《2026 Virtual Science Symposium Report》

Trees: Nature's Medicine for the Greenhouse Effect

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Abstract

Global warming is accelerating rapidly, with rising temperatures on land and in the oceans caused by the greenhouse effect. The melting of glaciers is leading to sea level rise, flooding in coastal areas, and more frequent extreme weather events—serious threats to human life and the environment.

To address these issues, we conducted a study on various types of trees found on and around our campus. We focused on the carbon reduction capacity of different leaves. Because trees perform photosynthesis, they absorb carbon dioxide from the atmosphere and release oxygen, helping to reduce greenhouse gas concentrations. While trees also emit carbon dioxide through respiration, photosynthesis allows them to convert carbon into organic matter, which is stored long-term in the form of wood tissue. Over time, this carbon storage plays an important role in mitigating the effects of global warming. Just like a natural medicine, trees help heal our planet by absorbing harmful gases. Their quiet but powerful presence may be one of Earth's best defenses against climate change.

Introduction of Literature

Since the Industrial Revolution, large amounts of industrial waste gases and carbon dioxide have been released into the atmosphere, leading to climate change, the intensification of the greenhouse effect, extreme weather events, and other environmental problems. As climate change worsens, public awareness of the need for carbon reduction continues to grow. While various strategies for reducing emissions are widely discussed, one of the most fundamental and natural solutions is tree planting.

Tree planting functions as a "carbon absorption" mechanism, helping to capture and store atmospheric carbon dioxide in trees and soil—a process often referred to as a carbon sink. Among these strategies, forest carbon sinks and forest carbon rights are gaining attention as practical solutions.

According to an interview by the Environmental Information Center with Dr. Liu Wanyu, a distinguished professor in the Department of Forestry at National Chung Hsing University, forests not only purify the air and offer psychological healing, but also play a vital role in carbon sequestration. However, the efficiency of carbon absorption varies. Larger trees generally store more carbon, but as trees age, their carbon absorption capacity declines. Therefore, to maximize the impact of tree planting, it is essential to select species with strong carbon sequestration potential and prioritize planting them in urban and community environments.

Research Questions

Based on this understanding, we designed a study to explore the carbon fixation abilities of different tree species on and around our school campus, aiming to identify which types of trees are most effective at absorbing carbon dioxide through photosynthesis.

Therefore, this study aims to explore the following questions:

1. What is the trend in temperature change in Kaohsiung from 2020 to 2024?
2. What is the trend in global upper 2000-meter ocean heat content (OHC) over the years?
3. How much carbon dioxide does each tree species fix through photosynthesis?
4. How does the carbon fixation efficiency vary among different tree species?
5. Based on the findings, which tree species with high carbon fixation efficiency should be recommended for widespread planting?

Research Methods

We used observational data collected at the Cianjin1 Station from 2020 to 2025 to analyze local temperature trends. In addition, we conducted field measurements of various tree species on and around our school campus to explore their carbon sequestration potential. To examine their carbon fixation efficiency, we used appropriate experimental tools and techniques. Leaf area was measured and calculated using ImageJ software to estimate the photosynthetic capacity of each species.

1. The location of Cianjin1 station

   Cianjin1 station locates in Kaohsiung City, Taiwan. The terrain is plain and the climate type is tropical monsoon.

Site Information

Site ID	104218
Name	Cianjin 1
Latitude	22.630026°
Longitude	120.291204°
Elevation	6.8m
Location Source	other

