



Tree species diversity and aboveground carbon stocks in Ban Nong Nae community forest: implications for ecosystem rehabilitation

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Abstract

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This study investigated tree species diversity, forest structure, and aboveground carbon stocks in the Ban Nong Nae Community Forest, Chachoengsao Province, Thailand. The objective was to quantify ecological attributes and examine the relationships between species diversity, forest structure, and carbon storage within a community forest ecosystem. Field data were collected from a 0.4 ha (4,000 m²) permanent plot by recording tree species composition and structural measurements. Aboveground biomass was estimated using the allometric equations developed by Ogawa et al. (1965) combined with standard carbon fraction values. A total of 27 tree species belonging to 19 families and 258 individuals were recorded, corresponding to a stand density of 645 individuals ha⁻¹. The Shannon–Wiener diversity index (H') was 2.59, and the evenness index (E) was 0.795, indicating moderate species diversity with a relatively even distribution of individuals among species. Total aboveground biomass was estimated at 48,384.24 kg, resulting in a carbon stock of 23,353.87 kg C (58.38 Mg C ha⁻¹). Carbon stocks were unevenly distributed, with 77.8% concentrated in six dominant species, notably *Pterocarpus macrocarpus*. This pattern indicates that carbon storage was strongly influenced by stand structural composition and species dominance, particularly the contribution of a small number of canopy-forming species. Overall, the findings suggest that aboveground carbon storage is closely associated with forest structural characteristics and dominant species composition. These findings provide baseline data for ecological assessment and carbon accounting in community forest ecosystems and highlight the importance of species diversity and forest structural in supporting ecosystem rehabilitation.

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1. Introduction

Climate change has intensified continuously over recent decades, exerting significant impacts on forest resources, ecosystem integrity, and human well-being, particularly in developing countries such as Thailand. Increasing variability in rainfall patterns, prolonged droughts, and widespread forest degradation have directly affected food security, rural livelihoods, and the long-term adaptive capacity of local communities to climate change [1, 2]. Forest degradation is closely linked to socioeconomic challenges at the grassroots level, often reinforcing cycles of poverty and environmental vulnerability [3]. In this context, community-based forest management, commonly referred to as community forests, has gained increasing recognition

as a critical mechanism for integrating natural resource conservation, biodiversity protection, and sustainable livelihood development. Community forests represent a form of collective action that empowers local stakeholders to manage forest resources while balancing ecological integrity and social well-being [4, 5]. Beyond serving as sources of subsistence, community forests underpin a wide range of ecosystem services, including provisioning services, environmental regulation, and the maintenance of biodiversity that supports ecosystem resilience [6, 7]. This approach is consistent with the objectives of Thailand's Community Forest Act B.E. 2562 [8], which formally recognizes community rights and responsibilities in forest governance for sustainable and equitable use. In addition to

their social and institutional significance, community forests play an important ecological role as terrestrial carbon sinks, contributing to climate change mitigation by accumulating carbon in forest biomass. Tree components, in particular, constitute the primary structural elements responsible for long-term carbon storage and ecosystem stability [1, 2]. In mosaic forest ecosystems, carbon cycling is influenced by the coexistence of diverse plant species, structural differences, and varied growth patterns. Compared with uniform stands, these mixed systems exhibit greater variation in the distribution of carbon across space and time. Fast-growing species contribute substantially to carbon uptake and biomass accumulation, whereas long-lived trees function as persistent carbon reservoirs that store carbon over extended periods,

collectively influencing net primary productivity and carbon sequestration capacity [9]. Furthermore, the forest carbon cycle is not limited to aboveground biomass but is closely linked to belowground soil organic carbon pools, which represent the largest terrestrial carbon reservoir yet remain highly sensitive to global climate shifts [10]. In highly heterogeneous tropical landscapes, including mosaic forest ecosystems, carbon dynamics are strongly influenced by biogeochemical processes that regulate carbon exchange among vegetation, litter, soils, and the atmosphere [10]. Variations in tree species composition can affect litterfall production, litter quality, and decomposition rates, thereby contributing to spatial heterogeneity in carbon cycling and ecosystem functioning [11].



