

SPECIES DIVERSITY AND CARBON STOCK OF DECIDUOUS DIPTEROCARP FOREST UNDER THAILAND COMMUNITY FOREST MANAGEMENT

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ARTICLE HIGHLIGHTS

- Although Ban Yod Udom Community Forest is classified as a secondary dipterocarp forest, it shows considerable diversity in woody species.
- Ban Yod Udom Community Forest is dominated by several economically important tree species found in Southeast Asia and Thailand, including *Sindora siamensis*, *Xylia kerrii*, and *Pterocarpus macrocarpus*, as evidenced by their high density, frequency, and basal area values.
- The biomass and carbon stock in Ban Yod Udom Community Forest is lower than that of other deciduous dipterocarp forests in the same region; however, species richness and density are comparatively higher.

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ABSTRACT

Sustainable and efficient forest management is widely recognized as an effective strategy for reducing greenhouse gas emissions, which are a primary driver of global warming. This study investigated woody species composition and diversity, and estimates carbon stocks in the deciduous dipterocarp forest managed under the community forestry scheme at Ban Yod Udom Community Forest, Sa Kaeo Province, Eastern Thailand. A total of 55 sampling plots were systematically established at 100 m intervals throughout the community forest area. Each plot measured 20 m × 20 m for tree assessment, 4 m × 4 m for saplings, and 1 m × 1 m for seedlings. Species composition and diversity were assessed using density, frequency, dominance, and diversity indices, as well as importance value index (IVI). Biomass was estimated using allometric equations, while carbon stock and carbon absorption were calculated accordingly. A total of 55 species from 26 families were identified, with the Fabaceae family exhibiting the highest species richness, with 9 species. Tree, sapling, and seedling densities were 1,014.09; 4,931.81; and 38,602.94 stems/ha, respectively. *Sindora siamensis*, *Momcydon scutellatum*, *Xylia kerrii*, *Pterocarpus macrocarpus*, and *Lannea coromandelica* were identified as ecologically significant trees based on the highest IVI. *M. scutellatum* was the most dominant sapling, while *S. siamensis* was the most prevalent among seedlings. The Shannon–Wiener index ranged from 1.31 to 2.16, indicating low diversity. Dominant woody species at various growth stages contributed greater biomass, carbon stocks, and carbon absorption than other species. The total tree biomass in the community forest was 52.26 tonnes/ha, corresponding to a total carbon stock of 24.56 tonnes C/ha and a total carbon absorption of 90.06 tonnes CO₂/ha. Saplings contributed a total biomass of 2.98 tonnes/ha, a total carbon stock of 1.40 tonnes C/ha, and a total carbon absorption of 5.13 tonnes CO₂/ha. To enhance species diversity and carbon storage in this community forest, it is recommended to increase enrichment planting and implement protective measures, such as wildfire management and regulation of non-timber forest products (NTFP) utilization.

Keywords: biomass, carbon sequestration, climate change, community-based forest management, community forest

INTRODUCTION

The emission of greenhouse gases (GHGs), which leads to rising global temperatures, has become a severe environmental issue worldwide. The potent GHGs comprise carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), which are released from anthropogenic activities such as the burning of fossil fuels, industrial production, and deforestation. The United Framework Convention on Climate Change (UNFCCC) has urged the world to come together to agree on actions to address the climate crisis, such as limiting the global temperature rise to 1.5 °C, helping vulnerable communities adapt to the effects of climate change, and achieving net-zero emissions by 2050 (UNFCCC 2025).

Plants absorb CO₂ from the atmosphere and store it in their biomass or living organisms. Through photosynthesis, plants convert CO₂ into carbohydrates and other organic compounds that become incorporated into aboveground biomass (stems, leaves, and branches) and belowground biomass (roots) (Khalid *et al.* 2024). This carbon can be stored for a period of time, depending on its lifespan, and may be released upon plant death and decomposition. Carbon fixation is essential in woody species or trees, because their size and longevity enable long-term carbon storage. Even after trees are felled, carbon remains sequestered in the wood and can persist for centuries in wooden structures and objects (Enríquez-de-Salamanca 2022).

Forests are major carbon stocks, defined as the total amount of carbon stored within a forest ecosystem, including living trees, dead wood, litter, and soils. They account for approximately 30% of the land surface and store about 45% of terrestrial carbon stocks (Bonan 2008). Tropical forests store most of their carbon in vegetation (biomass), particularly containing 50% of the global carbon stored in trees (World Resources Institute 2025). Forests are essential for sequestering carbon in order to reduce GHG emissions. In other words, forest-based carbon sequestration is an effective approach for reducing the atmospheric CO₂ concentration globally (Fisseha *et al.* 2025).

Community forest is one of the community-based forest management systems, which emphasizes active involvement of local citizens in forest management, promoting knowledge, and ensuring that management aligns with community needs and priorities (Mawa *et al.* 2023). This system has gained significant global attention and legal recognition over the past few decades as a means

of conserving forests and recognizing the rights of local communities. Additionally, locally managed community forest projects can positively impact carbon storage and sequestration and ultimately the GHG emissions caused by deforestation and forest degradation (Thammanu *et al.* 2021).

Thailand has officially launched the community forestry model under the Community Forest Act of 2019 (B.E. 2562). This legislation allows various groups of people other than the government sector to participate in decision-making about forest management and promotes the right of communities to manage and use forests. To date, 11,984 community forests have been formally registered, spanning approximately 1.07 million ha (6.57 million rai) over the country of Thailand (RECOFTC 2025). In Southeast Asia, community forests appear to act as significant roles in rural development, food security, poverty reduction, and local subsistence (Khongswasdi 2022; Thaung 2023).