【Figure 1. the site information of the Cianjin 1 station】

2. Experimental Equipment and Tools

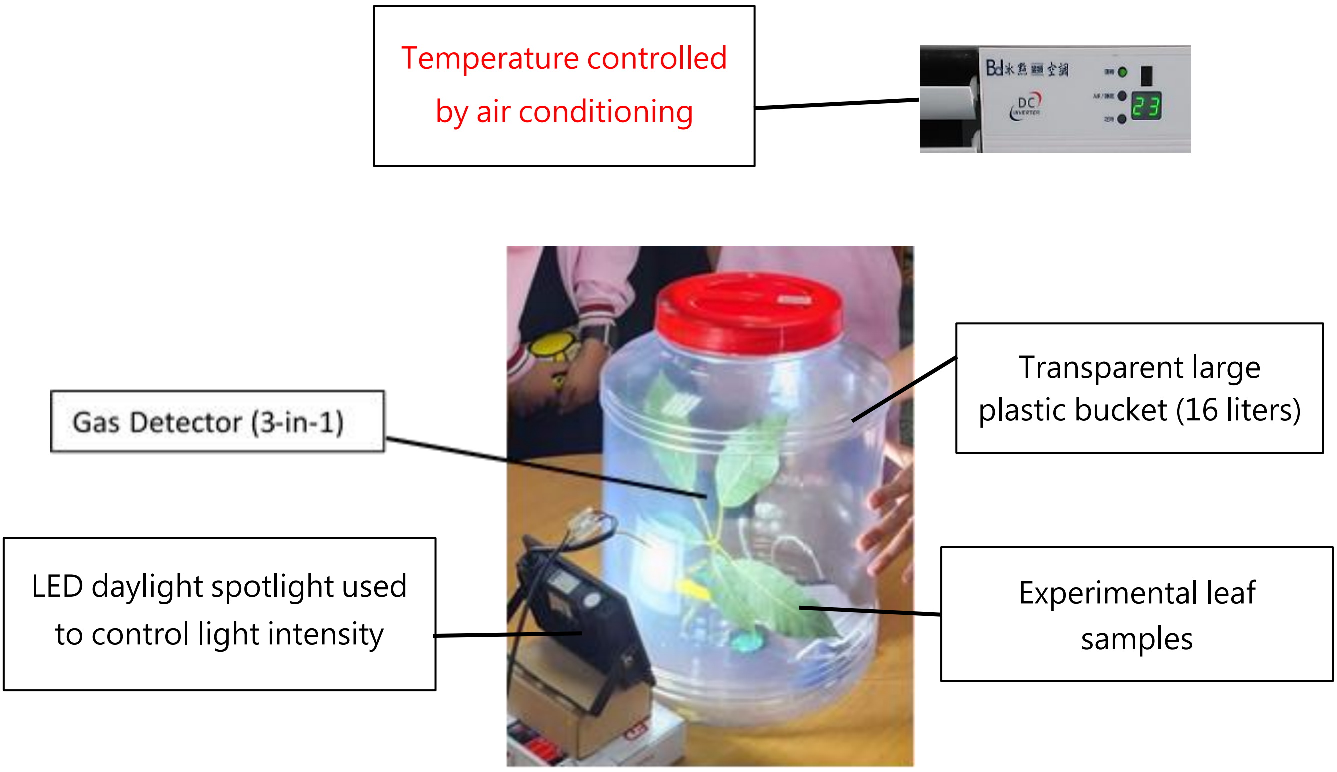
Below are the equipment and tools we used to conduct the experiment on the carbon fixation efficiency of these trees.

(1) All-in-One Printer : Scanned images of vegetable leaves were used to calculate the area using computer software. 	(2) PictureThis App : Used to identify tree species. 
(3) Gas Detector (3-in-1): Used to measure temperature, humidity, and CO_2 concentration in the air of the experimental chamber (dependent variables). 	(4) Transparent large plastic bucket (16 liters): Used to control the environmental air volume, providing transparent conditions for photosynthesis experiments. 
(5) LED Daylight Projector Lamp: LED lights were used as light sources for photosynthesis experiments. 	(6) Air Conditioner: Used to control the air temperature of the experimental environment, maintaining it between 23.0 °C and 25.0 °C (controlled variable). 
(7) Digital Hygrometer: Used to measure ambient humidity in the area around the trees. 	(8) Digital Thermometer: Used to monitor the daily maximum and minimum temperatures. 

【Figure 2. Experimental equipment and tools】

3. Experiment on Measuring the Carbon Fixation Efficiency of Photosynthesis in trees

The diagram below illustrates how we conducted the experiment to measure the carbon fixation efficiency of photosynthesis in tree species.



【Figure 3. Diagram of the experimental setup for measuring the carbon fixation efficiency of photosynthesis in vegetables】

4. Calculate Leaf Area

After completing the carbon fixation efficiency experiment, we collected the tree leaf samples for analysis. Measuring leaf area is important because it standardizes the photosynthetic surface across different tree species, allowing for more accurate comparisons of carbon fixation efficiency. We used ImageJ software to calculate the leaf area. The steps below explain how we used ImageJ to perform this calculation.

Step 1: Prepare a Template

Place a scale bar next to the leaf samples to provide a reference for measurement.

Step 2: Scan Leaf Samples

Use the all-in-one printer to scan images of the leaves along with the scale bar.

Step 3: Set the Scale in ImageJ

Import the scanned image into ImageJ and set the scale to define the measurement units.