Fig. 1 Overview of the Nong Nae community forest, Chachoengsao Province, Thailand, illustrating forest structure, local ecological knowledge, and community-based forest management. (a) Bamboo-dominated forest landscape; (b) information board on traditional bamboo use; (c) map of community forest boundaries and management zones; (d) non-timber forest products (wild mushrooms); (e) community learning center related to medicinal plants and forest resources; and (f) community participation in forest observation and learning activities.

Moreover, mosaic forests are frequently subjected to localized natural or anthropogenic disturbances that can destabilize carbon fluxes, shifting ecosystems from carbon sinks to temporary carbon sources. Therefore, maintaining resilient natural regeneration processes is essential for sustaining long-term carbon equilibrium and ecosystem stability [12]. However, research on community forests in Thailand has largely emphasized socioeconomic dimensions and resource utilization. In contrast, quantitative ecological assessments particularly those focusing on forest structure, tree species composition, and species-specific contributions to carbon sequestration remain limited. This knowledge gap is especially evident in community forests characterized by mixed or mosaic forest structures. Recent advancements in local forest allometry have underscored the critical importance of species-specific and site-specific models in

reducing uncertainties within greenhouse gas inventories and carbon accounting frameworks, such as preliminary destructive sampling models developed for selected plantation species in Thailand [13]. Nevertheless, these rigorous quantification methods remain heavily focused on monoculture systems, where stand structure, species composition, and biomass allocation patterns are relatively uniform. Empirical studies integrating tree species diversity, forest structural attributes, and species-specific contributions to aboveground carbon storage in complex, community-managed mosaic forests remain scarce, particularly within community forests of eastern Thailand.

To address this knowledge gap, the community forest of Nong Nae Subdistrict, Phanom Sarakham District, Chachoengsao Province, was selected as a representative mosaic forest ecosystem in which tree species coexist with

bamboo stands and other vegetation types. In such systems, trees function as key structural elements that regulate microclimatic conditions, support understory biodiversity, and serve as major reservoirs of biomass and carbon over time [14, 15]. Forest management and resource use in this area are strongly informed by local wisdom and traditional knowledge, which guide species selection and landscape stewardship.

These practices can be regarded as forms of adaptive knowledge that enhance community resilience to climatic variability and environmental change [16]. By simultaneously examining tree species diversity, forest structure, ecological dominance pattern, and aboveground carbon storage, this study provides an integrated assessment of ecosystem functioning and carbon sequestration potential in a community-managed mosaic forest.

Accordingly, this study aims to examine tree species composition and forest structure in a community-managed forest ecosystem. Species diversity, evenness, stand density, and species-level contributions to aboveground biomass and carbon stocks were evaluated to characterize patterns of ecological and functional dominance within the forest. The structural information obtained was further integrated with estimates of forest biomass and carbon sequestration potential, providing a scientific basis for evaluating the climate-mitigation capacity of community forests.

The findings are expected to support evidence-based community forest management and restoration planning, enhance climate resilience through increased carbon storage and sequestration, and contribute to the achievement of the Sustainable Development Goals, particularly SDG 13 (Climate Action) and SDG 15 (Life on Land), while indirectly supporting local livelihoods and poverty alleviation (SDG 1) through sustainable ecosystem services. The study area and its location within eastern Thailand are shown in Fig. 1.

2. Materials and Methods

Study Area

This study was conducted in two community forests: Ban Nong Nae community forest (Village No. 12) and Ban Pa Rai community forest (Village No. 14), located in Nong Nae Subdistrict, Phanom Sarakham District, Chachoengsao Province, eastern Thailand. The study area is classified as a mixed deciduous forest ecosystem and plays an important role in local community-based resource use and landscape-scale carbon storage. The geographic coordinates of the study area are 13°40'29.8" N and 101°19'47.1" E.

