



Carbon Sequestration Potential of Tree Species in Valaya Alongkorn Rajabhat University Under the Royal Patronage, Pathum Thani Province, Thailand

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ABSTRACT

Plantations in urban areas including universities have been recognized as an essential tool for mitigating global climate change. The purpose of this study was to examine the amount of carbon stored and sequestered by trees located within Valaya Alongkorn Rajabhat University. All trees were counted (100% sampling site), involving species identification and measurement of both diameter at breast height (DBH) and total tree height. Subsequently, estimations of above- and below-ground biomass, total biomass, and carbon sequestration values per tree were derived using allometric equations. The findings indicated that the university campus contained a total of 2,823 trees, of which 88.36% were perennial species and 11.64% were palm varieties. The common species was *Cassia fistula* followed by *Largestroemia speciosa*, and *Ptychosperma macarthurii*, respectively. Most trees in the study area were young perennial plants with 10-30 cm in DBH. The carbon storage and sequestration were 4.10 and 15.02 tonne/ha, respectively. The highest carbon sequestration belonged to *Peltophorum pterocarpum* (3.15 tonne/tree) due to its larger trunk, higher crown cover, complex roots, compared with other species. Our results indicated that the tree group can perform higher carbon sequestration potential than palm species. The large tree with wide DBH and high crown cover performed great carbon storage and capture due to more plant tissue for photosynthesis. Finally, our result suggested that the plantation in the university for carbon mitigation should select perennial plants with fast-growing and large sizes.

1. INTRODUCTION

Urban regions are defined in terms of dominant land associated with economic development and contributes to enhanced living conditions and societal welfare [1]. Currently, over 50% of the global population resides in city areas. Additionally, the expansion of developed urban land is accelerating worldwide at an estimated annual growth of 4% [2]. The importance of urban zones play a significant role in driving global greenhouse gas (GHG) emissions which causes global warming, life loss, disappearance of biodiversity, and climate change [3, 4]. Seto *et al.* [5] reported that urban regions are recognized as major contributors to global carbon emissions. They are responsible for approximately 71–75% of total emissions and consume about 67–76% of global primary energy resources. Urban trees can reduce the level of carbon dioxide in the atmosphere via the photosynthesis process [6, 7].

The urban trees include trees along the streets, urban parks, community gardens, private yards, and universities increase the green area in urban [8]–[10]. Furthermore, they

provide an important role in multiple ecosystem services such as reducing air pollution, air temperature reduction, absorption of ultraviolet radiation, increasing biodiversity, reducing building energy use, soil erosion, watershed runoff, aerial particulate matter, improving water quality, reducing noise, improve our health, increased property value etc. [11]–[13]. Numerous research efforts have demonstrated that trees in urban landscapes can reduce urban's carbon footprint. This contributes to alleviating the adverse consequences brought on by global climate shifts [14]. The cumulative carbon stored and the net annual carbon captured by individual urban trees can reach as much as 18 kilograms of CO₂ per tree each year [15]. Moreover, urban vegetation along with their surrounding soils also aid in sequestering carbon to support tree growth and absorb atmospheric carbon dioxide for the carbon balance in photosynthesis process [10, 16, 17]. Therefore, urban trees have many functions that serve as a key component in addressing climate change by capturing CO₂ via natural carbon sequestration mechanisms [18,19].

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In land-based ecosystems, carbon is typically stored in components such as live vegetation above ground which are trees, shrubs, forbs, grasses, and sedges, and underground biomass which are decaying wood, organic debris, and forest litter [20]. In this study, the total mass of above- and below-ground biomass per tree was calculated using the allometric equations from previous research which was a similar type of forest and climatic condition [34, 35]. All biomass production depends on the photosynthesis process which converts CO₂ into a tree's biomass. Hence, trees assist in lowering atmospheric CO₂ levels by accumulating carbon within their above- and below-ground biomass [20]. Different tree species can alter carbon storage and sequestration [12, 28, 44]. This is because there are specific shapes and sizes of trunk, crown, branches, leaves, bark, and root in each tree species. The species which has more leaves and complex branches can perform more photosynthesis and; subsequently, higher carbon dioxide absorption from the atmosphere. Large trunks and complex root systems can provide more space to store carbon in tree tissue [21]-[24]. In addition, a higher potential for carbon storage and sequestration can be found in elder trees [45]. This is because expanding crowns, leaves, branches, and trunks during the growing period provide a higher photosynthesis rate and more tissues for carbon storage. Hence, the carbon sequestration potential of each tree species require deeper investigation. This data is important for effective management of vegetated spaces in cities, such as parks or campuses, which is not only benefit in climate change mitigation, but also prevention of natural disaster, fires, insect outbreaks, disease epidemics [25]-[27].