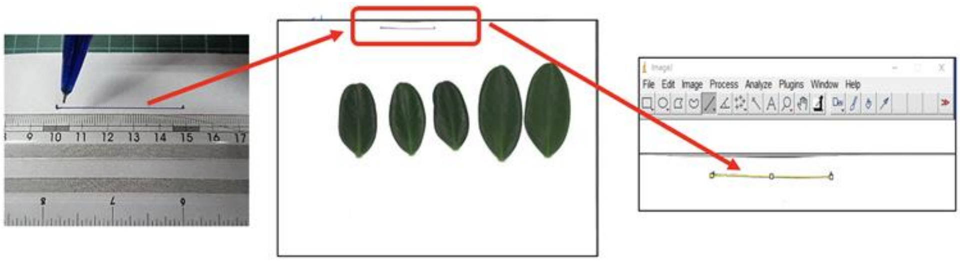
Step 4: Select the Leaf Area

Adjust the threshold settings to fill the leaf areas with red (as shown in Figure 6.) This highlights the region ImageJ will analyze.

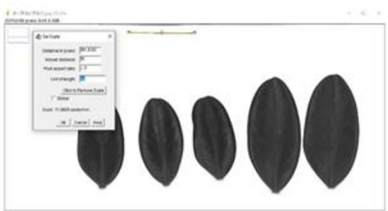
Step 5: Calculate Leaf Area

Use the Analyze function in ImageJ to calculate the total leaf area.

As shown in Figure 8., ImageJ can isolate and measure only the green (photosynthetically active) parts of the leaf, improving accuracy in photosynthesis-related studies.

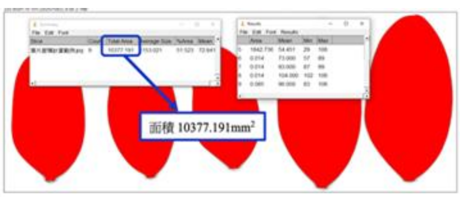


【Figure 4. Diagram of the scanned leaf sample template with a scale bar for reference】

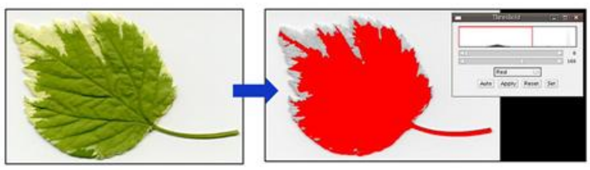


【Figure 5. Setting the image scale bar in ImageJ】

【Figure 6. Selecting the leaf area for image analysis】



【Figure 7. Calculating the total leaf area using ImageJ】



【Figure 8. Measuring only the green (photosynthetically active) parts of the leaf】

5. Experimental Procedures

To measure the carbon fixation efficiency of photosynthesis in tree species, we conducted a controlled indoor experiment using a sealed transparent large plastic bucket, artificial lighting, and gas concentration monitoring equipment. The following steps outline the complete experimental process:

(1) Collect Leaf Samples

Visit tree species on and around the campus to collect leaf samples. Wash and dry the leaves, then insert them into conical flasks filled with water to keep them fresh during the experiment.

(2) Set Indoor Temperature

Turn on the indoor air conditioner and maintain the room temperature between 23.0 °C and 25.0 °C to ensure a stable environment.

(3) Set Up the Experimental Bucket

Place the prepared leaf samples and the three-in-one gas detector in the bucket. Cover the lid to prevent external air from entering.

(4) Illuminate the Samples

Turn on the LED projector lamp and adjust the illumination to approximately 22,000 lux to simulate sunlight. Use a video recorder to continuously record the gas detector’s display panel for 30minutes.

(5) Scan and Measure Leaf Area

After 30 minutes, remove the leaf samples. Cut off the leaves and scan them using an all-in-one printer. Calculate the leaf area using ImageJ software.

(6) Record CO_2 Concentration

Review the recorded video and record the CO_2 concentration values at one-minute intervals.

Research Results

1. **Temperature Change Trends from 2020 to 2024**

Our analysis of daily maximum temperature trends from 2020 to 2024 reveals a steady increase in abnormal climate events, underscoring the growing influence of global warming on local and global weather patterns. Although seasonal temperature cycles remain, climate stability is clearly declining—a warning sign that reinforces the importance of natural climate regulators like trees.

2020: Temperature patterns were relatively stable, with only minor seasonal fluctuations. This year serves as a reference for typical climate conditions before more significant warming effects took hold.

