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

Angel Adhikari*[1], Alicia Peduzzi[1], Cristian R. Montes[1], Nathaniel Osborne[2], Deepak R. Mishra[3]
[1]Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA, United States
[2]Weyerhaeuser Company, United States
[3]Department of Geography, University of Georgia, Athens, GA, United States

This study aimed to utilize Terrestrial Laser Scanning (TLS) data to assess understory vegetation biomass in southeastern United States forests, where interspecies competition between herbaceous and woody plants is a major limiting factor for pine growth. Although TLS has been proven as a promising tool for mapping and quantifying vegetation using 3D profiles of entire forests, its potential for quantifying understory vegetation, particularly in the southeastern US, remains largely unexplored. Therefore, our study explores the feasibility of TLS-based metrics to help quantify evergreen understory vegetation more accurately than traditional methods in pine plantations. Moreover, we compare the results of different TLS metrics extracted from established methods, such as voxelized and alpha-hull fitting. Finally, we propose a new approach based on mean height and understory cover to estimate understory vegetation volume using TLS data.

For this study, field data were collected from an operational loblolly pine plantation in Nassau County, Florida. We established 60 sample plots of 1600m^2 distributed based on tree height and competing vegetation abundance. Ground-based laser scanning data was collected for the entire forest profile within the sampled plot. Two subplots of 1m^2 from each sample plot were destructively harvested, and the vegetation was oven dried for 48 hours to obtain understory biomass weights. A density-based individual tree detection method was utilized to filter out all trees within the sample plot from pre-processed and normalized point clouds collected from TLS. The remaining point clouds, representing only the understory layer (below 3 meters in height), were then used to calculate various statistical and 3D volume metrics for quantifying understory biomass.

Our study found that the model performed best using the 60th percentile of the echo height and a 3D volume metric based on mean height and understory cover (R^2=0.80, RMSE=283.2g/m^2) as an explanatory variable. We also discovered that the mean height and understory-based volume estimation method was more accurate than voxel and alpha hall-based 3D volume estimation methods, yielding R^2= 0.79, R^2= 0.47, and R^2= 0.57, respectively, when used independently in the model. Our findings suggest that terrestrial laser scanning data has the potential to capture and accurately quantify biomass variation in the forest understory. As a monitoring tool, TLS could aid plantation management and decision-making in monitoring competing vegetation and silviculture prescriptions.

Keywords: Understory biomass assessment, Voxelization, alpha-hull fitting, mean-height and understory cover-based volume estimation method