Forest structure and tree species diversity were assessed using permanent sample plots in combination with line transect sampling. Two-line transects were established across the study area, along which temporary circular plots with a diameter of 12 m were used to obtain preliminary information on tree spatial distribution and stand structure. Subsequently, four permanent rectangular plots measuring 20 × 50 m (0.1 ha each) were established for detailed forest inventory and carbon assessment, resulting in a total sampling area of 0.4 ha. Only data obtained from the four permanent rectangular plots were used for quantitative analyses of species diversity, forest structure, aboveground biomass, and carbon stocks.

The total sampling area of 0.4 ha is comparable to that used in several ecological and carbon assessment studies conducted in community forests and secondary tropical forests, providing a practical basis for characterizing local forest structure and aboveground biomass under site-specific conditions. Within each permanent plot, all trees with a diameter at breast height (DBH) ≥ 4.5 cm, measured at 1.3 m above ground level, were recorded. The minimum DBH threshold was adopted to include small- and medium-sized woody individuals that contribute substantially to stand structure and biomass accumulation in regenerating community forests. For each tree, species identity, DBH, and total height were measured and recorded, as shown in Fig. 2.



Fig. 2 Study area and field data collection in the Nong Nae community forest, Chachoengsao Province, Thailand. (a) Location of Ban Nong Nae Subdistrict in eastern Thailand; (b) spatial distribution of study sites within community-managed areas; (c) representative mixed deciduous forest with bamboo understory; (d) vegetation sampling within permanent plots; and (e) schematic illustration of diameter at breast height (DBH) measurement at 1.3 m above ground.

Ecological Data Analysis

Species Diversity

Species diversity was quantified using the Shannon–Wiener diversity index (H') following Shannon and Weaver [17]. The index was computed as;

$$H' = - \sum_{i=1}^S (p_i) \ln(p_i) \quad (1)$$

where:

S = total number of species,

p_i = proportion of individuals belonging to species i
 $(p_i = \frac{n_i}{N})$,

n_i = number of individuals of species i ,

N = total number of individuals across all species.

The Shannon index incorporates both species richness and relative abundance, thereby reflecting community heterogeneity.

Species Evenness

Following Pielou [18], Species evenness (E') was calculated to evaluate the equitability of individual distribution among species, as shown in the following equation;

$$E' = \frac{H'}{\ln S} \quad (2)$$

where:

H' = Shannon–Wiener diversity index,

S = total number of species.

Evenness values range from 0 to 1, with values approaching 1 indicating a more even distribution of individuals among species.

Basal Area

The basal area of each tree was calculated using Equation (3). To ensure conformity with conventional forestry reporting, individual values were converted from square centimeters (cm^2) to square meters (m^2) using the following equation:

$$BA = \frac{\pi \times (DBH^2)}{4,000} \quad (3)$$

where BA is the basal area of an individual tree (m^2), DBH is the diameter at breast height (cm), and π is the mathematical constant (3.14159). Total basal area was obtained by summing the basal area of all trees within each plot and expressed as $\text{m}^2 \text{ ha}^{-1}$. The cumulative basal area per hectare ($\text{m}^2 \text{ ha}^{-1}$) was subsequently extrapolated based on the total permanent plot sampling area (0.4 ha).

Estimation of Plant Biomass and Carbon Sequestration

The aboveground biomass of trees was estimated using the allometric equations developed by Ogawa *et al.* [19]. Although the pantropical model proposed by is widely used for biomass estimation in tropical forests, the Ogawa equations were selected because they have been extensively

applied in biomass and carbon stock assessments of deciduous forest ecosystems in Thailand. Their use facilitates comparison with previous studies conducted in similar forest environments. The study area comprises a community-managed mosaic forest containing elements of mixed deciduous forest, dry dipterocarp forest, bamboo stands, and other deciduous vegetation; therefore, the Ogawa equations were considered appropriate for estimating aboveground biomass in the present study. Nevertheless, biomass estimates derived from different allometric models may vary, introducing uncertainty into carbon stock assessments, and this limitation should be considered when interpreting the results.