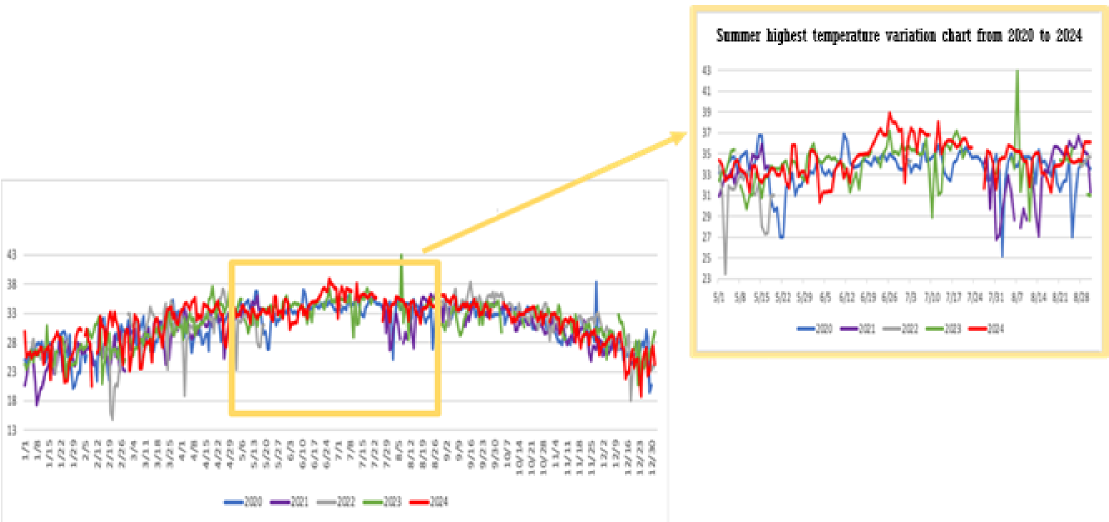
2021: An unusual drop in summer temperatures occurred in August, likely due to increased rainfall or typhoons—pointing to growing local weather disruptions.

2022: Temperature swings became much more dramatic, especially in spring and autumn. These fluctuations suggest increased atmospheric instability, a hallmark of climate change.

2023: While most of the year was relatively stable, a sharp spike exceeding 40 °C in August marked a dangerous heatwave. Such extremes threaten biodiversity, agriculture, and human health.

2024: The warming trend became most pronounced. Prolonged periods of high summer temperatures and the near disappearance of winter cold spells indicate a shift toward a more homogenized—and dangerously warmer—climate.

In light of these patterns, trees emerge as a powerful ally. Their ability to absorb carbon dioxide, regulate temperatures, and restore microclimates makes them a vital natural remedy for the intensifying greenhouse effect. This data-driven insight reinforces the urgent need for reforestation and tree protection as part of any comprehensive climate strategy.

