Assessment of understory vegetation in a plantation forest of the southeastern United States using Terrestrial Laser Scanning

Angel Adhikari1, Alicia Peduzzi1, Cristian R. Montes1, Nathaniel Osborne2, Deepak R. Mishra3
1Warnell School of Forestry and Natural Resources, UGA, 2Weyerhaeuser Company, 3Department of Geography, UGA

Background
Southeastern United States Forest
➢ 12 % of the world’s industrial roundwood
➢ 19 % pulp and paper productions

However, the growth rate of the existing pine plantations is substantially lower than the pine plantation in other temperate and subtropical regions. Low soil fertility and interspecific competition between herbaceous and woody plants for resources are documented as one of the major limiting factors for pine growth in the South (Lee Allen et al., 2005). Studies have shown a two to four-times increase in stand productivity and significant improvement in survival after controlling the competing vegetation (Miller et al., 2003; Michael, 1980).

Objectives:
➢ To quantify and map understory vegetation biomass and its spatial distribution using terrestrial laser scanning (TLS) derived metrics.
➢ To compare volume estimation methods for TLS point cloud, including voxelization, alpha-hull fitting, and Mean Height Understory cover based method.

Methods

Methods cont.

2) Terrestrial Laser Scanning (TLS) data
Collected using GeoSLAM ZEB HORIZON mobile laser scanner

TLS based twenty-seven metrics extraction from sub plots
➢ Volume based on voxel count
➢ Volume based on mean height and understory cover
➢ Volume based on 3D alpha-Hull fitting
➢ Echo height percentiles and descriptive statistical variables (mean, median, SD, etc.) of echo height

Method Flowchart

Study Area
Intensively managed loblolly and slash pine plantation forest in Nassau county, northern Florida

Study Data Collection: July-August, 2022
Sample: 60 plots and 2 subplots inside

Data Collection

1) Understory Biomass

The process for collecting understory dry biomass. First, a 1m PVC frame was used to establish an understory subplot (a). Then, after conducting destructive sampling, the samples were placed in bags and labeled (b). Next, the collected samples were dried in an oven (c) for 48 hours at 105°C before dry biomass weight measurement (d).

Results

Summary statistics

Volume estimation method comparison

Model for biomass prediction using TLS derived metrics

Where, $y$ is the understory biomass, $x_1$ is volume based on mean height and understory cover, $x_2$ is 20th percentile of echo heigh, $x_3$ is 10th percentile of echo height.

Predicted understory biomass maps

Discussion

➢ This non-destructive method for understory vegetation quantification can be very helpful for the timely detection and quantification of competing vegetation in plantation forests in the southeastern US.

➢ The mean height and understory-based volume estimation method showed to be more accurate than the voxel and alpha hull-based volume estimation methods, yielding adj. $R^2$ of 0.79, 0.47, and 0.57, respectively, when used as a single variable in the model.

➢ It is important to highlight that a major drawback in using TLS lidar data is the inconsistent density and limited detection range, especially when dealing with dense and wet understory vegetation.

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