Deciduous dipterocarp forests in Thailand provide essential social, economic, and environmental benefits for local livelihoods (Saisor *et al.* 2021). These forests are widely distributed across the country's dry regions, particularly from the Northern to the Eastern Regions (Smitinand 1966). In Eastern Thailand, the species structure and carbon storage of deciduous dipterocarp forests remain insufficiently studied, despite the dependence of many rural communities on these forests for a variety of products that support livelihoods and quality of life.

Recently, incentive mechanisms for sustainable forest management and conservation, such as REDD+ and the carbon market, have emerged and have gained significant attention for climate change mitigation. However, there has been limited analysis of their potential contribution to adaptation objectives, especially at the community level.

This study investigated the composition and diversity of woody species and evaluated carbon stocks in a community forest in Sa Kaeo Province, Eastern Thailand. The results provided insights into the status of the deciduous dipterocarp community, including forest composition, diversity, and woody species carbon stocks. These findings support community efforts to manage and restore their forests for sustainable resource use and enhance community resilience and climate change adaptation through forest protection and conservation in the region.

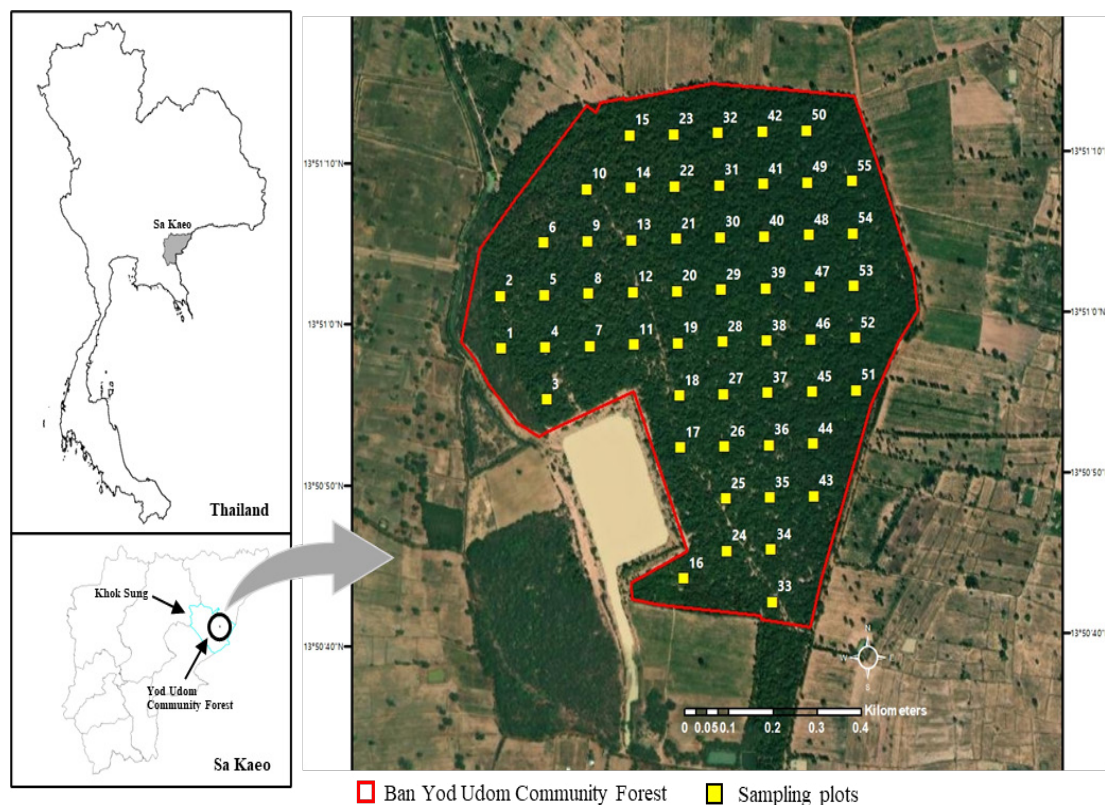


Figure 1 Location of Ban Yod Udom Community Forest in Khok Sung District, Sa Kaeo Province, Eastern Thailand

MATERIALS AND METHODS

Study Area

The study was conducted at Ban Yod Udom Community Forest (13°50'40" N to 13°50'40" N and 102°40'50" E to 102°41'25" E). This community forest is located in Khok Sung District, Sa Kaeo Province, Eastern Thailand (Fig. 1). The secondary growth of deciduous dipterocarp was classified as a forest type covering a total area of 69.12 ha at elevations between 80 and 100 m asl. In 2019, it was officially established as a community forest, as legally supported by the Community Forest Act of 2019, to protect and manage the forest resources for the sustainable livelihoods of local communities.

Vegetation Inventory

A total of 55 sampling plots were systematically established at 100 m intervals throughout the community forest to capture site heterogeneity (Fig. 1). Each of the 20 m × 20 m main plot was subdivided into smaller subplots to assess woody species structure and composition at different growth stages. Specifically, trees (DBH ≥ 4.5 cm, height ≥ 1.30 m) were measured in the main plots.