First, total tree height (h) was estimated from diameter at breast height (DBH) (cm) using the following equation:

$$h = \frac{124.8 \times (DBH)^{0.638}}{38.8 + 33.14 \times DBH^{0.638}} \quad (4)$$

The biomass components (stems, branches, and leaves) of each tree were calculated using the following allometric equations:

$$\text{Stem Biomass } (W_s) = 0.0396(DBH^2 \times h)^{0.933} \quad (5)$$

$$\text{Branch Biomass } (W_b) = 0.00349(DBH^2 \times h)^{1.03} \quad (6)$$

$$\text{Leaf Biomass } (W_l) = \left(\frac{28}{WTC} + 0.025 \right)^{-1} \quad (7)$$

Where:

DBH = diameter at breast height (cm)

h = total tree height (m)

W_s = stem biomass (kg)

W_b = branch biomass (kg)

W_l = leaf biomass (kg)

WTC = total woody biomass (kg)

calculated as:

$$WTC = W_s + W_b \quad (8)$$

Carbon Stock Assessment

The assessment of biomass and carbon stocks in the study plots followed the standard guidelines provided by the Royal Forest Department [20]. Aboveground biomass was separated into three components, including stems (W_s), branches (W_b), and leaves (W_l). For the calculation of carbon sequestration in each plant component, the biomass of each part was multiplied by its respective carbon fraction as established by Tsutsumi *et al.* [21], using values of 0.499 for stems, 0.487 for branches, and 0.483 for leaves. The total carbon stock (C_{total}) for each tree was calculated as follows:

$$C_{\text{total}} = (W_s \cdot 0.499) + (W_b \cdot 0.487) + (W_l \cdot 0.483) \quad (9)$$

This approach provides a component-based estimation of tree carbon stock by integrating biomass allocation with tissue-specific carbon fractions. The present study focused

exclusively on aboveground tree biomass and carbon stocks. Belowground biomass and soil organic carbon were not included because direct measurements were beyond the scope of this study. Consequently, the reported carbon stock values represent only the aboveground tree carbon pool and may underestimate the total ecosystem carbon stock of the community forest.

3. Results and Discussion

Floristic Composition and Stand Structure

The floristic survey conducted within a 4,000 m² (0.4 ha) sampling area recorded 27 tree species belonging to 19 families (Table 1), comprising 258 individuals. This corresponds to a stand density of 645 individuals ha⁻¹, which is consistent with values reported for secondary mixed deciduous forests in Thailand [22]. Ecological analysis (Table 2) yielded a Shannon–Wiener diversity index (H') of 2.590, indicating moderate species diversity and falling within the typical range reported for mixed deciduous forest

ecosystems [22, 23]. The evenness index ($E = 0.795$), calculated according to Pielou [24], indicates a relatively uniform distribution of individuals among species, with no single species exhibiting strong numerical dominance. Such evenness is commonly associated with structurally heterogeneous forest communities, with no single species exhibiting overwhelming numerical dominance. Such patterns are generally associated with structurally heterogeneous forest communities and a balanced distribution of individuals across species [24]. The observed diversity is reflected in the heterogeneous forest structure of the community forest. Species such as *Wrightia arborea* and *Holarrhena pubescens* (Fig. 3) contribute to structural variation through differences in growth form, stem characteristics, and canopy architecture. In addition, large-diameter trees, particularly *Pterocarpus macrocarpus*, are important contributors to stand biomass and carbon storage. These observations suggest that both species diversity and the presence of large woody individuals contribute to forest structural complexity and aboveground carbon accumulation within the study area.

