

Title of the thesis: ACCURACY, AGREEMENT AND TIME EFFICIENCY OF PORTABLE, LIDAR-BASED TOOLS IN TREE INVENTORIES

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High-precision forest inventories provide fundamental quantitative data required for characterizing stand structure, carbon accounting, and decision-making. Conventional field inventory methods remain labor-intensive, time-consuming, expensive, and susceptible to operator-induced bias. These limitations constrain resolution and repeatability across large or topographically challenging forest landscapes. The thesis developed by Jenny Magaly Morocho Toaza, explores the application of low-cost mobile LiDAR sensors and smartphone applications for forest mensuration, tree biometrics estimation, and multi-temporal structural monitoring. The thesis presents a comprehensive evaluation of personal laser scanning (PLS), and smartphone-based LiDAR tools across diverse forest ecosystems, topographies, and phenological seasons. This is achieved by:

- 1) Conducting a PRISMA-compliant literature review synthesizing relevant studies on handheld, mobile, and consumer-grade LiDAR applications in forestry. The review demonstrates that mobile LiDAR platforms reduce data acquisition time by up to 70% compared to traditional field methods and achieve diameter at breast height (DBH) accuracies within 1-3 cm RMSE, while noting systemic limitations in measuring total tree height due to canopy occlusion;
- 2) Evaluating 220 curated, paired tree measurements across three contrasting Romanian forest ecosystems using the iPhone-based Tree Scanner app. Results demonstrated negligible systematic bias for DBH and minor systematic underestimation for total tree height relative to conventional calipers and hypsometers;
- 3) Using as a reference 50 circular sample plots to compare the Tree Scanner app against a professional PLS system. The smartphone app yielded plot-level basal area estimates comparable to professional LiDAR while significantly reducing active field measurement time;
- 4) Documenting stand-level basal area agreement across a full longitudinal annual cycle in 50 mountain plots. Phenological development strongly influenced measurement agreement, yielding peak accuracy during leaf-off winter conditions. Statistical parity between platforms was achieved in autumn, while TreeScanner maintained stable operational times across all seasons;
- 5) Evaluating Cloud-to-Cloud (C2C) and Multiscale Model-to-Model Cloud Comparison (M3C2) algorithms applied to seasonal leaf-off vs. leaf-on point clouds. C2C achieved 100% spatial coverage suited for detecting large structural changes, whereas M3C2 demonstrated greater robustness against local surface roughness, point density variation, and vegetation noise.

Overall, Jenny's PhD thesis demonstrates high scientific and practical merit. By integrating rigorous field validation with modern technologies, it provides actionable methodologies, empirical metrics, and operational guidelines for integrating consumer-grade digital tools into precision forestry, carbon accounting, and big data forest inventories.

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