Study of carbon sequestration of the Queen Sirikit tree and the water fig tree in the Chulabhorn Science School, Trang, 2022 – 2024

Research Team: Chonlathid Limthong Natakoranon Kuaseng and Tanakorn O-mark

Advisers:

Princess Chulabhorn Science High School Trang

Thailand

Abstract

This study investigates the carbon sequestration potential of the Devil Tree (Alstonia scholaris) and Indian Laurel (Terminalia elliptica) at Princess Chulabhorn Science High School Trang from 2022 to 2024. The research aims to compare the growth characteristics of both species, analyze their carbon sequestration capacity, and evaluate the impact of soil quality on carbon storage.

Tree growth was assessed using the GLOBE Observer application, measuring height and trunk circumference, while biomass collection and drying methods were used to determine carbon sequestration. Soil samples were analyzed for pH, moisture, and nutrient content (NPK).

The findings reveal that the Devil Tree exhibited significantly greater height growth, attributed to its primary growth strategy, whereas the Indian Laurel displayed superior trunk expansion due to its lateral growth pattern. Despite the Devil Tree's rapid vertical growth, the Indian Laurel stored more carbon, benefiting from its higher wood density and biomass accumulation. Soil analysis showed that the Devil Tree thrived in nutrient-rich and high-moisture conditions, while the Indian Laurel, although growing in different soil conditions, sequestered more carbon.

These results highlight the importance of species selection in afforestation efforts aimed at enhancing carbon sequestration and mitigating climate change. The study suggests that the Indian Laurel may be a more effective carbon sink, contributing significantly to reducing atmospheric CO_2 and promoting sustainable environmental conservation.

1. Introduction

The problem of climate change and global warming has been intensifying in recent years. The main cause is the increase in the amount of greenhouse gases, especially carbon dioxide (CO_2), which is caused by the burning of fossil fuels such as coal, oil and natural gas, as well as deforestation that reduces the number of trees that play an important role in absorbing CO_2. Greenhouse gases accumulated in the atmosphere cause global temperatures to rise, resulting in natural disasters such as more severe droughts, longer heat waves, more frequent and intense rainstorms, and rising sea levels that affect coastal areas and large populations. These problems have a direct impact on the environment, economy and human quality of life.

Approaches to reduce carbon dioxide in the atmosphere generally rely on natural processes, such as carbon absorption by trees through photosynthesis, which helps to store carbon in the trunks, branches, leaves and roots, making forests an important carbon sink. However, the potential of trees to absorb carbon depends on the type of tree, the growth rate, the size of the tree and the density of the wood. In addition, the area of natural forests is continuously decreasing due to forest encroachment for agriculture and urban expansion, which reduces the efficiency of carbon absorption. Planting trees to replace destroyed forests is a beneficial long-term solution, but it still has limitations in terms of the growth period of trees and the suitable area for planting.

Studying the potential of each tree species to sequester carbon is a new approach that can help increase the efficiency of greenhouse gas reduction. Each tree species has a different carbon sequestration capacity, depending on biological and environmental factors. Data from the Science and Technology Journal found that growth is one of the factors of carbon content in trees. Therefore, the authors are interested in studying the carbon sequestration of the Queen Sirikit tree and the Water Lily tree in the Chulabhorn Science School, Trang, from 2022 to 2024, because both trees have visible growth and are popularly planted in the community. The Queen Sirikit tree and the Water Lily tree are specified as examples of prominent tree species to be tested to measure the amount of carbon in trees.

Research Questions

1. How do the growth of the Devil Tree and the Indian Laurel in Chulabhorn Science School, Trang differ?

2. How do the carbon sequestration of the Devil Tree and the Indian Laurel in Chulabhorn Science School, Trang differ?

3. How does soil quality affect the carbon sequestration of the Devil Tree and the Indian Laurel in Chulabhorn Science School, Trang differ?