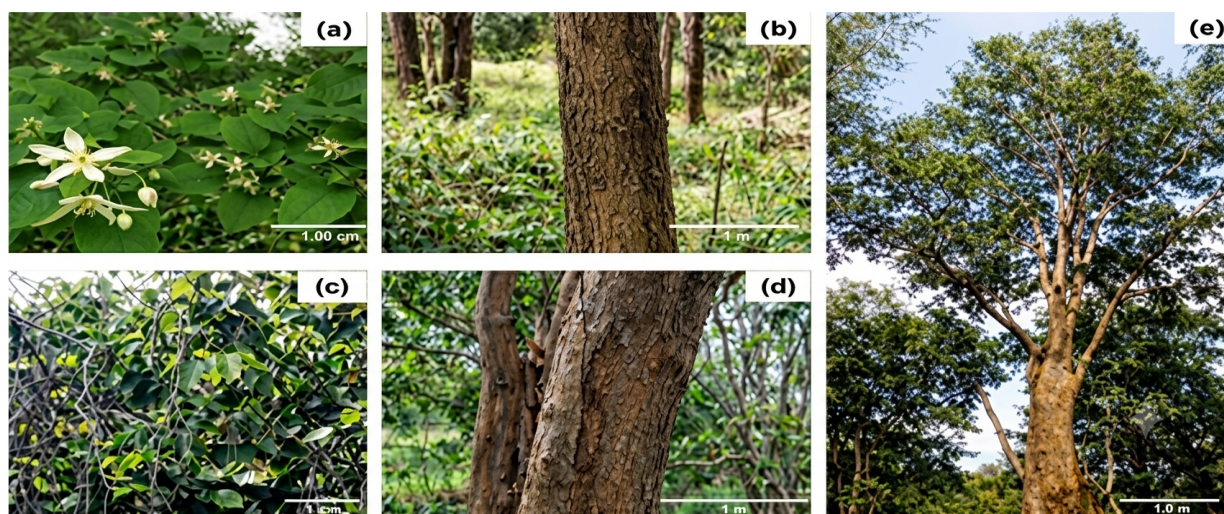


Fig. 3 Morphological characteristics of dominant tree species recorded in the Ban Nong Nae community forest: (a) flowers and (b) stem bark of *Wrightia arborea* (Dennst.) Mabb.; (c) fruits and (d) multi-stem bark structure of *Holarrhena pubescens* Wall. ex G. Don; and (e) canopy architecture of *Pterocarpus macrocarpus* Kurz within the study area. Scale bars are indicated in each panel.

Aboveground Biomass and Carbon Stock

The 0.4 ha study plot contained a total aboveground biomass (AGBM) of 48,384.24 kg, corresponding to 23,353.87 kg C, or 58.38 Mg C ha⁻¹. The estimated carbon stock of 58.38 Mg C ha⁻¹ falls within the range reported for deciduous forest ecosystems in Thailand and mainland Southeast Asia. For example, Terakunpisut *et al.* [25] reported carbon stocks ranging from approximately 40–90 Mg C ha⁻¹ in dry deciduous forests of northeastern Thailand, depending on stand age, species composition, and disturbance history. Similar patterns have also been observed in community-managed deciduous forests throughout the region, where the abundance of large trees and dominant woody species strongly influences carbon

storage. The stem component (W_s) constituted the largest proportion of biomass, followed by branches (W_b) and leaves (W_l). This allocation pattern is consistent with biomass partitioning commonly observed in forest ecosystems, where woody tissues account for a substantial proportion of aboveground biomass because carbon accumulates and is retained in stems and branches over relatively long periods [26, 27]. Among the recorded species, *Pterocarpus macrocarpus* contributed the highest carbon stock (7,096.04 kg C), accounting for 30.4% of the total carbon pool, followed by *Dalbergia cultrata* (3,179.04 kg C) and *Holarrhena pubescens* (3,011.49 kg C). Collectively, these three species accounted for 56.9% of the total carbon stock, while the six leading species contributed

77.8% (Table 3). This uneven distribution indicates that aboveground carbon storage within the community forest is concentrated in a relatively small number of species. The substantial contribution of *P. macrocarpus* and *D. cultrata* is likely associated with their relatively large stem sizes and high biomass stocks. Similar patterns have been reported in tropical forests, where a limited number of dominant tree species contribute disproportionately to stand-level biomass and carbon storage [28]. These findings indicate that variations in species composition and the presence of large trees are associated with differences in aboveground carbon storage within the study area. The baseline ecological information generated by this study may support community forest management, long-term carbon monitoring, and forest restoration planning. Such information is also relevant to climate change mitigation initiatives and the achievement of Sustainable Development Goal 13 (Climate Action).