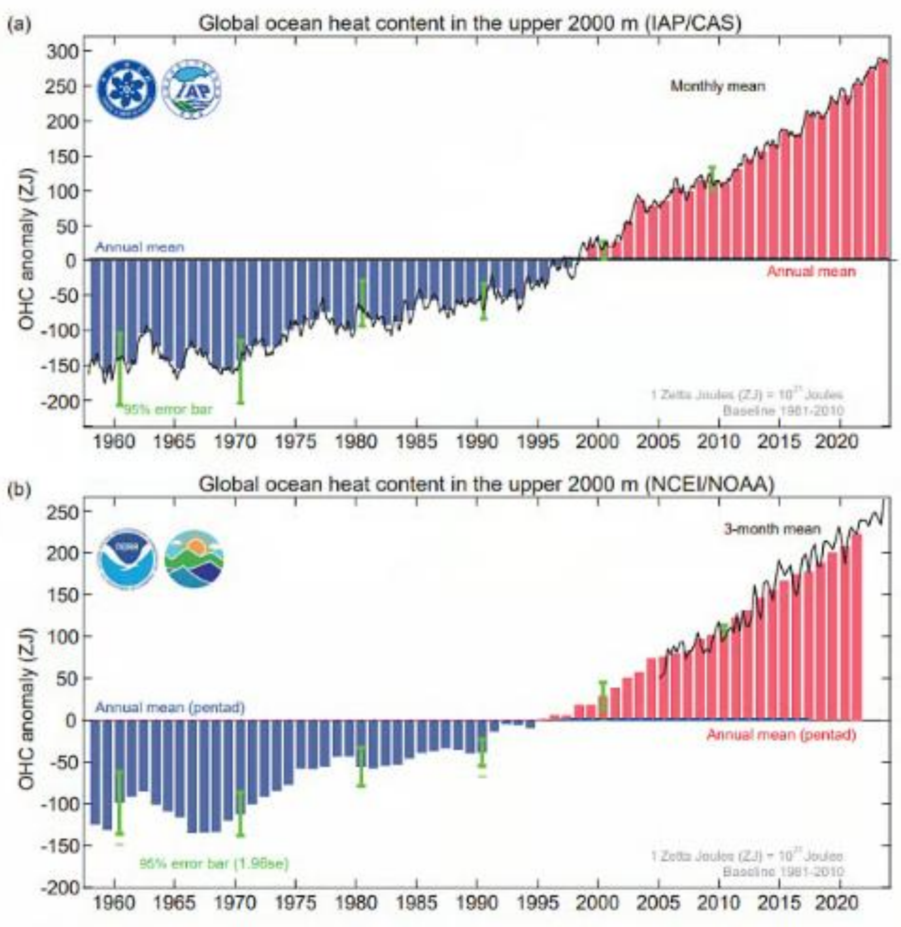


【Figure 9. Highest temperature variation chart for the years 2020-2024】

2. **Trend in Global Upper 2000-Meter Ocean Heat Content (OHC) Over the Years**

According to NOAA and recent studies, the global ocean heat content (OHC) in the upper 2,000 meters (as shown in Figure 10) has been rising steadily, reaching a record high in 2023. This long-term warming trend—especially since the mid-1990s—is strongly connected to human activities, mainly the release of greenhouse gases like carbon dioxide (CO_2). As more CO_2 builds up in the atmosphere, the ocean absorbs most of the extra heat, leading to rising sea levels, marine heatwaves, ocean acidification, and disruptions in global weather patterns.

These findings highlight the urgent need to reduce CO_2 in the atmosphere. One natural and effective way to help is by planting and protecting trees. Trees absorb CO_2 through photosynthesis, helping to lower greenhouse gas levels and cool the planet. In this way, trees act as nature's medicine for the greenhouse effect. Promoting tree growth can support ocean health and slow the effects of global warming.



【Figure 10. Global Upper 2000-Meter Ocean Heat Content (OHC)】

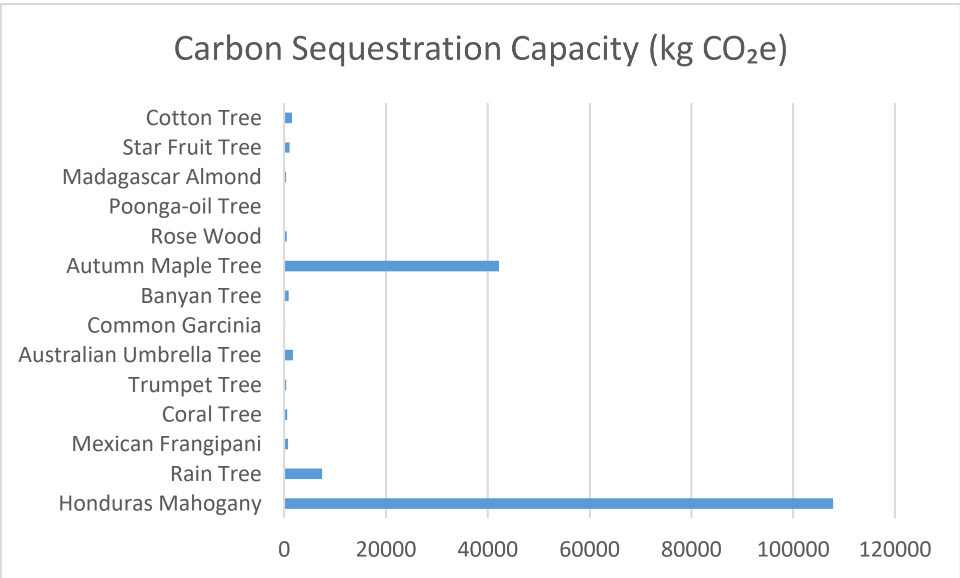
3. Exploration of Carbon Sequestration of the Tree Species on and Around the Campus

To better understand how trees help combat climate change, we investigated the carbon sequestration capacity of 14 various tree species found on and around our campus. As shown in the chart, different species have vastly different abilities to absorb and store carbon dioxide (CO_2) from the atmosphere—a key process in reducing the greenhouse effect.

Among all the species studied, Honduras Mahogany stands out as the most effective carbon sink, capable of sequestering nearly 115,000 kg of CO_2. This remarkable capacity highlights its potential role as a powerful ally in climate mitigation efforts. The Autumn Maple Tree also demonstrated significant carbon storage, with over 40,000 kg CO_2 sequestered, making it another valuable species in our local environment.