Opjective

1. To study the carbon growth of Devil Tree and Indian Laurelin Chulabhorn Science School, Trang, 2022-2024

2. To study the amount of carbon sequestration of Devil Tree and Indian Laurel in Chulabhorn Science School, Trang, 2022-2024

3. To study the effect of soil quality on the amount of carbon sequestration of Devil Tree and Indian Laurel in Chulabhorn Science School, Trang, 2022-2024

Research Hypothesis

1. The growth of the Devil Tree and the Indian Laurelin Chulabhorn Science School, Trang differ.

2. The carbon sequestration of the Devil Tree and the Indian Laurel in Chulabhorn Science School, Trang differ.

3. How does soil quality affect the carbon sequestration of the Devil Tree and the Indian Laurelin Chulabhorn Science School, Trang differ?

2. Mathods, materials, and Research Methodology

Materials and materials

1. Measuring tape
2. GLOBE observer application
3. Digital scale
4. Meteorological Department website
5. Dryer
6. Plastic bag
7. Soil classification manual

Research Methodology

Section 1: Determination of the study point

This research was conducted in the area of Chulabhorn Science School, Trang, 196 Moo 4, Trang-Sikao Road, Bangrak Subdistrict, Mueang Trang District, Trang Province, located at latitude 7.5528442, longitude 99.5583281.

Section 2: Determination of the time period and determination of the study points of prominent tree species

The study of prominent tree species The research team compared the amount of carbon of prominent tree species in the area of Chulabhorn Science School, Trang during 2022 - 2024 by dividing the prominent tree species in the study into 2 types: the Queen's Flower and the Water Lily, as shown in the picture.

Image 1 shows the image of the Devil Tree and the Indian Laurel, respectively.

Section 3: Study of External Characteristics of Trees

1. Begin studying the Devil Tree and Indian Laurel in order, using the GLOBE Observer application by selecting the GLOBE Observer Trees Height application to measure the height of each tree. Start by capturing images from the base, top, and the entire tree.

2. Measure the trunk circumference of each tree at a height of 135 cm above the ground. If there are multiple trunks, measure all and take the total circumference divided by the number of trunks.

3. Observe the characteristics of leaves and flowers, then record all data in Google Sheets.

4. Identify locations of trees within each area, assigning code A for Indian Laurel and D for Devil Tree, as shown in the example.

Image 2 Locations of Devil Tree and Indian Laurel

Section 4: Mapping Trees

1. Draft a simple school layout based on Google Earth, as shown in the image.

Image 3 Layout of Princess Chulabhorn Science High School Trang

2. Draw tree symbols to represent each tree species—blue for Devil Tree and purple for Indian Laurel, as shown.

Image 4 Symbols representing key tree species studied

3. Mark tree symbols at their respective locations.

4. Insert all tree data into the corresponding tree images.

5. Assign a code to each tree and hyperlink it to the corresponding tree image.

Section 5: Data Collection for Carbon Credit Calculation

1. Define a 1-square-meter area around each tree.

2. Collect fallen tree components within that area.

3. Weigh the fresh biomass.

4. Dry it at 70°C for 4 hours.

5. Weigh the dried biomass.

Section 6: Carbon Credit Calculation Dry biomass weight method:

- Biomass carbon = Dry mass * 0.45

- CO_2 equivalent = Biomass carbon * 44/12

Tree height and circumference method:

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

- $W_b = 0.00348D^2 H^{(1.0270)}$

- $W_1 = (28.0/(W_s + W_b) + 0.025)^{(-1)}$

Section 7: Soil Quality Assessment Using the GLOBE method, measure soil pH, moisture content, soil texture, nutrient levels (N, P, K), and organic matter:

1. Define sampling points, dividing the study area into four sections based on dominant tree species.

2. Collect soil samples using a 50x50 cm Quadrat, gathering soil up to 5 cm depth, mixing thoroughly, and taking 600g per Quadrat (10 samples total) for lab analysis:

- pH using a pH meter

- Nitrogen, Phosphorus, and Potassium using an NPK test kit

- Weighing soil before and after drying at 60°C for 24 hours to determine moisture content