Due to the importance of tree plantations for addressing global warming, numerous international studies on carbon sequestration potential in urban regions has been studied extensively worldwide. However, in Thailand, research specifically focusing on how urban trees grow and develop remains limited. The information on the carbon sequestration potential of university-based urban trees is scanty. Several studies in Asia and Indian universities showed that urban trees had more carbon sequestration potential than nonurban trees [28]. The urban trees are the selected perennial plant species that can grow quickly so they can provide shading and recordation area for people as soon as possible. Meanwhile, nonurban trees are trees that randomly grow in forests. Trees in urban areas including the university have faster growth rates because they receive more maintenance processes such as watering, fertilizing, and canopy trimming. These processes are essential and lead to optimal growth of the tree. According to Ritchie [29, 30], universities, as part of the higher education sector, are expected to take accountability in both managing and minimizing the carbon emissions they generate. Universities may be subject to increased scrutiny on process management approaches in reducing carbon emissions because the university is publicly funded. In addition, students,

university staff and government officials are well informed of sustainability issues as reducing carbon emissions approach. Nowadays, Thai government agencies are also requiring a process of carbon management approach from universities. Thus, there may be a good way for universities to investigate how much carbon urban tree species can capture, in order to evaluate the sequestration capabilities across different planted species. However, the carbon sequestration potential of tree species in Valaya Alongkorn Rajabhat University has not been studied. Therefore, the purpose of this research is to quantify how much carbon is retained in the above-ground portions of selected species planted at the university campus in Phatum Thani and calculate their total carbon sequestration potential. Results can effectively support policies on green university with the sustainable development goals (SDGs), and positioning it as a model institution in carbon sequestration practices.

2. MATERIALS AND METHODS

2.1 The study area

This research was carried out at Valaya Alongkorn Rajabhat University Under the Royal Patronage, located in Phatum Thani Province (14° 8' 0"North 100° 36' 41"East) (Figure 1). The campus was established in 1972 and covers over 61 hectares with plenty of green spaces around it [31]. The area around campus has urban sprawl leading to higher throughout the years, including many industrial buildings. Based on climatological records collected over a 30-year period (1991–2020) indicates that the average yearly temperature in this region ranges from 27-30 °C, with annual precipitation levels between 1,200-1,400 mm [32]. The monthly minimum and maximum temperatures vary between 22 – 26 °C and 33 – 36 °C. The study area experiences three distinct climatic periods: winter (October to February), summer (April to May), and the rainy or monsoon period (June to September) [32].

2.2 Data collections

Sampling was conducted from June 2021 to June 2022. All trees at study area are shed leaves. The total number of trees were done manually, and a complete enumeration of the 2,823 trees (100% sampling site) on the Phatum Thani campus (Figure 1). In order to evaluate the biomass of various tree species, a non-invasive approach was applied by measuring tree height and diameter at breast height (DBH). DBH of individual trees of the campus typically measured at approximately 1.3 meters from the base level [33]. The height and width of each tree were measured using a clinometer and measuring tape with field measurements conducted between 8:00 a.m. and 2:00 p.m. throughout the sampling campaign. For every tree, data such as species, height, and DBH were recorded in spreadsheets, except shrubs and herbs were not recorded.



Fig. 1. The study area at Valaya Alongkorn Rajabhat University Under the Royal Patronage, located in Phathum Thani Province.