Within each main plot, one 4 m × 4 m subplot was used for saplings (DBH < 4.5 cm, height ≥ 1.30 m), and one 1 m × 1 m subplot was used for seedlings (DBH < 4.5 cm, height < 1.30 m). DBH and height were measured using a diameter tape and a Nikon Forestry Pro II laser rangefinder camera, respectively.

Data Analysis

Species Composition and Diversity

Plants were categorized according to their species, genera, and families. The taxonomic identification of all species was determined by referring to available sources (Pooma & Suddee 2014; www.theplantlist.org) and verified by a specialist in plants from the Royal Forest Department of Thailand. Herbarium specimens are available in the herbarium of the College of Creative Agriculture for Society, Srinakharinwirot University.

A quantitative study identified the ecological features of the Ban Yod Udom Community Forest. Trends in species density, growth, and regeneration were observed by analyzing DBH and height classes. The ecological values of vegetation

in the community forest were assessed using the following indicators:

$$\text{Relative frequency (RF)} = \frac{\text{Number of occurrences of a species}}{\text{Total number occurrences of all species}} \times 100$$

$$\text{Relative density (RD)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

$$\text{Relative dominance (RDo)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \times 100$$

The diversity indicators, including the Shannon–Wiener Index (H'), Simpson Index, and Evenness Index, were calculated in accordance with Shannon & Weaver (1949), He & Hu (2005), and Magurran (2007), respectively. The formulas are as follows:

1. Shannon–Wiener Index (H')

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

where :

H' = Shannon's Diversity Index

p_i = the proportion of each species in the sample

$\ln p_i$ = the natural logarithm of this proportion

Higher H' value indicates greater species diversity, while a lower value indicates less diversity.

2. Simpson Index (D)

$$D = 1 - \left[\frac{\sum n_i(n_i - 1)}{N(N - 1)} \right]$$

where:

D = the diversity index

n_i = the number of individuals in species i

N = the total number of species in the sample

D value ranges between 0 and 1. Higher D values correspond to greater sample diversity.

3. Evenness Index (E)

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

where:

E = the species evenness index

H' = the Shannon–Wiener Index

S = the number of species

$\ln$ = the natural logarithm

The E quantifies the relative abundances of species within a community. Higher values of E correspond to greater evenness among species.

Biomass, carbon stock, and carbon absorption

The biomass of woody species found in Ban Yod Udom Community was estimated using an allometric equation that is widely used for deciduous forests in Thailand. Aboveground biomass (AGB) and belowground biomass (BGB) were calculated

according to the following equations:

1. For trees (Ogawa *et al.* 1965)

$$Ws = 0.0396(D^2 H)^{0.9326}$$

$$Wb = 0.003487(D^2 H)^{1.0270}$$

$$Wl = (28.0/Wtc + 0.025)^{-1}$$

$$Wr = 0.0264(D^2 H)^{0.775}$$

2. For saplings (Issaree 1982)

$$Ws = 0.0893059(D^2 H)^{0.66513}$$

$$Wb = 0.0153063(D^2 H)^{0.58255}$$

$$Wl = 0.000014(D^2 H)^{0.44363}$$

3. For saplings (IPCC 2006)

$$Wr = 0.28Wt$$

4. Biomass

$$AGB = Ws + Wb + Wl$$

$$BGB = Wr$$

where:

Ws = the stem biomass (kg)

Wb = the branch biomass (kg)

Wl = the leaf biomass (kg)

Wr = the root biomass (kg)

Wtc = the sum of Ws and Wb

Wt = the sum of Ws , Wb , and Wl

D = the diameter at breast height (cm)

H = the total height (m)

Then, biomass was converted into carbon stock based on the formula developed by IPCC (2006), noting that the carbon content of living biomass is about 47% by dry weight. Thus, the carbon stock was estimated using the following formula:

$$\text{Carbon stock} = \text{Biomass} \times 0.47$$

The carbon absorption (CO_2 emissions removed from the atmosphere) was calculated using the carbon stock multiplied by the ratio between the CO_2 molecule (44) and the carbon atom (12), which is equivalent to 3.67 (IPCC 2006):

$$\text{Carbon absorption} = \text{Carbon Stock} \times 3.67$$

RESULTS AND DISCUSSION

Species Composition and Diversity

A total of 55 species belonging to 26 families were identified at Ban Yod Udom Community Forest. Distribution of families and their species is illustrated in Figure 2. Fabaceae was the most species-rich family with nine species. The Rubiaceae family ranked second, comprising seven species.

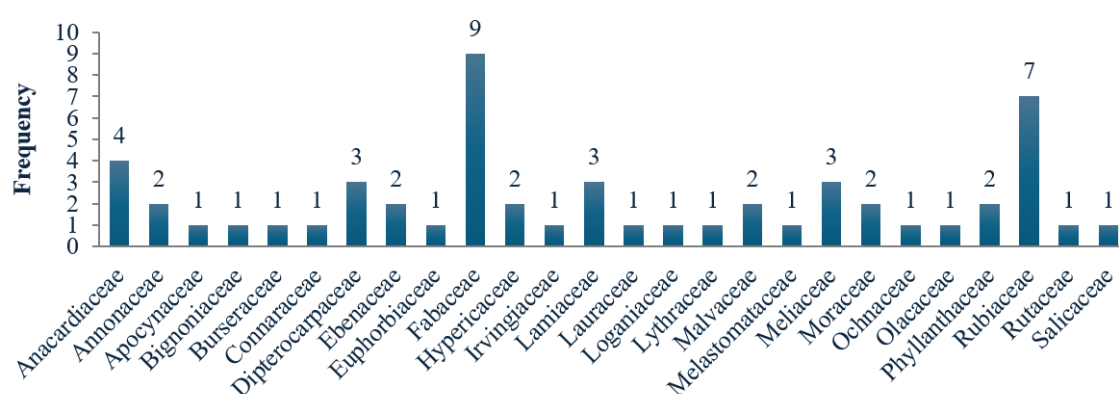


Figure 2 Distribution of plant families and species in Ban Yod Udom Community Forest

Anacardiaceae was the third most species-rich family with four species, followed by Dipterocarpaceae, Lamiaceae, and Meliaceae as the fourth most species-rich family, with three species, respectively. The remaining families were represented by one to two species each.