- Organic matter content by further heating at 450°C for 5 hours

- Data Submission to Data Entry

3.3 Data Analysis

- Mean calculations

- Paired sample t-test

Results and data

Study of carbon sequestration of the Queen Sirikit tree and the water fig tree in the Chulabhorn Science School, Trang, 2022 – 2024

consists of three sections:

Section 1: Study of Growth in Key Tree Species at Princess Chulabhorn Science High School Trang

Image 5: Bar chart showing average height of Devil Tree and Indian Laurel (2022–2024)

Image 6: Bar chart showing average trunk circumference of Devil Tree and Indian Laurel (2022–2024)

Section 2: Study of Carbon Sequestration in Key Tree Species at Princess Chulabhorn Science High School Trang

Image 7: Bar chart comparing carbon sequestration of Devil Tree and Indian Laurel (2022–2024)

Section 3: Study of Soil Quality Affecting Carbon Sequestration in Devil Tree and Indian Laurel at Princess Chulabhorn Science High School Trang

Table 1: Soil Quality of Devil Tree and Indian Laurel at the School

Discussion

The growth patterns of the Devil Tree and Indian Laurel at Princess Chulabhorn Science High School Trang (2022-2024) showed statistically significant differences. The Devil Tree exhibited greater height growth due to its primary growth strategy, wherein apical meristem tissue enables rapid stem elongation. This adaptation allows the tree to efficiently compete for sunlight in densely vegetated environments.

Conversely, the Indian Laurel demonstrated greater trunk circumference growth, facilitated by cambium tissue expansion. This characteristic enhances the tree's structural stability and water storage capacity, which is particularly advantageous in waterlogged environments.

Carbon Sequestration Capacity

A significant difference was observed in the carbon sequestration abilities of the two species. The Indian Laurel exhibited higher carbon sequestration capacity compared to the Devil Tree, primarily due to its denser wood composition and larger biomass accumulation. Although the Devil Tree had a higher growth rate, its lighter wood density contributed to lower carbon storage per unit volume.

Impact of Soil Quality

Soil conditions played a critical role in tree growth and carbon storage. The Devil Tree was found in nutrient-rich, high-moisture environments, allowing for faster growth but lower carbon sequestration. In contrast, the Indian Laurel, despite growing in different soil conditions, demonstrated higher carbon storage efficiency.

Environmental Implications

The results suggest that the Indian Laurel is a more effective carbon sink than the Devil Tree. These findings support reforestation efforts, emphasizing the selection of high-carbon-sequestering species to mitigate climate change. If widely planted, the Indian Laurel could contribute significantly to reducing atmospheric CO_2 and improving global carbon balance.

Conclusion

The growth of devil tree and Indian laurel at Princess Chulabhorn Science High School Trang during the years 2022-2024 showed significant differences between the two species. The devil tree exhibited a greater increase in height compared to the Indian laurel because it is a fast-growing tree with prominent primary growth. Its shoot tips contain apical meristem tissue, which allows the stem to elongate rapidly in order to compete for sunlight in environments with dense vegetation. The rapid height growth of the devil tree results from a growth strategy that prioritizes access to sunlight over stem girth expansion.

In contrast, the Indian laurel exhibited a greater increase in trunk circumference compared to the devil tree. As a perennial tree, the Indian laurel continuously expands its trunk size through the development of lateral meristem tissue (cambium), which thickens annually. This rapid increase in girth supports the weight of its branches and aids in water storage. Since the Indian laurel thrives in waterlogged areas, its stem must expand for structural stability and self-support.

The carbon sequestration capacity of the devil tree and Indian laurel at Princess Chulabhorn Science High School Trang during 2022-2024 also exhibited significant differences. The tree with a greater increase in carbon sequestration was the Indian laurel.