2.3 Total biomass estimation

The total biomass for each tree (TB) was calculated by summation from both AGB (above-ground biomass) and BGB (below-ground biomass) using the specified formula:

$$TB \text{ (kg/tree)} = AGB + BGB \quad (1)$$

Above-ground biomass

Estimation of above-ground biomass (AGB) for trees within the Phathum Thani campus was conducted on field measurements of the tree's diameter at breast height (DBH), biomass was calculated through established allometric formulas [34]. Then, AGB data were obtained from the allometric formulas for the general tree group (2) which is a perennial plant, and palm group biomass (3) which is a smooth and slender trunk with evergreen leaves arranged at the top of an unbranched stem [35].

$$W_S = 0.0396 (D^2 H)^{0.933} \quad (2)$$

$$W_B = 0.00349 (D^2 H)^{1.030}$$

$$W_L = (28 / (W_S + W_B + 0.025))^{-1}$$

$$W_T = W_S + W_B + W_L$$

$$W_T = 6.666 + 12.826 (H)^{0.5} (\ln H) \quad (3)$$

where:

W_S = the above-ground biomass of the stem section [kg]

W_B = the above-ground biomass of branch [kg]

W_L = the above-ground biomass of leaf [kg]

W_T = combined above-ground biomass [kg]

D = tree diameter at 1.3 m above ground level [cm]

H = vertical height of tree individual [m]

Below-ground biomass

Below-ground biomass (BGB) refers to the total mass of living root structures, excluding fine roots with diameters smaller than 2 mm [36]. Its value was derived by applying multiplication factors to the ratio between the BGB and

AGB by 0.27 factors for general tree group (4) and 0.41 factors for palm group as the root: shoot ratio (5) [37]. This is because there are different proportions between AGB (trunk and leaf biomass) and BGB (root and litter) of these plant species. Based on the report from the Thailand Greenhouse Gas Management Organization [37], the proportion of below-ground biomass such as root system, litter, and dead wood of general tree species was less than palm species. This is because palms have less trunk and leaf biomass than the general tree; meanwhile, roots and litter are similar.

$$BGB \text{ (kg/tree)} = (AGB) \times 0.27 \text{ (kg/tree)} \quad (4)$$

$$BGB \text{ (kg/tree)} = (AGB) \times 0.41 \text{ (kg/tree)} \quad (5)$$

2.4 Carbon storage and carbon sequestration

In this research, carbon storage was determined by applying the average carbon fraction (47% of dry mass) to the total biomass per tree [38].

$$\text{Carbon storage (kg/tree)} = 0.47 \times \text{Total Biomass} \quad (6)$$

Carbon sequestration describes the quantity of atmospheric CO_2 that is absorbed and retained within ecosystems. In the case of trees, the carbon content in plant tissue comes from the capture by drawing carbon dioxide from the air during photosynthesis. Therefore, this study converted carbon sequestration from carbon storage using the equation below [39].

$$\text{Carbon sequestration (kg/tree)} = (\text{Carbon storage} \times 44) / 12 \quad (7)$$

3. RESULTS AND DISCUSSION

3.1 Tree abundance in Valaya Alongkorn Rajabhat University

A total of 2,823 trees were recorded across the designated survey area, belonging to 56 different tree species (Table 1). The most abundant species recorded on campus was *Cassia fistula*, comprising 530 individuals, followed by

Largestroemia speciosa and *Ptychosperma macarthurii*, with respective counts of 274 and 233 trees. The species *Cassia fistula* is frequently cultivated in city landscaping projects and offers canopy cover, making it an ideal choice for trees along the streets. It was found to be planted in some universities in tropical zones [28, 40] because it grows well in the open area. It can be planted in both loamy soil sandy loam clay soil or can adapt well to various soil conditions that have good tolerance to drought and saline soils. One of the disadvantages of this is the method of planting is to use the seed method, which may take time to grow slowly, but if successful, it will grow quickly. Hence, many people prefer to use the method of grafting the top instead, but there is a risk that the *Cassia fistula* is easier to die. The second most common tree in the study area is *Largestroemia speciosa*, also known as the Pride of India tree. It commonly spreads in Southeast Asia, India, including Thailand. It is widely preferred for urban environments due to its drought resistance, durability, and resilience to polluted air and it is a plant that grows quite fast and likes strong sunlight. Moreover, it is easy to propagate and visually striking,

producing vibrant flower clusters throughout the year. *Ptychosperma macarthurii* was found to be the third most common species because it was planted for decorating the road around the university. It belongs to the palm family with good resistance to diseases and insects.

