Proposal for Carbon Storage Assessment Using Satellite Data at Xinwu Senior High School

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Abstract

This research evaluates the potential of using satellite-derived NDVI to accurately measure carbon storage at Xinwu Senior High School (XWSH). Located on a subtropical coastal plain, the site's unique monsoon climate provides a rigorous setting for studying woody plant resilience. The study explores the relationship between physical structures—Diameter at Breast Height (DBH) and tree height—and spectral data.

We hypothesize that higher DBH and tree height yield higher NDVI values. To test this, we conducted field surveys one to two times per week using measuring tapes and the GLOBE Observer app. These ground-based measurements serve as "ground truth" to establish a statistical correlation with satellite data.

By analyzing how species diversity and location affect this model, we aim to provide a streamlined method for estimating carbon storage. This approach reduces the labor required for fieldwork and supports a new planting strategy for the school, focusing on species with high carbon storage and NDVI performance.

Research Question(s) and Hypothesis

Question:

Can we use satellite pictures (NDVI) to accurately measure how much carbon a tree holds, and what things (like tree type or location) make that measurement better or worse?

Hypothesis:

We hypothesize that higher DBH and tree height values yield higher NDVI.

Description of Study Site

The research is conducted in a rural area of Xinwu District, Taoyuan City (24.970544, 121.1017254). This site is positioned along the subtropical coast of Taiwan and belongs to the Taoyuan Alluvial Fan Plain. Due to its coastal location and monsoon climate, the environment experiences powerful northeast winds every winter, making it an unique setting to study the resilience and efficiency of woody plants.

Data Collection Plan

We conducted a year-long field study of 320 trees across 44 species on the XWSH campus. To ensure a systematic approach, we established a custom tree-numbering system and carried out the investigation in phased zones. The collected data were integrated into the Campus Tree Information Platform to estimate the corresponding carbon storage (expressed as CO_2 equivalent) for each tree.

Data Collection Plan

Throughout the data collection phase, we maintained a monitoring frequency of one to two times per week, utilizing traditional measuring tapes in conjunction with the GLOBE Observer app to acquire precise tree height and Diameter at Breast Height (DBH) data. Furthermore, this study utilized the ground-based measurements as ground truth to establish a statistical correlation between NDVI and carbon storage. By evaluating NDVI as a remote sensing indicator, we aimed to develop a site-specific carbon estimation formula: Carbon Storage = a × (NDVI) + b. This model could potentially be scaled to the wider community, providing a streamlined method for estimating carbon storage that significantly reduces the labor and time required for on-site fieldwork.

Background and Supporting Information

Global policies now prioritize sustainability in response to climate change. Recent studies have employed diverse methods to quantify carbon dynamics: Qiu et al. (2024) and Wu et al. (2024) utilized field measurements such as DBH and tree height for urban parks and specific species; PTJH (2024) highlighted the gap between natural carbon sinks and human emissions; and Li et al. (2025) explored seasonal efficiency variations.

To enhance scalability, Samphutthanont et al. (2024) integrated Sentinel-2 NDVI data with ground-truth measurements at Chiang Mai Rajabhat University. By establishing a regression model ($R^2 = 0.817$), they demonstrated that satellite-derived indices can serve as a reliable tool for rapid carbon estimation and forest restoration monitoring. Aligning with Taiwan's 2025 national climate targets, this study focuses on the XWSH campus, combining ground surveys with satellite data to estimate carbon storage and promote community-level sustainability through student-led action.

Expected Outcomes or Goals

We are exploring the link between tree structure and NDVI. This study has enhanced our understanding of environmental issues and allows us to propose a new planting strategy for the school—focusing on species with high carbon storage and NDVI performance.

References

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