In contrast, many of the other trees, such as the Cotton Tree, Star Fruit Tree, and Trumpet Tree, contribute on a smaller scale. However, even these trees play an essential role when planted in large numbers, collectively enhancing the carbon-capturing ability of green spaces.

These findings support the idea that trees are nature's medicine for the greenhouse effect, with their ability to store atmospheric carbon serving as a natural remedy against global warming. By choosing and planting high-sequestration species strategically, we can make a meaningful contribution to the fight against climate change.



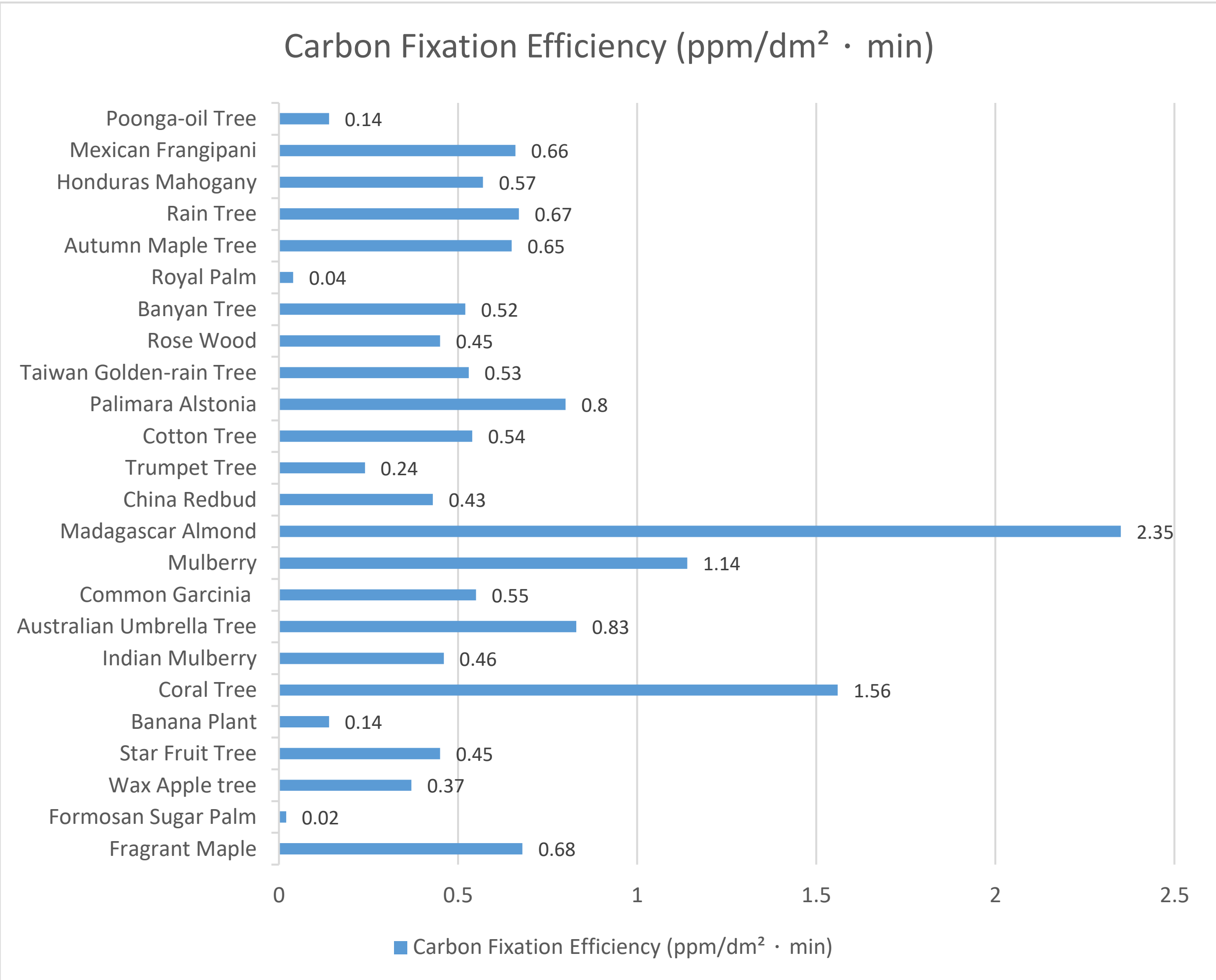
【Figure 11. Chart of Carbon Sequestration Capacity of Various Tree Species】

4. Exploration of the Carbon Fixation Efficiency of Different Tree Species

To further understand how trees mitigate the greenhouse effect, we explored the carbon fixation efficiency (measured in ppm/dm²/hr) of 24 different tree species located on and around our school campus. This data reveals significant variations in how effectively different species absorb atmospheric carbon dioxide—a key process in reducing greenhouse gases.

