Estimation of Urban Tree Biomass Using Airborne and Mobile Laser Scanning: A Case Study of the Higashiyama Campus, Nagoya University

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Introduction

Quantification of urban carbon sinks is essential for achieving a carbon-neutral society. In particular, the accurate estimation of urban tree biomass is a fundamental requirement for developing climate change mitigation strategies and for green space management. Although traditional methods based on field measurements and allometric equations provide reliable estimates, they are often impractical for large-scale assessment.

Airborne laser scanning (ALS) enables tree height estimation across broad areas; however, the absence of diameter at breast height (DBH) data limits its potential application. In contrast, mobile laser scanning (MLS), which acquires detailed point cloud data from ground-based moving platforms, provides higher spatial resolution and allows direct DBH estimation. In this study, we estimated and compared aboveground biomass by integrating ALS and MLS data, using the Higashiyama Campus of Nagoya University as a case study.

Experimental Procedures

The Higashiyama Campus of Nagoya University, the target area of this study, includes both street trees and forested zones. Metasequoia *(Metasequoia glyptostroboides)* and camphor (*Cinnamomum camphora*) trees were selected as representative species of coniferous and b roadleaf street trees, respectively, and were measured using MLS. ALS was applied to all trees, including those selected for MLS measurements.

For ALS data, semantic segmentation was applied to classify forested areas and ground surfaces, and biomass was estimated using a regression equation [1] based on average tree height. For MLS data, DBH was obtained by circular fitting of point cloud slices, and tree height was measured from the vertical extent of each tree. Aboveground biomass was then calculated using a standard allometric equation [2].

Results and Discussion

Semantic segmentation of the airborne point cloud data identified 17 distinct forested areas, with a total estimated aboveground biomass of 2,640 t. For coniferous trees, the aboveground biomass of 17 Metasequoia trees was estimated at 9.44 t using ALS data, whereas the MLS-based estimate was 16.6 t. For broadleaf trees, the aboveground biomass of 24 camphor trees was estimated at 0.803 t from ALS and 4.93 t from MLS. These results indicate that ALS-based estimates tend to underestimate biomass compared to MLS, particularly for broadleaf species.

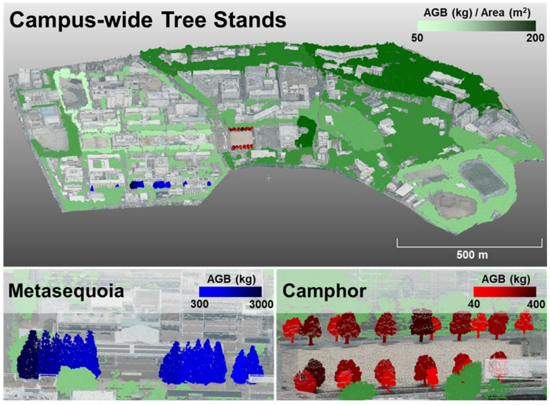

Figure 1. Aboveground biomass distribution on Higashiyama Campus, Nagoya University.

To improve the accuracy of urban tree biomass estimation, we propose an integrated approach that combines the broad coverage and efficiency of ALS with the high-resolution structural information provided by MLS.

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References

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