The total number of individuals of woody species at different growth stages, including trees, saplings, and seedlings, observed in 55 sampling plots at Ban Yod Udom Community Forest were 2,231; 434; and 210 stems, respectively. The corresponding densities of trees, saplings, and seedlings were 1,014.09; 4,931.81; and 38,602.94 stems/ha, respectively (Table 1). Theoretically, a vegetation community is considered to have good regeneration status when the number of individuals follows the pattern: seedlings > saplings > trees.

Table 1 Density of trees, saplings, and seedlings in Ban Yod Udom Community Forest

Growth stages	Density (stems/ha)
Trees	1,014.09
Saplings	4,931.81
Seedlings	38,602.94

The majority of trees were observed in the DBH class of < 10 cm, followed by those in the 11 – 20 cm, 21 – 30 cm, and 31 – 40 cm DBH classes, respectively. This distribution forms a reverse J-shaped curve, characterized by a high frequency of small-diameter trees and progressively fewer trees in larger diameter classes (Fig. 3).

Height class distribution exhibited the highest number of trees in the 5 – 10 m height class, followed by those in the 10 – 15 m, < 5 m, 15 – 20 m, and 20 – 25 m height classes, respectively. This tendency forms a bell-shaped curve, also

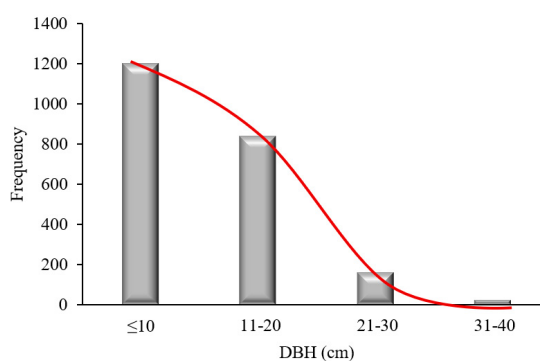


Figure 3 Diameter at breast height (DBH) size class distribution of trees in Ban Yod Udom Community Forest

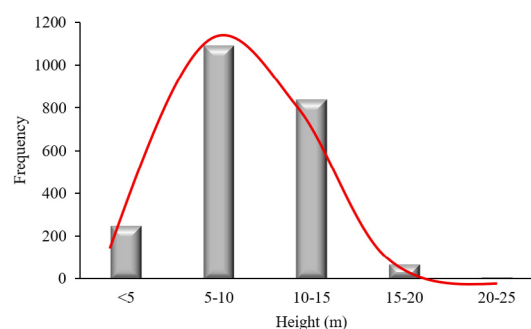


Figure 4 Height class distribution of trees in Ban Yod Udom Community Forest

known as a normal distribution, in which the majority of species falling within a medium height classes, and the rest are at the lower and higher height classes (Fig. 4). Based on the DBH and height class distributions in the study area, the forest vegetation shows good regeneration and recruitment potential, which may be caused by the removal of medium- and large-diameter trees due to anthropogenic and natural disturbances (Abdela *et al.* 2021).

The structural analysis of woody species based on relative frequency, density, dominance, and importance value index (IVI), is summarized in Tables 2 – 4, with species ranked according to IVI values. The dominance of a limited number of species indicates variation in IVI among species. In Table 2, the first five tree species with the highest IVI, accounting for 70.73%, were *Sindora siamensis*, *Memecylon scutellatum*, *Xylia kerrii*, *Pterocarpus macrocarpus*, and *Lannea coromandelica* with IVI values of 96.14, 44.39, 36.74, 21.10, and 13.81, respectively.

Table 2 Relative frequency (RF), Relative density (RD), Relative dominance (RDo) and Importance value index of trees in Ban Yod Udom Community Forest

