie-Forest Border Region of Wisconsin. *Ecology* **1951**, *32*, 476–496. [CrossRef]
80. Wong, J.L.G.; Thornber, K.; Baker, N. *Resource Assessment of Non-Wood Forest Products: Experience and Biometric Principles*; FAO: Rome, Italy, 2001.
81. Jarernsuk, S.; Petchsri, S.; Poolprasert, P.; Wattanadumrong, B.; Jongjitvimol, T. Economic value of non-timber forest products used by the largest Hmong community in Thailand. *NU. Int. J. Sci.* **2015**, *12*, 38–51.
82. Yamane, T. *Statistics: An Introductory Analysis*; Harper and Row: New York, NY, USA, 1967.
83. R Development Core Team. R: A Language and Environment for Statistical Computing. Available online: https://www.r-project.org/ (accessed on 12 August 2021).
84. Larpkern, P.; Moe, S.R.; Totland, Ø. The effects of environmental variables and human disturbance on woody species richness and diversity in a bamboo–deciduous forest in northeastern Thailand. *Ecol. Res.* **2009**, *24*, 147–156. [CrossRef]
85. Lamotte, S.; Gajaseni, J.; Malaisse, F. Structure diversity in three forest types of north-eastern Thailand (Sakaerat Reserve, Pak Tong Chai). *Biotechnol. Agron. Soc. Environ.* **1998**, *2*, 192–202.
86. Marod, D.; Kutintara, U.; Yarwudhi, C.; Tanaka, H.; Nakashisuka, T. Structural dynamics of a natural mixed deciduous forest in western Thailand. *J. Veg. Sci.* **1999**, *10*, 777–786. [CrossRef]
87. Teejuntuk, S.; Sahunalu, P.; Sakura, K.; Sungpalee, W. Forest structure and tree species diversity along an altitudinal gradient in Doi Inthanon National Park, northern Thailand. *Tropics* **2003**, *12*, 85–102. [CrossRef]
88. Sahunalu, P. Stand structure and species composition in the long-term dynamic plots of Sakaerat Deciduous Dipterocarp Forest, northeastern Thailand. *J. For. Manag.* **2009**, *3*, 1–20.

89. Bunyavejchewin, S.; Baker, P.J.; Davies, S.J. Seasonally dry tropical forests in continental Southeast Asia-Structure, composition, and dynamics. In *The Ecology and Conservation of Seasonally Dry Forests in Asia*; McShea, W., Davis, S., Bhumpakphan, N., Eds.; Smithsonian Institution Scholarly Press: Washington, DC, USA, 2011; pp. 9–35.
90. Mokopen, K.; Duangjai, W.; Kroeksakul, P.; Racharak, P.; Hanpattanakit, P. Community forest carbon assessment in eastern Thailand from forest conservation management by local people. *Chem. Eng. Trans.* **2021**, *83*, 361–366.
91. Pothawong, N.; Sringernyuang, K.; Seetakoses, P.; Fongmoon, S.; Kumyong, S. Forest structure, diversity and utilization under the community resource management of the community forest at Baan Ta Pa Pao, Thapladuk Sub-District, Lamphun Province. In Proceedings of the 5th of Thai Forest Ecological Research Network, Bangkok, Thailand, 16–17 December 2015; pp. 56–65.
92. Papakjan, N.; Asanok, L.; Thapyai, C. Plant community and environment factors influence on the natural regeneration on tree in the forest edge of deciduous dipterocarp forest and mixed deciduous forest after highland maize cropping at Mae Khum Mee Watershed, Phrae Province. In Proceedings of the 6th of Thai Forest Ecological Research Network, Nakhon Pathom, Thailand, 19–20 December 2017; pp. 123–131.