A total of 2,823 individual trees were recorded throughout the surveyed area. It can be accounted as 46.28 trees/ha for tree density which consists of 88.36% for perennial plants and 11.64% for palm. Most of the trees are not large in DHB commonly found only 20-30 cm (Figure 2). The tree species *Peltophorum pterocarpum* exhibited the highest diameter at breast height (DBH), reaching 67.78 cm. This was followed by *Ficus benjamina* and *Ficus religiosa*, with DBH measurements of 60.31 cm and 60.28 cm, respectively. However, these species accounted for only 4.53% of all trees. These results demonstrate that most trees within the study site were still in early growth stages, yet they show promising capacity for long-term carbon storage and sequestration.

Table 1. Carbon storage and carbon sequestration of tree species in Valaya Alongkorn Rajabhat University Under the Royal Patronage

No.	Species Name Scientific Name	Common Name	Total No. of Trees	DBH (cm)	Height (m)	Above- Ground Biomass (kg)	Below- Ground Biomass (kg)	Total Biomass (kg)	Carbon storage (kg)	Carbon sequestration (kg)	Carbon sequestration (tonne/tree)
1	<i>Cassia fistula</i>	Golden Shower	530	19.91	5.67	29,930.60	8,081.26	38,011.86	17,865.57	65,507.11	0.124
2	<i>Pterocarpus indicus</i>	Burmese Rosewood	124	32.67	7.29	31,701.52	8,559.41	40,260.94	18,922.64	69,383.02	0.560
3	<i>Polyalthia longifolia</i>	Indian Mast Tree	207	16.27	6.28	10,874.64	2,936.15	13,810.79	6,491.07	23,800.59	0.115
4	<i>Delonix regia</i>	Flame Tree	153	22.74	5.85	20,307.33	5,482.98	25,790.32	12,121.46	44,445.32	0.290
5	<i>Largestroemia speciosa</i>	Pride of India	274	15.06	4.42	9,665.57	2,609.70	12,275.27	5,769.38	21,154.38	0.077
6	<i>Ficus benjamina</i>	Weeping Fig	32	60.31	7.09	26,530.27	7,163.18	33,693.46	15,835.93	58,065.05	1.814
7	<i>Millettia brandisiana</i>	Thit Pagan	70	14.28	5.21	2,958.71	798.85	3,757.56	1,766.05	6,475.53	0.092
8	<i>Mangifera indica</i>	Mango	157	17.32	5.45	9,557.64	2,580.56	12,138.21	5,704.96	20,919.17	0.133
9	<i>Peltophorum pterocarpum</i>	Copper Pod	70	67.78	10.89	100,835.92	27,225.70	128,061.61	60,188.96	220,692.85	3.153
10	<i>Dalbergia cochinchinensis</i>	Siamese Rosewood	9	15.07	4.91	313.99	84.78	398.76	187.42	687.20	0.076
11	<i>Tamarindus indica</i>	Tamarind	40	25.65	6.74	7,199.42	1,943.84	9,143.26	4,297.33	15,756.88	0.394
12	<i>Terminalia ivorensis</i>	Black Afara	102	21.63	5.63	8,551.30	2,308.85	10,860.15	5,104.27	18,715.66	0.183
13	<i>Leucaena leucocephala</i>	Horse Tamarind	7	28.73	7.14	193.04	52.12	245.16	115.23	422.50	0.060
14	<i>Pithecellobium dulce</i>	Manila Tamarind	16	29.82	6.83	3,065.74	827.75	3,893.49	1,829.94	6,709.78	0.419
15	<i>Terminalia catappa</i>	Indian Almond	19	30.96	7.36	5,493.73	1,483.31	6,977.03	3,279.20	12,023.75	0.633
16	<i>Phyllanthus acidus</i>	Otaheite Gooseberry	55	8.27	4.43	545.68	147.33	693.01	325.72	1,194.29	0.022
17	<i>Morinda citrifolia</i>	Indian Mulberry	11	8.11	4.11	102.82	27.76	130.58	61.37	225.04	0.020
18	<i>Senna siamea</i>	Siamese Senna	32	14.93	5.43	1,441.91	389.32	1,831.23	860.68	3,155.82	0.098
19	<i>Mimusops elengi</i>	Spanish Cherry	46	20.57	5.18	3,446.91	930.67	4,377.57	2,057.46	7,544.02	0.164
20	<i>Ficus religiosa</i>	Sacred Fig	26	60.28	7.90	26,305.01	7,102.35	33,407.36	15,701.46	57,572.02	2.214
21	<i>Dolichandrone serrulata</i>	Mangrove Trumpet	67	20.25	5.99	8,874.81	2,396.20	11,271.00	5,297.37	19,423.69	0.290
22	<i>Shorea roxburghii</i>	Temak	6	8.49	3.70	54.02	14.59	68.61	32.25	118.23	0.020
23	<i>Syzygium cumini</i>	Java Plum	15	23.57	5.83	1,596.94	431.17	2,028.11	953.21	3,495.11	0.233
24	<i>Acacia mangium</i>	Hickory Wattle	53	28.73	7.14	9,790.30	2,643.38	12,433.67	5,843.83	21,427.37	0.404
25	<i>Albizia saman</i>	Rain Tree	42	58.55	7.55	44,105.67	11,908.53	56,014.21	26,326.67	96,531.14	2.298
26	<i>Azadirachta indica</i>	Neem Tree	33	19.28	6.23	2,666.93	720.07	3,387.00	1,591.89	5,836.93	0.177
27	<i>Alstonia scholaris</i>	Scholar Tree	59	33.78	7.52	18,797.46	5,075.31	23,872.77	11,256.29	41,140.74	0.697
28	<i>Artocarpus heterophyllus</i>	Jackfruit	13	17.10	4.68	559.33	151.02	710.35	333.86	1,224.17	0.094
29	<i>Bauhinia purpurea</i>	Orchid Tree	30	12.56	4.64	778.50	210.20	988.70	464.69	1,703.85	0.057
30	<i>Moringa oleifera</i>	Drumstick Tree	16	13.04	5.25	601.95	162.53	764.48	359.30	1,317.45	0.083
31	<i>Elaeocarpus hygrophilus</i>	-	35	19.28	6.23	3,764.64	1,016.45	4,781.09	2,247.11	8,239.41	0.235