Among all species analyzed, **Madagascar Almond** stood out with the highest carbon fixation efficiency at 2.35 ppm/dm²/hr, making it an especially effective species for carbon capture and climate regulation. Other high-performing trees include the **Coral Tree** with a carbon fixation efficiency of 1.56 ppm/dm²/hr, the **Mulberry** at 1.14 ppm/dm²/hr, the **Australian Umbrella Tree** at 0.83 ppm/dm²/hr, and the **Palimara Alstonia** at 0.80 ppm/dm²/hr. In contrast, some species showed much lower fixation rates. For example, Formosan Sugar Palm and Royal Palm exhibited very limited efficiency at just 0.02 and 0.04 ppm/dm²/hr, respectively.

These findings demonstrate that not all trees contribute equally to carbon reduction. Selecting and planting species with higher carbon fixation efficiency—especially in urban areas—can enhance the effectiveness of reforestation and greening efforts in combating climate change.



【Figure 12. Chart of Carbon Fixation Efficiency of Various Tree Species】

5. Recommending Tree Species for Widespread Planting

As nature's frontline defense against the greenhouse effect, trees offer more than just shade and beauty—they actively absorb carbon dioxide and help stabilize the climate. To maximize this natural remedy, it is important to identify which tree species provide the greatest environmental benefits.

Based on the results of our carbon fixation efficiency experiment, we recommend the following high-performing species for widespread planting: Madagascar Almond, Coral Tree, Mulberry, Australian Umbrella Tree, and Palimara Alstonia. These trees demonstrated significantly higher carbon fixation rates, making them particularly effective at reducing atmospheric CO_2.

In addition, findings from our carbon sequestration capacity investigation highlight that Honduras Mahogany, Autumn Maple Tree, and Rain Tree are especially capable of storing large amounts of carbon over time. Their long-term contribution to carbon sinks also makes them ideal candidates for reforestation and urban greening efforts.

In conclusion, strategically planting these recommended species can enhance the role of trees as natural medicine for the greenhouse effect—mitigating climate change while supporting ecological balance.

Our research clearly demonstrates the powerful role that trees play in fighting the greenhouse effect—by reducing temperatures, storing carbon, and absorbing CO_2 from the atmosphere. Through careful selection and planting of high-performing tree species, we can turn school campuses, parks, and cities into nature-based climate solutions. Trees are more than scenery—they are medicine for a warming planet.

Discussion

1. Limitations in Carbon Sequestration Measurements

In our investigation of the carbon sequestration capacity of various tree species on and around our campus, we measured each tree's height and diameter at breast height (DBH), then used the **Carbon Sink Calculator** from the **Taiwan Campus Tree Information Platform** to estimate the amount of carbon stored. While this method provided useful approximations, it was difficult to avoid certain sources of error—particularly in measuring tree height, which can vary depending on the tools used, the observer's angle, and the irregular shape of trees. These uncertainties may have slightly affected the accuracy of our carbon storage estimates.

Another important factor is **tree age**, which we were unable to account for in this study due to lack of data. As trees age, their rate of carbon sequestration may slow down, even though they continue to store carbon. Since we did not know the ages of the trees we measured, this could have influenced our results.

In future experiments, we suggest measuring the same trees at a fixed time each year. This would allow us to track their **annual carbon accumulation** and better understand how their sequestration capacity changes over time. Long-term monitoring would not only improve accuracy but also offer insights into the carbon dynamics of trees at different life stages.

2. Factors Affecting Carbon Fixation Efficiency

Our experiment on carbon fixation efficiency spanned three seasons—from summer through winter. Since the rate of photosynthesis and leaf growth varies with temperature, sunlight, and seasonal conditions, some species may not have reached their peak performance during the observation period. This seasonal variation may have affected the measurement of carbon fixation efficiency. In future studies, extending the observation to a full year would offer more comprehensive and balanced data.

3. Ecological Considerations Beyond Carbon Performance

While our data highlights the most effective species for carbon sequestration and carbon fixation, it is important to recognize that not all tree species serve the same purpose. Some trees, despite showing lower carbon absorption capabilities, contribute in other vital ways—such as improving biodiversity, providing habitat for wildlife, resisting pests, supporting water cycles, or enhancing soil quality. Additionally, promoting ecological balance is crucial; over-reliance on a few high-performing species may reduce biodiversity and make ecosystems more vulnerable to disease or climate stress.