93. Sukara, N. Tropical forest biodiversity to provide food, health and energy solution of the rapid growth of modern Society. *Procedia Environ. Sci.* **2014**, *20*, 803–808. [CrossRef]
94. Aerts, R.; Honnay, O.; Nieuwenhuyse, A.V. Biodiversity and human health: Mechanisms and evidence of the positive health effects of diversity in nature and green spaces. *Br. Med. Bull.* **2018**, *127*, 5–22. [CrossRef]
95. Culmsee, H.; Leuschner, C.; Moser, G.; Pitopang, R.; Silman, M. Forest aboveground biomass along an elevational transect in Sulawesi, Indonesia, and the role of Fagaceae in tropical montane rain forests. *J. Biogeogr.* **2010**, *37*, 960–974. [CrossRef]
96. Alvarez, E.; Duque, A.; Saldarriaga, J.; Cabrera, K.; Salas, G.L.; Valle, I.; Lema, A.; Moreno, F.; Orrego, S.; Rodríguez, L. Tree above-ground biomass allometries for carbon stocks estimation in the natural forests of Colombia. *For. Ecol. Manag.* **2012**, *267*, 297–308. [CrossRef]
97. Magalhães, T.; Seifert, T. Tree component biomass expansion factors and root-to-shoot ratio of Lebombo ironwood: Measurement uncertainty. *Carbon Balance Manag.* **2015**, *10*, 9. [CrossRef]
98. Zhao, L.; Xiang, W.; Li, J.; Lei, P.; Deng, X.; Fang, X.; Peng, C. Effects of topographic and soil factors on woody species assembly in a Chinese Subtropical Evergreen Broadleaved Forest. *Forests* **2015**, *6*, 650–669. [CrossRef]
99. Kimmins, J.P. *Forest Ecology*; Macmillan Publishing Company: New York, NY, USA, 1987.
100. Myo, K.K.; Thwin, S.; Khaing, N. Floristic composition, structure and soil properties of mixed deciduous forest and deciduous dipterocarp forest: Case study in Madan Watershed, Myanmar. *Am. J. Plant Sci.* **2016**, *7*, 279–287.
101. Gebeyehu, G.; Soromessa, T.; Bekele, T.; Teketay, D. Species composition, stand structure, and regeneration status of tree species in dry Afromontane forests of Awi Zone, northwestern Ethiopia. *EHS* **2019**, *5*, 199–215. [CrossRef]
102. Hermhuk, S.; Chaiyes, A.; Thinkampheang, S.; Danrad, N.; Marod, D. Land use and above-ground changes in a mountain ecosystem, northern Thailand. *J. For. Res.* **2019**, *31*, 1733–1742. [CrossRef]
103. Felfili, J.M. Diameter and height distributions in a gallery forest tree community and some of its main species in central Brazil over a six-year period (1985–1991). *Rev. Bras. Bot.* **1997**, *20*, 155–162. [CrossRef]
104. Sharma, D.; Tiwari, B.K.; Chaturvedi, S.S.; Diengdoh, E. Status, utilization and economic valuation of non-timber forest products of Arunachal Pradesh, India. *J. For. Environ. Sci.* **2015**, *31*, 24–37. [CrossRef]
105. Mukul, S.A.; Rashid, A.Z.M.M.; Uddin, M.B.; Khan, N.A. Role of non-timber forest products in sustaining forest-based livelihoods and rural households' resilience capacity in and around protected area: A Bangladesh study. *J. Environ. Plan. Manag.* **2016**, *59*, 628–642. [CrossRef]
106. Mushi, H.; Yanda, P.Z.; Kleyer, M. Socioeconomic factors determining extraction of non-timber forest products on the slopes of Mt. Kilimanjaro, Tanzania. *Hum. Ecol.* **2020**, *48*, 695–707. [CrossRef]
107. Shrestha, U.B.; Bawa, K.S. Economic contribution of Chinese caterpillar fungus to the livelihoods of mountain communities in Nepal. *Biol. Conserv.* **2014**, *177*, 194–202. [CrossRef]
108. Kar, S.P.; Jacobson, M.G. NTFP income contribution to household economy and related socio-economic factors: Lesson from Bangladesh. *For. Policy Econ.* **2012**, *14*, 136–142. [CrossRef]
109. Thammanu, S.; Han, H.; Marod, D.; Srichaichana, J.; Chung, J. Above-ground carbon stock and REDD+ opportunities of community-managed forests in northern Thailand. *PLoS ONE* **2021**, *16*, e0256005. [CrossRef] [PubMed]
110. DNP. *The Biological Diversity in Protected Area: Omkoi Wildlife Santuary*; Protected Area Regional Office 16: Chiang Mai, Thailand, 2016.