Scientific name	RF	RD	RDo	IVI
<i>Sindora siamensis</i> Teijsm. ex Miq.	12.56	33.39	50.18	96.14
<i>Memecylon scutellatum</i> (Lour.) Hook & Arn.	10.87	24.47	9.05	44.39
<i>Xylia kerrii</i> Craib & Hutch.	11.84	15.06	9.85	36.74
<i>Pterocarpus macrocarpus</i> Kurz	6.76	5.11	9.23	21.10
<i>Lannea coromandelica</i> (Houtt.) Merr.	7.25	2.78	3.78	13.81
<i>Cratogeomys cochinchinense</i> (Lour.) Blume	4.83	2.60	1.26	8.69
<i>Erythrophloeum succirubrum</i> Gagnep.	4.83	2.20	1.27	8.30
<i>Microcos tomentosa</i> Sm.	3.86	1.70	0.62	6.19
<i>Suregada multiflora</i> (A.Juss.) Baill.	3.62	1.43	1.03	6.08
<i>Canarium subulatum</i> Guillaumin	2.17	0.81	1.73	4.71
<i>Dipterocarpus intricatus</i> Dyer	2.90	0.67	0.90	4.47
<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre	2.17	0.76	1.34	4.27
<i>Ochna integerrima</i> (Lour.) Merr.	2.42	0.94	0.92	4.27
<i>Morinda coreia</i> Buch.-Ham.	2.66	0.67	0.43	3.76
<i>Ellipanthus tomentosus</i> Kurz	2.42	0.63	0.69	3.73
<i>Shorea obtusa</i> Wall. ex Blume	2.17	0.90	0.63	3.70
<i>Bombax anceps</i> Pierre	1.93	0.36	0.91	3.20
<i>Dalbergia cultrata</i> Graham ex Benth.	0.97	0.72	1.38	3.06
<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	1.93	0.76	0.29	2.98
<i>Shorea siamensis</i> Miq.	0.72	0.81	1.01	2.54
<i>Catunaregam tomentosa</i> (Blume ex DC.) Tirveng.	1.21	0.45	0.76	2.42
<i>Azadirachta indica</i> A. Juss.	1.21	0.31	0.29	1.81
<i>Artocarpus lacucha</i> Roxb. ex Buch.-Ham.	0.72	0.22	0.47	1.42
<i>Buchanania siamensis</i> Miq.	0.72	0.22	0.15	1.10
<i>Chukrasia tabularis</i> A. Juss.	0.48	0.36	0.11	0.95
<i>Polyalthia cerasoides</i> (Roxb.) Benth. ex Bedd.	0.72	0.13	0.06	0.91
<i>Mangifera caloneura</i> Kurz	0.48	0.13	0.20	0.82
<i>Wrightia arborea</i> (Dennst.) Mabb.	0.48	0.13	0.08	0.69
<i>Dalbergia glomeriflora</i> Kurz	0.48	0.13	0.08	0.69
<i>Senna garrettiana</i> (Craib) H. S. Irwin & Barneby	0.48	0.13	0.05	0.67
<i>Aporosa villosa</i> (Wall. Ex Lindl.) Baill.	0.48	0.09	0.02	0.59
<i>Spondias pinnata</i> (L.f.) Kurz	0.24	0.09	0.26	0.59
<i>Casearia grevillifolia</i> Vent.	0.24	0.04	0.24	0.53
<i>Haldina cordifolia</i> (Roxb.) Ridsdale	0.24	0.13	0.12	0.50
<i>Bauhinia racemosa</i> Lam.	0.24	0.04	0.13	0.42
<i>Diospyros montana</i> Roxb.	0.24	0.09	0.07	0.40
<i>Mitragyna rotundifolia</i> (Roxb.) Kuntze	0.24	0.04	0.11	0.39
<i>Phyllanthus emblica</i> L.	0.24	0.09	0.04	0.37
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	0.24	0.04	0.06	0.35

Scientific name	RF	RD	RDo	IVI
<i>Vitex peduncularis</i> Wall. ex Schauer	0.24	0.04	0.06	0.35
<i>Cratoxylum formosum</i> (Jacq.) Benth. & Hook.f. ex Dyer	0.24	0.04	0.05	0.34
<i>Markhamia stipulata</i> (Wall.) Seem.	0.24	0.04	0.04	0.33
Unknown	0.24	0.04	0.03	0.31
<i>Diospyros defectrix</i> H.R.Fletcher	0.24	0.04	0.02	0.31
<i>Irvingia malayana</i> Oliv. ex A.W.Benn.	0.24	0.04	0.01	0.30
<i>Lagerstroemia floribunda</i> Jack	0.24	0.04	0.01	0.29
Total	100.00	100.00	100.00	300.00

Notes: RF = Relative frequency; RD = Relative density; RDo = Relative dominance; IVI = Important value index.

In saplings, *M. scutellatum* exhibited the highest IVI, with a value of 184.12 (61.37%), followed by *X. kerrii*, *S. siamensis*, *Microcos tomentosa*, and *Suregada multiflora* with IVI values of 25.28, 14.10, 13.36, and 10.10, respectively. The remaining species had IVI values between 1 and 8 (Table 3).

Table 3 Relative frequency (RF), Relative density (RD), Relative dominance (RDo) and Importance value index of saplings in Ban Yod Udom Community Forest

