Tropentag, September 11-13, 2024, hybrid conference

"Exploring opportunities ...
for managing natural resources and a better life for all"

Modeling the horizontal distribution of tree crown biomass using terrestrial laser scanning: A method for advancing the accuracy of forest biomass estimates and monitoring techniques

Muluken Nega Bazezew, Nils Griese, Lutz Fehrmann, Nils Nölke, Christoph Kleinn

Georg-August-Universität Göttingen, Forest Inventory and Remote Sensing, Germany

Abstract

Accurate biomass estimation methods serve as a keystone for informed decision-making in forest monitoring and policy formulations. By providing reliable biomass estimates or carbon stocks, decision-makers can develop sustainable forest monitoring strategies and carbon sequestration initiatives, which is pivotal for maintaining ecological balance and safeguarding the long-term health of forests.

Crown biomass, which accounts for considerable share of total tree biomass, can be considered one of the key forest variables and may provide substantial benefits if quantified accurately. Tree crown biomass is rarely assessed, though, in forest monitoring, but when it is to be reported, conversion factors are commonly used for predicting crown biomass as a function of stem biomass. Further, in conventional methods, the predicted total biomass is assigned exclusively to the stem position. In reality, however, crown biomass is spatially distributed over the entire crown projection area: so far, models describing this distribution are absent in the forestry literature. The conventional approach also does not take into account that forest biomass is a variable with continuous horizontal distribution over any plot or inventory area. This has been a bottleneck in matching remotely-sensed biomass predictors to a specific field plot inventory biomass; since remotely-sensed information offers continuous spatial pixel information across crown parts.

We investigated a new biomass modeling approach, the *Horizontal Biomass Distribution* (HBD), which serves to spatially depict crown biomass distribution over the crown projection area of trees. Here, crown biomass is modeled as a continuous distribution, which enables the spatial allocation of crown biomass as a function of horizontal distance from the tree stem. To develop HBD models, we considered empirical functions and terrestrial laser scanning (TLS)-derived tree metrics. Our approach was examined using TLS data from trees outside the forest in Goettingen, Germany.

Conversely, our approach expands the horizon for mapping biomass distributions with the highest possible accuracy. This research can also be extended to further applications beyond the scope of this study, such as if modeling biomass loss in partially damaged tree crowns, or modeling fuel loads and forest fire spreads may be of interest.

Keywords: Carbon sequestration, continuous distribution of crown biomass, spatial distribution of crown biomass, TLS point cloud

---

Contact Address: Muluken Nega Bazezew, Georg-August-Universität Göttingen, Forest Inventory and Remote Sensing, Büsgenweg 5, 37077 Goettingen, Germany, e-mail: mbazeze@uni-goettingen.de