111. DNP. *A Permanent Plot Sampling Project in a Dry Dipterocarp Forest in Mae Ping National Park: Chiang Mai, Lum Phun and Tak Provinces*; DNP: Bangkok, Thailand, 2015.
112. Zhang, W.; Kato, E.; Bhandary, P.; Nkonya, E.M.; Ibrahim, H.I.; Agbonlahor, M.U.; Ibrahim, H.Y. Communities' perceptions and knowledge of ecosystem services: Evidence from rural communities in Nigeria. *FPRI Discuss. Pap. 01418* **2014**, *1*, 1–56.
113. Ouko, C.; Mulwa, R.; Kibugi, R.; Owuor, M.; Zähringer, J.G.; Oguge, N. Community perceptions of ecosystem services and the management of Mt. Marsabit Forest in northern Kenya. *Environments* **2018**, *5*, 121. [CrossRef]
114. Gouwakinnou, G.N.; Biaou, S.; Vodouhe, F.G.; Tovihessi, M.S.; Awessou, B.K.; Biaou, H.S.S. Local perceptions and factors determining ecosystem services identification around two forest reserves in northern Benin. *J. Ethnobiol. Ethnomed.* **2019**, *15*, 61. [CrossRef] [PubMed]

115. Leone, M. Women as decision makers in community forest management: Evidence from Nepal. *J. Dev. Econ.* **2019**, *138*, 180–191. [CrossRef]
116. Moktan, M.R.; Norbu, L.; Choden, K. Can community forestry contribute to household income and sustainable forestry practices in rural area? A case study from Tshapey and Zariphensum in Bhutan. *For. Policy Econ.* **2016**, *62*, 149–157. [CrossRef]
117. Sukwong, S.; Dhamanittakul, P. Fire ecology investigations in dry dipterocarp forest. In Proceedings of the National Forestry Conference, Bangkok, Thailand, November 1977; pp. 41–56.
118. Bunyavejchewin, S. Analysis of tropical dry deciduous forest of Thailand. I. Characteristics of dominance types. *Nat. Hist Bull. Siam Soc.* **1983**, *31*, 109–122.
119. Akaakara, S. *Forest Fire Control in Thailand*; RFD: Bangkok, Thailand, 2000.
120. Giri, C.; Shrestha, S. Technical note: Forest fire mapping in Huay Kha Khaeng Wildlife Sanctuary, Thailand. *Int. J. Remote Sens.* **2000**, *21*, 2023–2030. [CrossRef]
121. Ganz, D.; Moore, P. Living with fire: Summary of communities in flames international conference. In *Communities in Flames, Proceedings of an International Conference on Community Involvement in Fire Management, Balikpapan, Indonesia, 25–28 July 2001*; Moore, P., Ganz, D., Tan, L.C., Enter, T., Durst, P.B., Eds.; FAO: Bangkok, Thailand, 2002; pp. 1–9.
122. Hoare, P. A process for community and government cooperation to reduce the forest fire and smoke problem in Thailand. *Agric. Ecosyst. Environ.* **2004**, *104*, 35–46. [CrossRef]
123. RFD. Causes of Forest Fires. Available online: https://www.forest.go.th (accessed on 12 September 2021).
124. Sriviraj, S.; Kaoses, P.; Thidpad, P. Tree ordainment: Indigenous knowledge for forest conservation in northern Thailand community through Buat-Pah Ritual. *J. Humanit. Soc. Sci.* **2019**, *10*, 121–144.
125. Patsin, T.; Kenaphoom, S. The community forest management by using the local wisdom, Maha Sarakham, Thailand. *EEO* **2021**, *20*, 1064–1070.
126. Rakyutidharm, A. Forest fire in the context of territorial rights in northern Thailand. In *Communities in Flames, Proceedings of an International Conference on Community Involvement in Fire Management, Balikpapan, Indonesia, 25–28 July 2001*; Moore, P., Ganz, D., Tan, L.C., Enter, T., Durst, P.B., Eds.; FAO: Bangkok, Thailand, 2002; pp. 112–116.