Scientific name	RF	RD	RDO	IVI
<i>Memecylon scutellatum</i> (Lour.) Hook & Arn.	38.66	72.35	73.11	184.12
<i>Xylia kerrii</i> Craib & Hutch.	11.76	6.22	7.30	25.28
<i>Sindora siamensis</i> Teijsm. ex Miq.	8.40	2.53	3.16	14.10
<i>Microcos tomentosa</i> Sm.	5.88	3.69	3.79	13.36
<i>Suregada multiflora</i> (A. Juss.) Baill.	5.04	2.53	2.52	10.10
<i>Cratoxylum cochinchinense</i> (Lour.) Blume	4.20	2.07	2.21	8.49
<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	4.20	1.38	0.66	6.24
<i>Melia azedarach</i> L.	2.52	1.38	0.91	4.81
<i>Polyalthia erecta</i> (Pierre) Finet & Gagnep.	1.68	2.53	0.50	4.72
<i>Erythrophloeum succirubrum</i> Gagnep.	1.68	0.69	1.66	4.03
<i>Lannea coromandelica</i> (Houtt.) Merr.	1.68	0.46	0.59	2.73
<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	0.84	0.46	1.25	2.55
<i>Bombax anceps</i> Pierre	1.68	0.46	0.34	2.48
<i>Pterocarpus macrocarpus</i> Kurz	1.68	0.46	0.19	2.33
<i>Ochna integerrima</i> (Lour.) Merr.	1.68	0.46	0.10	2.24
<i>Shorea siamensis</i> Miq.	0.84	0.23	0.45	1.52
<i>Vitex peduncularis</i> Wall. ex Schauer	0.84	0.23	0.27	1.34
<i>Dioecrescis erythrocclada</i> (Kurz) Tirveng.	0.84	0.23	0.20	1.27
<i>Azadirachta indica</i> A.Juss.	0.84	0.23	0.20	1.27
<i>Premna</i> sp.	0.84	0.23	0.14	1.21
<i>Vitex canescens</i> Kurz	0.84	0.23	0.14	1.21
<i>Markhamia stipulata</i> (Wall.) Seem.	0.84	0.23	0.09	1.16
<i>Chukrasia tabularis</i> A.Juss.	0.84	0.23	0.09	1.16
<i>Peltophorum dasyrrhachis</i> (Miq.) Kurz	0.84	0.23	0.09	1.16
<i>Clausena excavata</i> Burm.f.	0.84	0.23	0.05	1.12
Total	100.00	100.00	100.00	300.00

Notes: RF = Relative frequency; RD = Relative density; RDo = Relative dominance; IVI = Important value index.

Table 4 Relative frequency (RF), Relative density (RD) and Importance value index (IVI) of seedlings in Ban Yod Udom Community Forest

Scientific name	RF	RD	IVI
<i>Sindora siamensis</i> Teijsm. ex Miq.	42.62	53.81	96.43
<i>Memecylon scutellatum</i> (Lour.) Hook & Arn.	26.23	23.33	49.56
<i>Suregada multiflora</i> (A.Juss.) Baill.	6.56	10.00	16.56
<i>Polylepis evela</i> (Pierre) Finet & Gagnep.	3.28	5.71	8.99
<i>Ochna integerrima</i> (Lour.) Merr.	4.92	1.43	6.35
<i>Pterocarpus macrocarpus</i> Kurz	4.92	0.48	5.39
<i>Cratogeomys cochinchinense</i> (Lour.) Blume	1.64	2.38	4.02
<i>Xylia kerrii</i> Craib & Hutch.	1.64	0.48	2.12
<i>Strychnos nux-blanda</i> A.W.Hill	1.64	0.48	2.12
<i>Microcos tomentosa</i> Sm.	1.64	0.48	2.12
<i>Ficus hispida</i> L.f.	1.64	0.48	2.12
<i>Dipterocarpus intricatus</i> Dyer	1.64	0.48	2.12
<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	1.64	0.48	2.12
Total	100.00	100.00	200.00

Notes: RF = Relative frequency; RD = Relative density; RDo = Relative dominance; IVI = Important value index.

In seedlings, the most dominant species were *S. siamensis*, followed by *M. scutellatum*, *S. multiflora*, *Polylepis evela*, and *Ochna integerrima*, with IVI values of 96.43, 49.56, 16.56, 8.99, and 6.35, respectively, accounting for 59.30%. In contrast, the remaining species had IVI values between 1 and 5 (Table 4). The elevated IVI of the dominant species is affected by their high relative frequency, density, and dominance. It indicates the ecological importance of those species (indicator species), in the community of Ban Yod Udom forest. Conversely, several species had a much lower IVI than those prominent species, indicating lesser ecological impact or presence in the study area.

Fabaceae species were abundant in Ban Yod Udom Community Forest, with economically significant species like *S. siamensis*, *X. kerrii*, and *P. macrocarpus* also being predominant. These results align with previous research showing Fabaceae dominance in deciduous dipterocarp forests in both Northern (Marod *et al.* 2019) and Northeastern (Plybour *et al.* 2025) Thailand. However, in contrast to previous research, this study found a low abundance of Dipterocarpaceae species, as reflected in IVI values for *Dipterocarpus intricatus*, *Shorea obtusa*, and *S. siamensis*, even though these species are typically found in such forests. The observed decline in dominant and economically important tree species is attributed to anthropogenic disturbances such as illegal logging,

livestock grazing, non-timber forest product (NTFP) collection, and wildfire, all of which have been documented in this community forest. These disturbances have been shown to negatively affect population structure, species diversity, and forest regeneration (Marod *et al.* 2017; Pawar & Mule 2025).

The Shannon–Wiener diversity index (H') varied from 1.31 to 2.16. Trees showed the highest values (2.16) among other growth stages, while saplings were the lowest with the value of 1.31 (Table 5).

Table 5 Diversity indices for woody species in Ban Yod Udom Community Forest

Diversity indices	Trees	Saplings	Seedlings
Shannon- Wiener index	2.16	1.31	1.39
Simpson index	0.80	0.47	0.64
Evenness index	0.56	0.41	0.54

The woody species in Ban Yod Udom Community Forest are classified as low diversity based on the Shannon diversity classification scheme established by Fernando (1998), which defines values of 1 to 2.49 as low, 2.5 to 2.99 as moderate, and 3 or higher as high.

The Simpson index ranged from 0.47 to 0.80. The maximum value was found in trees with the value of 0.80, followed by seedlings and saplings with the values of 0.64 and 0.47, respectively.