In Thailand, the carbon stock estimates generated in this study may also provide baseline information relevant to preliminary assessments under the Thailand Voluntary Emission Reduction Program (T-VER), although further monitoring and verification would be required before carbon credit certification could be considered. The carbon stock estimated in this study represents a single-time assessment and therefore reflects only the current state of aboveground carbon storage within the community forest. Long-term carbon dynamics are influenced by tree growth, recruitment, mortality, and natural or anthropogenic disturbances, which may substantially alter carbon accumulation over time. Similar temporal variability has been reported in tropical forest ecosystems, highlighting that forest carbon stocks should be interpreted as dynamic rather than static ecosystem attributes. In addition, biomass estimates were derived using allometric equations developed by Ogawa *et al.* [19] and did not incorporate species-specific wood density data. Consequently, some degree of uncertainty may be

associated with the estimated biomass and carbon stock values. Future studies incorporating repeated measurements, species-specific wood density information, and belowground carbon pools would improve the accuracy and comprehensiveness of forest carbon assessments.

Relationship Between Biodiversity and Carbon Storage

Although the forest supported a moderately diverse tree community ($H' = 2.590$), most aboveground carbon was concentrated in a relatively small number of dominant species. This pattern highlights the distinction between species diversity and biomass dominance within the forest community. Shannon diversity reflects species heterogeneity [23], whereas aboveground biomass is often disproportionately influenced by large trees and species capable of attaining substantial stem dimensions [27]. The prominent stem size and canopy architecture of *Pterocarpus macrocarpus* (Fig. 3e) illustrate its substantial contribution to stand-level biomass and carbon storage. Similar patterns have been reported in tropical forests, where a limited number of dominant species account for a large proportion of total biomass despite relatively high species richness [28]. According to the Biodiversity–Ecosystem Function (BEF) theory [29], species-rich communities may promote ecosystem functioning through complementary resource use and niche differentiation. In the present study, the coexistence of 27 tree species contributed to structural heterogeneity, whereas a small number of dominant species accounted for most of the aboveground carbon stock. These findings indicate that biodiversity and carbon storage represent related but distinct components of forest ecosystem functioning. Integrating diversity indices with biomass-based assessments, therefore, provides a more comprehensive understanding of forest structure and supports community forest management, conservation, and restoration planning.

Table 1 Species composition and taxonomic diversity in Ban Nong Nae community forest.

No.	Scientific Name	Family	Local Name (Thai)
1	<i>Pterocarpus macrocarpus</i> Kurz	Fabaceae	Pradu Pa
2	<i>Dalbergia cultrata</i> Graham ex Benth.	Fabaceae	Kraphi Khao Khwai
3	<i>Holarrhena pubescens</i> Wall. ex G. Don	Apocynaceae	Mok Luang
4	<i>Aporosa villosa</i> (Wall. ex Lindl.) Baill.	Phyllanthaceae	Muat Lot
5	<i>Sindora siamensis</i> Teijsm. ex Miq.	Fabaceae	Makha Tae
6	<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	Kuk
7	<i>Wrightia arborea</i> (Dennst.) Mabb.	Apocynaceae	Mok Man
8	<i>Fernandoa adenophylla</i> (Wall. ex G. Don) Steenis	Bignoniaceae	Khac Hang Khang
9	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Combretaceae	Samo Phiphek
10	<i>Millingtonia hortensis</i> L. f.	Bignoniaceae	Pip
11	<i>Morinda citrifolia</i> L.	Rubiaceae	Yo Pa
12	<i>Mitragyna rotundifolia</i> (Roxb.) Kuntze	Rubiaceae	Krathum Noen
13	<i>Spondias bipinnata</i> Airy Shaw & Forman	Anacardiaceae	Makok Pa
14	<i>Buchanania lanzan</i> Spreng.	Anacardiaceae	Mamuang Hua Maeng Wan
15	<i>Bombax anceps</i> Pierre	Malvaceae	Ngiu Pa
16	<i>Garuga pinnata</i> Roxb.	Burseraceae	Ta Khram