Table 1. Carbon storage and carbon sequestration of tree species in Valaya Alongkorn Rajabhat University Under the Royal Patronage (cont'd)

No.	Species Name Scientific Name	Common Name	Total No. of Trees	DBH (cm)	Height (m)	Above- Ground Biomass (kg)	Below- Ground Biomass (kg)	Total Biomass (kg)	Carbon storage (kg)	Carbon sequestration (kg)	Carbon sequestration (tonne/tree)
32	<i>Streblus asper</i>	Toothbrush Tree	40	4.90	2.89	102.96	27.80	130.76	61.46	225.34	0.006
33	<i>Citrus maxima</i>	Pummelo	5	6.31	4.34	28.84	7.79	36.62	17.21	63.11	0.012
34	<i>Spondias mombin</i>	Hog Plum	1	29.94	10.89	262.78	70.95	333.73	156.85	575.12	0.570
35	<i>Barringtonia racemosa</i>	Powder Puff Tree	1	13.38	4.17	22.93	6.19	29.13	13.69	50.19	0.050
36	<i>Syzygium malaccense</i>	Malay Apple	1	21.66	4.95	67.24	18.15	85.39	40.13	147.16	0.150
37	<i>Careya arborea</i>	Wild guava	1	28.34	5.13	115.90	31.29	147.19	69.18	253.66	0.250
38	<i>Calophyllum inophyllum</i>	Alexandrian Laurel	1	16.88	5.25	44.32	11.97	56.29	26.46	97.01	0.090
39	<i>Syzygium</i>	Rose Apple	3	17.52	5.55	131.56	35.52	167.08	78.53	287.94	0.097
40	<i>Tectona grandis</i>	Teak	2	18.47	6.27	129.32	34.92	164.23	77.19	283.02	0.140
41	<i>Lagerstroemia Loudonii</i>	Thai Bungor	1	9.87	4.17	12.91	3.48	16.39	7.70	28.25	0.020
42	<i>Carissa carandas</i>	Karandang	4	8.28	5.39	50.21	13.56	63.77	29.97	109.89	0.025
43	<i>Limonia acidissima</i>	Wood Apple	1	46.50	7.23	411.17	111.01	522.18	245.42	899.89	0.900
44	<i>Casuarina junghuhniana</i>	Mountain Ru	5	49.49	8.96	3,907.44	1,055.01	4,962.44	2,332.35	8,551.95	1.710
45	<i>Couropita guianensis</i>	Cannonball Tree	7	40.67	9.33	3,146.29	849.50	3,995.79	1,878.02	6,886.09	0.983
46	<i>Erythrina variegata</i>	Tiger's Claw	1	9.55	5.37	15.41	4.16	19.57	9.20	33.73	0.030
47	<i>Psidium guajava</i>	Guava	6	14.33	5.13	72.05	19.45	91.50	43.00	157.68	0.027
48	<i>Prunus subg</i>	Cherry	3	11.89	4.93	72.70	19.63	92.33	43.40	159.12	0.053
49	<i>Annona squamosa</i>	Sugar Apple	11	8.69	4.46	125.77	33.96	159.73	75.07	275.27	0.025
50	<i>Flacourtia rukam</i>	Rukam	24	15.54	5.10	1,048.81	283.18	1,331.99	626.04	2,295.46	0.095
51	<i>Sesbania grandiflora</i>	Agathi	25	14.83	5.43	1,216.32	328.41	1,544.73	726.02	2,662.08	0.106
52	<i>Citrus hystrix</i>	Kaffir Lime	3	8.81	4.07	31.27	8.44	39.72	18.67	68.45	0.020
53	<i>Sandoricum koetjape</i>	Santol	2	7.64	4.59	17.44	4.71	22.15	10.41	38.18	0.015
54	<i>Ptychosperma macarthurii</i>	Macarthur Palm	233	13.30	4.94	12,056.85	4,943.31	17,000.16	7,021.06	25,743.91	0.110
55	<i>Roystonea regia</i>	Cuban royal palm	74	15.08	5.50	4,242.73	1,739.52	5,982.25	2,470.67	9,059.11	0.122
56	<i>Cocos nucifera</i>	Coconut	19	28.51	5.91	1,175.77	482.06	1,657.83	684.68	2,510.51	0.132
Total			2,823			419,121.29	115,609.29	534,730.56	249,954.95	916,370.19	