The trend of Evenness Index was similar to that of the H' and Simpson indices, with the highest values in trees, followed by seedlings and saplings, with the values of 0.56, 0.54, and 0.41, respectively. Based on the Evenness index values, the forest community was considered as a less even community, meaning only a few species dominate the community according to the following classification (Magurran & McGill 2011): 0 – 0.25 are not even; 0.26 – 0.50 are less even; 0.51 – 0.75 are somewhat even; 0.76 – 0.95 are nearly even; and 0.96 – 1.00 are even.

Compared to other studies in various locations of Thailand's deciduous dipterocarp forests, our findings indicate that the species diversity in this community forest is lower. Nevertheless, the species richness and density surpass those reported by Thammanu *et al.* (2021), who documented a species composition of 22 species, H' of 2.44 at Ban Mae Chiang Rai Lum Community Forest, Lampang Province. Srikanha & Gajasen (2000) reported species richness of 14 species, tree density of 720 stems/ha, and H' of 2.89 at Huai Kha Khaeng Wildlife Sanctuary, Uthaitani Province. Furthermore, Sahunalu (2009) reported a tree density of 687 stems/ha and H' of 2.34 at Sakaerat deciduous dipterocarp forest, Nakhon Ratchasima Province.

Our study observed higher diversity indices at the tree stage than at the seedling and sapling stages. This finding is significant because it contrasts with previous research, which generally indicates that seedling and sapling stages exhibit higher diversity than the tree stage due to successional processes, as not all seedlings or saplings reach maturity (Dalmaso *et al.* 2020; Aminatun *et al.* 2021). In this context, the observed pattern may be attributed to conservation and management practices implemented by the Ban Yod Udom community. Specifically, protective measures such as patrols to prevent illegal logging and wildfire control are likely to contribute to tree preservation, whereas activities such as livestock grazing and the overexploitation of NTFPs may inhibit the growth of saplings and seedlings.

An estimation of biomass, carbon stock, and carbon absorption of woody species at Ban Yod Udom Community Forest is listed in Table 6. The total biomass of trees was 52.26 tonnes/ha, distributed among AGB at 44.97 tonnes/ha and BGB at 7.29 tonnes/ha. The total carbon stock of trees was 24.56 tonnes C/ha, with the total carbon absorption at 90.06 tonnes CO₂/ha.

The first five species of trees with the highest total biomass accumulation were *S. siamensis* (27.67 tonnes/ha), *P. macrocarpus* (5.28 tonnes/ha), *X. kerrii* (4.90 tonnes/ha), *M. scutellatum* (3.58 tonnes/ha), and *L. coromandelica* (1.97 tonnes/ha). These species contributed the carbon stock at 13.01, 2.48, 2.30, 1.68, and 0.92 tonnes C/ha, respectively, with the carbon absorption at 47.69, 9.10, 8.44, 6.18, and 3.39 tonnes CO₂/ha, respectively. The proportions of biomass, carbon stock, and carbon absorption of those tree species were 52.95%, 10.10%, 9.37%, 6.85%, and 3.76%, respectively, and the rest of 41 species accounted for 16.97%.

In saplings, the total biomass was 2.98 tonnes/ha, distributed among AGB at 2.33 tonnes/ha and BGB at 0.65 tonnes/ha. Furthermore, the total carbon stock was 1.40 tonnes C/ha with the total carbon absorption at 5.13 tonnes CO₂/ha. The first five species of saplings with the highest total biomass accumulation were *M. scutellatum* (2.14 tonnes/ha), *X. kerrii* (0.23 tonnes/ha), *M. tomentosa* (0.12 tonnes/ha), *S. siamensis* (0.11 tonnes/ha), and *S. multiflora* (0.08 tonnes/ha). These prominent sapling species contributed carbon stocks of 1.00, 0.11, 0.06, 0.05, and 0.04 tonnes C/ha, with the carbon absorption rates at 3.68, 0.40, 0.20, 0.18, and 0.14 tonnes CO₂/ha, respectively. The proportions of biomass, carbon stock, and carbon absorption of those tree species were 71.81%, 7.72%, 4.02%, 3.69%, and 2.68%, respectively, and the rest of 20 species accounted for 10.08%.

In Thailand, deciduous dipterocarp forests usually demonstrate the biomass ranging between 67 and 158 tonnes/ha and carbon stock between 34 and 80 tonnes C/ha (Wattayakorn & Diloksumpun 2011). Moreover, Kanhom *et al.* (2019) reported 54.55 tonnes/ha of biomass and 25.64 tonnes C/ha of carbon stock found in Ban Nong Mek Community Forest, Sa Kaeo, and Thammanu *et al.* (2021) demonstrated a total of 63.60 tonnes/ha with carbon stock of 29.89 tonnes C/ha at Ban Mae Chiang Rai Lum Community Forest, Lampang. Further, Plybour *et al.* (2025) reported 144.51 tonnes/ha of biomass and 67.92 tonnes C/ha at the forest of Nature Study Center, Maha Sarakham.