127. SAO. *Forest Management by Local Wisdom-Based and Policy Process*; SAO: Chiang Rai, Thailand, 2019.
128. Marod, D.; Kutintara, U.; Tanaka, H.; Nakashizuka, T. The effects of drought and fire on seed and seedling dynamics in a tropical seasonal forest in Thailand. *Plant Ecol.* **2002**, *161*, 41–57. [CrossRef]
129. Bi, S.G.; Bitty, E.A.; Yao, A.K.; McGraw, W.S. Foot patrols enhance conservation efforts in threatened forest reserves of Coastal Côte d'Ivoire. *Trop. Conserv. Sci.* **2019**, *12*, 1940082919872637.
130. Pretty, J.; Buck, L. Social capital and social learning in the process of natural resource management. In *Natural Resources Management in African Agriculture: Understanding and Improving Current Practices*; Barrett, C.B., Place, F., Aboud, A.A., Eds.; CABI Publishing: Wallingford, UK, 2002.
131. Putman, R.D. The prosperous community: Social capital and public life. *TAP* **1993**, *13*, 35–42.
132. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990.
133. Ostrom, E. A general framework for analyzing sustainability of social-ecological systems. *Science* **2009**, 419–422. [CrossRef] [PubMed]
134. Nath, T.K.; Inoue, M.; Pretty, J. Formation and function of social capital for forest resource management and the improved livelihoods of indigenous people in Bangladesh. *JRCD* **2010**, *5*, 104–122.
135. Lee, Y.; Rianti, I.; Park, M.S. Measuring social capital in Indonesian community forest management. *For. Sci. Technol.* **2017**, *13*, 133–141. [CrossRef]
136. Certini, G. Effects of fire on properties of forest soils: A review. *Oecologia* **2005**, *143*, 1–10. [CrossRef]
137. Carvalho, A.; Monteiro, A.; Flannigan, M.; Solman, S.; Miranda, A.I.; Borrego, C. Forest fires in a changing climate and their impacts on air quality. *Atmos. Environ.* **2011**, *45*, 5545–5553. [CrossRef]
138. Aregai, T.; Neary, D. Water quality impacts of forest fires. *J. Pollut. Eff. Cont.* **2015**, *3*, 1–7.
139. Janzen, D.H. Tropical dry forests. *Biodiversitas* **1988**, *15*, 538.
140. Ido, A. The effect of social capital on collective action in community forest management in Cambodia. *Int. J. Commons.* **2019**, *13*, 777–803. [CrossRef]
141. Sukwong, S. *Equator Prize 2004: Pred Nai Community Forestry Nomination File*; UNDP: Bangkok, Thailand, 2004.
142. Pragtong, K. Recent decentralization plans of the Royal Forest Department and its implications for forest management in Thailand. In *Decentralization and Devolution of Forest Management in Asia and the Pacific*; Thomas, E., Patrick, B., Durst, T., Victor, M., Eds.; RAP Publication: Bangkok, Thailand, 2000.
143. Blair, H.W.; Olpadwala, P.D. *Forestry in Development Planning: Lessons from the Rural Experience*; Westview Press: London, UK, 1988.
144. ITTO. *Criteria for the Measurement of Sustainable Tropical Forest Management*; ITTO: Yokohama, Japan, 1992.
145. FAO. *Sustainable Management of Tropical Moist Forest for Wood: In the Challenge of Sustainable Forest Management*; FAO: Rome, Italy, 1993.
146. Thai Government. *Royal Decree on Restricted Forest Products B.E. 2530*; Royal Thai Government Gazett: Bangkok, Thailand, 1987.
147. RFD. *Implementation Guidelines for Community Forest Projects of the Royal Forest Department*; RFD: Bangkok, Thailand, 2014.

148. Wanthongchai, K.; Goldammer, J.G.; Bauhus, J. Effects of fire frequency on prescribed fire behavior and soil temperatures in dry dipterocarp forests. *Int. J. Wildland Fire* **2011**, *20*, 35–45. [CrossRef]
149. CBD. Covention on Biological Diversity, United Nations Environment Programme. Available online: https://www.cbd.int/convention/ (accessed on 1 June 2018).