Table 2. Comparison of carbon storage and carbon sequestration across other areas

Area	Tree Density (trees/ha)	Carbon Storage (tonne/ha)	Carbon Sequestration (tonne/ha)	Reference
Valaya Alongkorn Rajabhat University Under the Royal Patronage (Thailand)	46.28	4.10	15.02	This study
University of Western Australia (Australia)	31.25	20.21	74.10	[41]
KIWI University (New Zealand)	63.65	24.38	89.41	[30]
Shivaji University (India)	0.11	0.45	1.64	[40]
B.A.M. University (India)	1.36	0.29	1.06	[18]
Urban Forest (Sheuyan, China)	596.00	33.22	121.81	[42]
Mixed deciduous forest (Ratchaburi, Thailand)	450.00	36.44	133.61	[43]

3.2 Carbon storage and carbon sequestration of tree species

Results from the observation and calculation show that the estimated above- and below-ground biomass values totaled 419,121.27 kg and 115,609.29 kg, respectively, as shown in Table 1. The total biomass (TB) accumulated reached 534,730.56 kg, while carbon retained in the university's tree population amounted to 249,954.95 kg or 4.10 tonne/ha. The entire tree population contributed to approximately 916.20 tonnes of sequestered carbon. Compared with other research, carbon sequestration in this study was found to be lowered due to low tree density (Table 2). Carbon storage

and carbon sequestration in the study area were much lower than KIWI University, urban forest, and mixed deciduous forest. This result corresponded to less abundant tree density. In contrast, our results demonstrate that the study area has higher carbon sequestration potential than Shivaji University and B.A.M. University although there is a similar climate condition. This is also due to more tree density in the study areas. Therefore, it can be referred from our results that the area with more trees has a higher capacity of carbon accumulation derived from both subterranean and aerial biomass components; subsequently, the greater carbon sequestration.

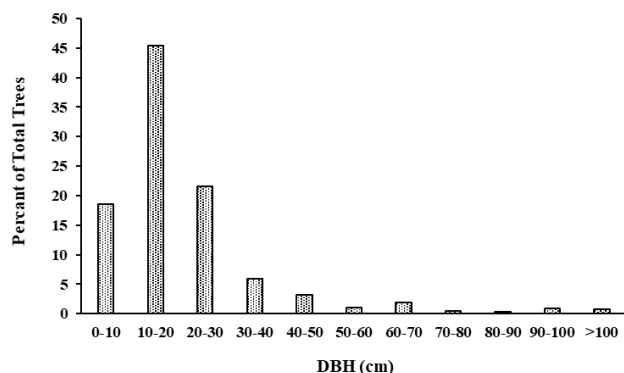


Fig. 2. Percent of trees based on DBH at the field site.