Table 1 Species composition and taxonomic diversity in Ban Nong Nae community forest (continued).

No.	Scientific Name	Family	Local Name (Thai)
17	<i>Dalbergia cana</i> Graham ex Kurz	Fabaceae	Kraphi Nang Nuan
18	<i>Litsea glutinosa</i> (Lour.) C. B. Rob.	Lauraceae	Mi Men
19	<i>Schleichera oleosa</i> (Lour.) Merr.	Sapindaceae	Ta Khro
20	<i>Cassia fistula</i> L.	Fabaceae	Khun
21	<i>Lagerstroemia floribunda</i> Jack	Lythraceae	Tabaek Na
22	<i>Colona flagrocarpa</i> (C. B. Clarke) Craib	Malvaceae	Yab Bai Yao
23	<i>Streblus asper</i> Lour.	Moraceae	Khoi
24	<i>Memecylon scutellatum</i> (Lour.) Hook. & Arn.	Melastomataceae	Muat Ae
25	<i>Flacourtia indica</i> (Burm. f.) Merr.	Salicaceae	Ta Khob Pa
26	<i>Cratoxylum cochinchinense</i> (Lour.) Blume	Hypericaceae	Tiu Kiang
27	<i>Antidesma sootepense</i> Craib	Phyllanthaceae	Ma Mao Sai

Table 2 Ecological indices of the tree community in Ban Nong Nae community forest.

Ecological Parameters	Value
Shannon–Wiener Diversity Index (H')	2.590
Pielou's Evenness Index (E)	0.795
Species Richness (S)	27
Stand Density (individuals per 4,000 m ²)	258
Estimated Stand Density (individuals ha ⁻¹)	645

Table 3 Aboveground biomass components and organic carbon stocks of tree species in Ban Nong Nae community forest (0.4 ha).

No.	Scientific Name	W_s (kg)	W_b (kg)	W_l (kg)	AGBM (kg)	TC (kg C)
1	<i>Pterocarpus macrocarpus</i> Kurz	9,985.10	2,406.85	256.96	12,648.91	7,096.04
2	<i>Dalbergia cultrata</i> Graham ex Benth.	4,553.60	1,117.02	109.45	5,780.07	3,179.04
3	<i>Holarrhena pubescens</i> Wall. ex G. Don	4,370.57	863.69	172.37	5,406.63	3,011.49
4	<i>Aporosa villosa</i> (Wall. ex Lindl.) Baill.	2,725.68	663.49	64.58	3,453.76	1,799.41
5	<i>Sindora siamensis</i> Teijsm. ex Miq.	2,450.84	520.42	86.49	3,057.76	1,690.94
6	<i>Lannea coromandelica</i> (Houtt.) Merr.	2,074.49	439.66	75.80	2,589.95	1,414.11
7	<i>Wrightia arborea</i> (Dennst.) Mabb.	1,850.06	399.68	65.29	2,315.03	1,270.95
8	<i>Fernandoa adenophylla</i> (Wall. ex G. Don) Steenis	1,482.38	287.97	59.89	1,830.24	984.67
9	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	1,069.11	243.06	33.91	1,346.08	740.35
10	<i>Millingtonia hortensis</i> L. f.	1,061.86	214.67	41.49	1,318.03	727.56
11	<i>Morinda citrifolia</i> L.	730.22	143.25	29.29	902.77	492.01
12	<i>Mitragyna rotundifolia</i> (Roxb.) Kuntze	506.44	104.31	19.37	630.13	347.83
13	<i>Spondias bipinnata</i> Airy Shaw & Forman	324.60	65.52	12.76	402.88	218.36
14	<i>Buchanania lanzan</i> Spreng.	316.25	65.39	11.89	393.53	213.29
15	<i>Bombax anceps</i> Pierre	250.70	47.13	10.43	308.25	166.46
16	Other species (12 species)	2,323.51	493.12	83.01	2,899.63	1,362.83
Total		39,075.41	8,075.25	1,233.58	48,384.24	23,353.87
						(58.38 Mg C ha ⁻¹)