Soil quality influenced the growth of dominant tree species at Princess Chulabhorn Science High School Trang between 2022 and 2024. The species with higher soil moisture percentage and organic matter content was the devil tree. Additionally, the soil surrounding the devil tree had higher levels of nutrients (NPK) due to its deep-root system, which enables it to absorb more nutrients for growth. However, despite its favorable growth conditions, the devil tree exhibited lower carbon sequestration compared to the Indian laurel.

Citations

Plant Database, Digital Agriculture Database. Indian Laurel and Devil Tree.

Retrieved February 2, 2025,

from https://data.addrun.org/plant/search-plant-data

GLOBE Observer. Tree Height and Circumference Measurement.

Retrieved November 3, 2024,

from https://observer.globe.gov/do-globe-observer/trees/taking-observations

National Forest Inventory. Carbon Sequestration Calculation Formula.

Retrieved November 3, 2024,

from https://shorturl.asia/0IGuL

Badge descriptions

Appendix with raw data

Image 8 Study Area Points

Image 9 Biomass Sample Collection

Image 10 Biomass Weighing

Image 11 Biomass Drying

	ส่วนสูง (M.)			เส้นรอบวง (CM.)			กักเก็บคาร์บอน (kg.)		
ต้นไม้	2565	2566	2567	2565	2566	2567	2565	2566	2567
A1	6.79	6.46	7.51	71.875	59.84	64.78	1267.11	885.96	1087.15
A2	8.40	8.595	9.50	42.75	46.70	55.94	545.29	650.28	1012.12
A3	8.28	8.475	9.41	51	63.13	70.81	956.49	1208.85	1620.28
A4	9.78	10.105	10.07	47	47.75	56.63	733.61	925.83	1095.28
A5	10.04	8.295	10.07	47.79	55.25	47.14	967.86	1346.26	759.67
A6	5.58	6.87	7.40	47.75	38.00	69.25	195.26	276.12	1235.31
A7	5.38	6.405	6.27	34.75	35.50	55.19	289.15	323.12	668.22
A8	6.15	8.83	9.44	69.5	92.50	100.88	1211.52	2723.44	3266.76
A9	7.39	7.01	7.58	58	52.60	56.50	860.29	804.76	839.94
A10	5.83	7.155	6.44	57.25	111.75	48.00	762.20	2948.19	518.52
A11	7.29	8.285	7.36	53.75	85.25	76.38	819.82	2128.76	1493.26
A12	7.37	7.12	7.62	54	126.5	63.17	771.47	3920.33	1053.83

Image 12 Average Height, Circumference, and Carbon Sequestration of Indian Laurel

	ส่วนสูง (M.)			เส้นรอบวง (CM.)			กักเก็บคาร์บอน (kg.)		
B1	17.55	19.06	19.26	129.5	142.75	133.50	9980.18	15054.93	11126.68
B2	20.51	21.58	21.04	195.5	177.50	91.25	28663.83	23776.88	5649.01
B3	19.81	17.70	19.87	88.665	107.25	85.75	5118.38	10368.06	4731.47
B4	20.15	17.73	21.57	126	86.84	86.58	10675.31	4377.42	5204.95
B5	13.08	15.97	25.32	109	100.88	103.38	5268.34	5377.25	8614.28
B6	14.90	16.99	24.24	126.75	115.88	130.50	7994.47	8407.33	13189.71
B7	28.75	22.08	13.79	207	207.00	208.00	38900.46	30412.04	19789.08
B8	13.40	13.76	10.79	114	90.50	103.63	5891.49	3737.19	3909.43
B9	8.73	9.68	7.18	64	71.00	70.81	1223.60	1657.33	1248.51
B10	6.79	9.68	8.15	222.5	218.50	210.63	11743.27	16357.95	12433.83
B11	11.99	12.52	9.71	70	78.63	80.38	2380.20	2608.51	2132.03
B12	17.17	13.83	16.21	183.75	184.25	203.13	19103.45	15612.49	21901.22
B13	12.38	11.97	12.31	67	66.75	72.81	1856.73	1826.93	2183.85

Image 13 Average Height, Circumference, and Carbon Sequestration of Devil Tree