Each tree species can perform altered carbon storage and sequestration due to differences in size and growth patterns (Table 1). Trees with large DBH and height can store more carbon in their tissue and sequester more carbon dioxide through photosynthesis activity. As shown in Figure 3, even though *Cassia fistula* was identified as the dominant species present across the surveyed site, the highest carbon sequestration belonged to *Peltophorum pterocarpum*. This is because *Peltophorum pterocarpum* was a larger trunk and higher than *Cassia fistula*. In this study, the DBH of *Peltophorum pterocarpum* and *Cassia fistula* were 67.78 ± 23.68 and 19.91 ± 5.90 cm, respectively. The height of *Peltophorum pterocarpum* and *Cassia fistula* were found to be 10.89 ± 2.98 and 5.67 ± 1.26 m, respectively. Concordance with other research [21]–[24], tree species with larger trunk, higher crown cover, more branches and leaves can perform higher carbon sequestration due to more tissue for carbon storage and photosynthesis abilities. As shown in Table 1, each tree species has individual carbon sequestration. This is because there are differences in size and pattern of trunk, crown, branches, leave, and root system. The highest sequester was 3.153 tonne/tree which belonged to *Peltophorum pterocarpum* followed by 2.298 and 2.214 tonne/tree which belonged to *Ficus religiosa* and *Albizia saman*, respectively. These tree species are perennial plants with large DBH (>50 cm). In contrast, the lowest sequester was 0.006 tonne/tree which is *Streblus asper* (Toothbrush Tree). This species is a medium-sized tree with DBH in the range of 3.18–7.00 cm. These results show that the larger tree species have more carbon sequestration potential than those that are smaller. Our results also found that the tree group can perform higher carbon sequestration potential than palm species. This is because there are more branches, larger trunks, and a complex root system. However, palm trees with elder age can have higher carbon storage and sequestration than young perennial trees due to larger DBH. Expanding trunks, branches, roots, and crown cover through the growing period can result in more plant tissue for carbon storage and sequestration. Therefore, the larger tree provides a greater area for carbon storage; subsequently, increasing carbon capture from the atmosphere.

Compared with previous research, the carbon sequestration of individual trees found in this study was much lower than other research in Solapur University [28] and SHUATS (Sam Higginbottom University of Agriculture, Technology and Sciences). [44]. This is because most of trees in Valaya Alongkorn Rajabhat University (the study area) were smaller. The DBH was only 10–30 cm (Figure 2) which referred to the young age of perennial plants. The smaller size of trunk can perform lower carbon sequestration potential due to less plant tissue for photosynthesis [21]–[24]. Moreover, the younger age of perennial plants can absorb less atmospheric CO₂ than the older plant. This can be attributed to the younger trees are less expanding leave, branches, and crown cover. Carbon sequestration increases with the tree age [45]. The plantation period can significantly influence carbon sequestration potential. Hence, the area with more elderly trees can have more carbon sequestration, and the plantation period of the study area may be started after other research.

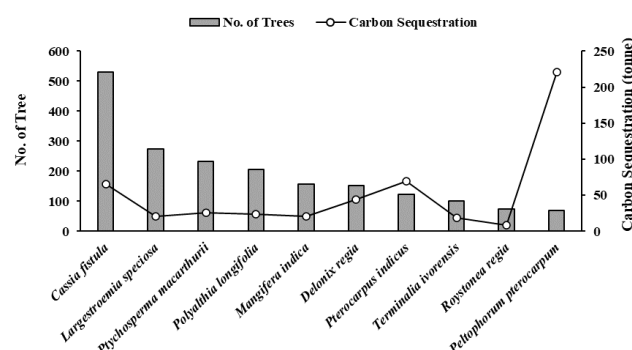


Fig. 3. Carbon sequestration of individual tree species surveyed within the study area.