Table 6 Aboveground and belowground biomass, carbon stock, and carbon absorption of trees and saplings in Ban Yod Udom Community Forest

Stage	Ranking No.	Scientific name	Biomass (tonnes/ha)			Carbon stock (tonnes C/ha)			Carbon absorption (tonnes CO ₂ /ha)		
			Above	Below	Total	Above	Below	Total	Above	Below	Total
Trees	1	<i>Sindora siamensis</i> Teijsm. ex Miq.	23.97	3.71	27.67	11.26	1.74	13.01	41.30	6.39	47.69
	2	<i>Pterocarpus macrocarpus</i> Kurz	4.60	0.68	5.28	2.16	0.32	2.48	7.93	1.17	9.10
	3	<i>Xylia kerrii</i> Craib & Hutch.	4.14	0.76	4.90	1.94	0.36	2.30	7.13	1.31	8.44
	4	<i>Memecylon scutellatum</i> (Lour.) Hook & Arn.	2.96	0.63	3.58	1.39	0.30	1.68	5.09	1.08	6.18
	5	<i>Lannea coromandelica</i> (Houtt.) Merr.	1.70	0.26	1.97	0.80	0.12	0.92	2.94	0.45	3.39
	6	<i>Canarium subulatum</i> Guillaumin	0.82	0.12	0.94	0.38	0.06	0.44	1.41	0.21	1.62
	7	<i>Dalbergia cultrata</i> Graham ex Benth.	0.62	0.09	0.70	0.29	0.04	0.33	1.07	0.15	1.21
	8	<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre	0.59	0.09	0.68	0.28	0.04	0.32	1.01	0.16	1.17
	9	<i>Erythrophleum succirubrum</i> Gagnep.	0.56	0.10	0.66	0.26	0.05	0.31	0.96	0.18	1.14
	10	<i>Suregada multiflora</i> (A.Juss.) Baill.	0.47	0.08	0.55	0.22	0.04	0.26	0.80	0.14	0.95
	11-46	Others	4.54	0.77	5.33	2.15	0.36	2.51	7.85	1.32	9.17
Total			44.97	7.29	52.26	21.13	3.43	24.56	77.49	12.56	90.06
Saplings	1	<i>Memecylon scutellatum</i> (Lour.) Hook & Arn.	1.67	0.47	2.14	0.78	0.22	1.00	2.87	0.80	3.68
	2	<i>Xylia kerrii</i> Craib & Hutch.	0.18	0.05	0.23	0.08	0.02	0.11	0.31	0.09	0.40
	3	<i>Microcos tomentosa</i> Sm.	0.09	0.03	0.12	0.04	0.01	0.06	0.16	0.04	0.20
	4	<i>Sindora siamensis</i> Teijsm. ex Miq.	0.08	0.02	0.11	0.04	0.01	0.05	0.14	0.04	0.18
	5	<i>Suregada multiflora</i> (A.Juss.) Baill.	0.06	0.02	0.08	0.03	0.01	0.04	0.11	0.03	0.14
	6	<i>Cratoxylum cochinchinense</i> (Lour.) Blume	0.05	0.02	0.07	0.03	0.01	0.03	0.09	0.03	0.12
	7	<i>Erythrophleum succirubrum</i> Gagnep.	0.04	0.01	0.05	0.02	0.00	0.02	0.06	0.02	0.08
	8	<i>Hymenodictyon orixense</i> (Roxb.) Mabb.	0.02	0.01	0.03	0.01	0.00	0.01	0.04	0.01	0.05
	9	<i>Melia azedarach</i> L.	0.02	0.01	0.03	0.01	0.00	0.01	0.04	0.01	0.05
	10	<i>Litsea glutinosa</i> (Lour.) C.B.Rob.	0.02	0.00	0.02	0.01	0.00	0.01	0.03	0.01	0.04
	11-25	Others	0.10	0.01	0.10	0.04	0.03	0.06	0.16	0.04	0.19
Total			2.33	0.65	2.98	1.09	0.31	1.40	4.01	1.12	5.13

Notes: Each 'Total' is the sum of above- and below-ground values for biomass, carbon stock, or carbon absorption. 'Others' includes all unlisted species. See Supplementary Table 1 for details.

Our findings revealed that biomass and carbon stock at Ban Yod Udom Community Forest were lower than those of dipterocarp forests. Biomass and carbon storage within forest ecosystems are influenced by multiple factors (Rajput *et al.* 2017). Deciduous tree species exhibit resilience to extreme conditions, including drought, soil nutrient deficiencies, and fire disturbance (Rundel *et al.* 2017). These stressors negatively affect regeneration and productivity. Furthermore, the extraction of forest resources reduces species diversity and alters population dynamics (Thapa & Chapman 2010). Increasing diversity and carbon storage through enrichment planting, strict regulation of NTFP utilization, and effective fire control could enhance both biodiversity and carbon stocks in Ban Yod Udom Community Forest.

CONCLUSION

Ban Yod Udom Community Forest exhibits a diverse woody species composition, despite being classified as a secondary dipterocarp forest. Species richness was notable, with 55 species representing 26 families. The woody population demonstrated a normal structure and high regeneration status, as evidenced by the abundance of seedlings exceeding that of saplings and mature trees. *S. siamensis*, *M. scutellatum*, and *X. kerrii* were identified as the most significant species based on their highest IVI scores. These species serve as indicator species and play a critical role in the community forest ecosystem. However, both species diversity and population density were relatively low, resulting in reduced biomass storage within Ban Yod Udom Community Forest. Consequently, carbon stock and carbon sequestration capacity were also limited. Furthermore, the observed carbon storage was lower than the average carbon accumulation reported for typical dry dipterocarp forests in Thailand. Therefore, it is recommended to implement specific conservation measures, such as enriching planting with key species, promoting natural regeneration, and controlling disturbances, to enhance forest diversity and carbon stocks in this community forest.

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