Note: W_s , Biomass of stems; W_b , Biomass of branches; W_l , Biomass of leaves; AGBM, aboveground biomass; Total aboveground organic carbon. (converted to Mg C ha⁻¹). Value in parentheses represents the estimated carbon stock per hectare (Mg C ha⁻¹), calculated using a conversion factor of 2.5 (10,000 m² per 4,000 m²)

4. Conclusion

The findings indicate that tree species composition is closely associated with carbon storage in the Ban Nong Nae community forest. Although species diversity was relatively high, aboveground carbon storage was concentrated in a small

number of dominant species, suggesting that biodiversity and carbon sequestration represent complementary but distinct aspects of ecosystem functioning. Maintaining both species diversity and large carbon-storing trees is therefore important for sustaining ecological functions and forest carbon stocks.

Taken together, these results provide baseline ecological data for community forest management, biodiversity conservation, forest restoration, and carbon assessment. Long-term monitoring is needed to improve understanding of carbon accumulation and ecosystem change over time. Such information may support sustainable forest management and contribute to maintaining the carbon sequestration capacity of community forest ecosystems.

5. Suggestions

Given that 77.8% of the total carbon stock was concentrated in six dominant species, particularly *Pterocarpus macrocarpus*, these species contribute substantially to current carbon storage within the Ban Nong Nae community forest. Conservation and monitoring of these dominant species are therefore important for maintaining existing carbon stocks and forest structure. With a carbon density of 58.38 Mg C ha⁻¹, the forest could be further evaluated for voluntary carbon accounting schemes, including the Thailand Voluntary Emission Reduction Program (T-VER), subject to verification of eligibility criteria. Future restoration efforts should consider incorporating native species with complementary ecological traits to support both biodiversity conservation and carbon storage. In addition, community engagement and environmental awareness activities can support the long-term sustainability of forest management and conservation outcomes.

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7. Declaration of Generative AI in Scientific Writing

Generative AI tools were used only for language editing and readability improvement. All scientific content and interpretations are the responsibility of the authors.

8. CRediT Author Statement

Sureporn Thummikkaphong: Conceptualization, Funding acquisition, Methodology, Investigation, Data curation, Writing – original draft. **Puangpaka Kaewkrom:** Methodology, Formal analysis, Investigation, Validation, Writing – original draft. **Nutcharin Kleawkla:** Project administration, Methodology, Supervision, Validation, Writing – review & editing.

9. Research Involving Human and Animal Rights

This study involved field surveys and documentation of local ecological knowledge. All information was collected with prior informed consent from community representatives. No personal identifying data was recorded. The study complied with institutional and national ethical standards for research involving human participants.

10. Ethics Approval and Consent to Participate

Ethics Approval: The study protocol was reviewed and granted an exemption by the Ethics Review Board of Rangsit University (DPE. No. RSUERB2024-023). The review was conducted under the Exemption Review category, in compliance with the Standard Operating Procedures and the Declaration of Helsinki and Good Clinical Practice. **Consent to Participate:** Informed consent was obtained from all individual participants involved in the study before data collection.

11. Declaration of Competing Interest

The authors declare no competing interests.

12. References

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