3.3 Factors affecting carbon sequestration potential

Results from this study revealed that increasing in diameter at breast height (DBH) and height (H) corresponded to greater carbon sequestration potential (Figure 4). In concordance with other research [11, 42, 46, 47, 48], the maximum carbon sequestration was found in the larger tree with high DBH and H. These parameters are widely employed to indicate the growth of a tree. In the same species, the larger value of DBH and H refers to the elder tree that can store more carbon in the tree tissue; subsequently, more potential to capture carbon dioxide. Comparison between tree species, the higher DBH and H responded to the larger tree's volume and biomass consequently the relative carbon storage and sequestration potential of the tree. As shown in Table 2, a comparison between the study area with others shows that even though tree density was low, high carbon sequestration was found in the University of Western Australia [41]. This can be explained by our finding that a larger size of DBH class can achieve more carbon sequestration. Therefore, our results suggest that for future plantations in the study area with

effective carbon sequestration potential, the tree species *Cassia fistula* and *Peltophorum pterocarpum* should be planted more due to fast-growing trees with a commitment to large sizes of DBH and H in the future.

Although results from this study demonstrated that the influence of tree size on carbon storage and sequestration is well established, yet comprehensive understanding of other related factors is still lacking. Moreover, limited records exist regarding the planting timeline of each tree. Our result was a carbon inventory, and it was the preliminary result of the carbon sequestration project at Valaya Alongkorn Rajabhat University. Therefore, to be able to compare with other areas and investigate the relationship between carbon stock and growth factors, the plant ages along with other affecting factors such as temperature, rainfall, planting area, climatic conditions, maintenance process, and fertilizer application should be considered in further study.

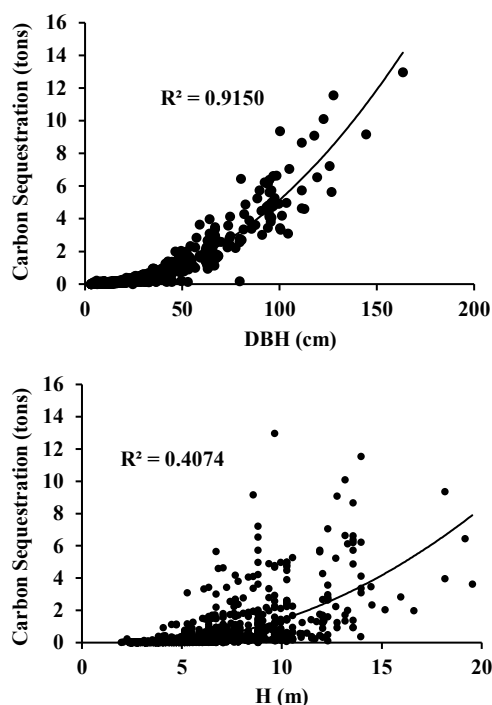


Fig. 4. Correlation between carbon sequestration and tree characteristics as diameter at breast height (DBH) and height (H)

4. CONCLUSIONS

Tree species, size, and density were identified; subsequently, the ecosystem's carbon storage and sequestration capacity within Valaya Alongkorn Rajabhat University was evaluated. Results revealed that there were 2,823 trees in the study area, and it can be accounted as 46.28 trees/ha. Most trees are perennial plants. The most abundant species was *Cassia fistula*, followed by *Largestroemia speciosa* and *Ptychosperma macarthurii*, respectively. However, the highest carbon sequestration

belonged to *Peltophorum pterocarpum* because there was a larger trunk and higher crown cover than others. This corresponds with more branches, leaves, roots, and other plant tissues for carbon storage and photosynthesis. The cumulative carbon sequestration recorded across the study location reached 916.20 tonne or 15.02 tonne/ha which was lower than the university in New Zealand due to less tree density. Our results showed that most of the trees at the field site were small which referred to the young age of the perennial plant. It has the potential to store and sequester carbon through expanding parts of the tree during the growing period. Moreover, our results found that the tree group performed higher carbon sequestration potential than palm species due to more branches, larger trunks, and a complex root system. Enhancements in diameter at breast height (DBH) and tree height (H) results in greater carbon capture from the atmosphere. The effective carbon sequestration plant was a fast-growing tree with large sizes of DBH and H. Eventually, these results can be a guideline for greening the university, carbon sinks in urban communities, and other projects for carbon mitigation purpose. However, for a better understanding of optimization in carbon sequestration, other influencing factors and the ages of trees are recommended in future research.

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