Therefore, when making decisions about planting trees for climate action, we should take a holistic approach—considering not only carbon performance, but also the local environment, native species, biodiversity, and long-term sustainability. Trees are not just carbon sinks; they are part of a living, interconnected system that supports the health of our planet.

Conclusion

1. From 2020 to 2024, maximum temperatures in winter remained relatively stable, while summer temperatures showed a gradual rise and occasionally reached abnormally high levels. These patterns indicate the growing influence of global warming on seasonal temperature extremes..
2. The global ocean heat content (OHC) in the upper 2,000 meters has been steadily increasing, reaching a record high in 2023. This trend underscores the urgent need to reduce atmospheric CO_2. One natural and effective solution is to plant and protect trees, which absorb carbon dioxide through photosynthesis.
3. In our investigation of the carbon sequestration capacity of various tree species on and around the campus, Honduras Mahogany emerged as the most effective carbon sink, capable of storing nearly 115,000 kg of CO_2. This highlights its strong potential in climate mitigation efforts.
4. In our experiment on carbon fixation efficiency, Madagascar Almond demonstrated the highest rate at 2.35 $ppm/dm^2/hr$, making it an especially effective species for atmospheric CO_2 absorption and climate regulation.
5. Based on our findings, we recommend the following high-performing species for widespread planting due to their excellent carbon fixation rates: Madagascar Almond, Coral Tree, Mulberry, Australian Umbrella Tree, and Palimara Alstonia. We also recommend Honduras Mahogany, Autumn Maple Tree, and Rain Tree for their outstanding long-term carbon storage capacity.
6. Many environmental factors—such as seasonal variation, sunlight, and temperature—can affect the rate of photosynthesis and carbon absorption in trees. While our study provided meaningful data through field measurements, the results are subject to experimental limitations and possible measurement errors.
7. This study was limited to sampling tree species on and around the Cianjin Junior High School campus. However, Taiwan is home to a rich diversity of trees. Future research can expand to include a wider range of species across different regions. Additionally, improving experimental design, reducing sources of error, and measuring carbon sequestration at fixed intervals each year will help produce more accurate and long-term insights.

Citations

1. Environmental Information Center
   https://e-info.org.tw/node/236007
2. Cedars Digita
   https://www.cedars-digital.com/zh-hant/forest-carbon-sink/
3. Green peace
   https://www.greenpeace.org/taiwan/update/27689/
4. ESG TIMES
   https://esgtimes.com.tw/11405-2/
5. Picture This
   https://www.xingse.net/
6. Campus Tree Information Platform
   https://edutreemap.moe.edu.tw/trees/#/Carbon

《Optional Badges》

I Am a Collaborator

This research was successfully completed through the collaborative efforts of a three-member team, with each member taking responsibility for specific tasks. All team members are classmates from the same school and class. Kuo, Ye served as a strong and dependable leader, helping guide the team's direction. Huang, Yu-Wen contributed as a thoughtful and optimistic team player, offering valuable insights and support. Liou, Yi-Syuan worked as a fast-thinking editor, ensuring the clarity and quality of the final content. Together, we formed an effective and cooperative team, demonstrating strong communication, teamwork, and shared responsibility. Therefore, we believe we fully meet the criteria for the Collaborator badge.

I Am a STEM Professional

Our research is in the field of environmental science and studies how tree photosynthesis can help reduce global warming. We investigated the carbon absorption ability of different tree species on and around our school campus. With guidance from our science teacher, who has extensive experience in scientific research and has conducted many research projects, we designed our experiments and analyzed our results. We used STEM tools such as gas detectors to measure carbon dioxide, LED lights to simulate different conditions, and ImageJ software to measure leaf area. We also used the Carbon Sink Calculator from the Taiwan Campus Tree Information Platform to estimate carbon storage. By collecting data, analyzing results, and solving real environmental problems, we practiced scientific thinking and showed the skills and responsibility of STEM professionals. Therefore, we believe our project meets the criteria for the STEM Professional badge.

I Make an Impact

Our research helps fight climate change by showing how trees can reduce carbon dioxide in the air. We studied different tree species on and around our school to find out which ones are best at storing carbon and cleaning the air. Our findings identified specific high-performing tree species that can be strategically planted to increase carbon absorption in urban environments. By sharing our results and raising awareness about the importance of tree selection and preservation, we hope to inspire our school, community, and future policymakers to take action—starting with simple yet powerful steps like planting the right trees in the right places. This project not only deepened our understanding of environmental science, but also empowered us to make a real difference for a more sustainable future. That's why we believe we deserve the "I Make an Impact" badge.