# Estimation of Bamboo Biomass Using Aerial Point Clouds at Nagoya University

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## Introduction

The sustainable utilization of biomass resources is essential for achieving a circular society, making the accurate estimation of biomass increasingly important. Among various biomass resources, bamboo is highly valued not only for its potential as a renewable energy source and novel material but also for its capacity as an efficient carbon sink due to its rapid growth. Despite these beneficial characteristics, research on bamboo biomass estimation remains limited. Consequently, this study was undertaken to address this knowledge gap, by applying Airborne Laser Scanning (ALS) point cloud data to the estimation of bamboo biomass. The method offers the advantage of rapid and efficient measurement of biomass over extensive areas.

Bamboo biomass was estimated by combining bamboo forest area data, derived from aerial photographs, with ALS point cloud data. The Higashiyama Campus of Nagoya University was selected as the site for this case study.

## Experimental Procedures

Aerial photographs of the Higashiyama Campus of Nagoya University were acquired and bamboo forest regions were extracted using an open pre-trained deep learning model for image segmentation [1]. The identified regions were then integrated with Airborne Laser Scanning (ALS) point cloud data of the same area to derive forest extent and culm height. Bamboo biomass was then estimated using an empirical formula developed from ALS and Mobile Laser Scanning (MLS) data at Makinogaike Ryokuchi Park in Nisshin City, Aichi Prefecture. The total biomass of the entire target area was then estimated by applying this formula to the previously calculated area and culm heights.

## Results and Discussion

The deep learning model accurately extracted bamboo forest regions within the campus, with ALS analysis revealing that the area measured 0.0722 ha and that the average bamboo culm height was 9.46 m. Using the empirical formula developed in this study, the total biomass and density of bamboo in the target area was estimated as 4.60 t and 63.7 t/ha, respectively.

These findings demonstrate that ALS-based point cloud analysis, combined with aerial photographs and MLS data, provides a reliable approach for estimating bamboo biomass over large areas. The estimated biomass density (63.7 t/ha) is consistent with that reported for temperate bamboo forests (30–90 t/ha [2]), supporting the validity of the method. Future studies should evaluate the applicability of the empirical formula to other regions enhance the accuracy of bamboo detection from aerial imagery, and refine culm height estimation by improving ALS-derived height metrics rather than relying on mean point heights.

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## References

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