|  |
| --- |
| **Unlocking the potential of consumer-grade UAV laser scanners for accurate assessment of plantation forests.** |
| **Introduction/Aim:** **The sustainable management of plantation forests requires precise inventory techniques to collect data for various purposes, including tree growth monitoring, timber value assessment, and silvicultural planning. Unmanned aerial vehicle laser scanning (ULS) offers a cost-effective method to accurately estimate forest structural attributes at both plot and individual tree levels, thereby facilitating the acquisition of inventory data for informed decision-making in forest management practices.****Methods:** **In this study, we evaluated ULS data collected using a consumer-grade sensor for its capability to detect and segment individual trees, create digital terrain models (DTMs) and canopy height models (CHMs), and predict two crucial forest structural attributes, diameter at breast height (DBH) and stem volume, across varying point densities. We also tested the performance of two modelling methods for DBH predictions: Partial least squares (PLS) and random forest (RF). This assessment was conducted in a radiata pine (*Pinus radiata* D. Don) plantation located in the North Island of New Zealand. The study site, being at an assessment age (9-years old), proved to be an ideal candidate for testing the precision of tree measurements used for selections.****Results:** **The accuracy assessment of individual tree segmentation consistently revealed F1 scores exceeding 0.96 across different point densities. However, CHMs derived from lower-density point clouds consistently exhibited overestimations compared to those from higher-density point clouds. We also observed a systematic bias in CHM estimations associated with varying point cloud densities. In contrast, DTMs obtained from decimated point clouds showed minimal variation to the DTM created from the highest density point cloud, with the differences ranging from 0.02 m to 0.11 m across different densities. Predictions of volume and DBH reveal that PLS consistently outperformed RF models in terms of accuracy across varying point densities. There was little difference in models that used metrics extracted from point clouds normalised using the high-density point cloud DTM and those extracted point clouds normalised using their native DTMs. Using data from the native DTMs, DBH estimation using PLS had the lowest RMSE of 1.62 cm and the highest *R*2 of 0.76 at a density of 12,200 points/m2, while stem volume estimation yielded the lowest RMSE of 0.04 m3 and the highest *R*2 of 0.79 at the same density. Both RMSE values remained relatively stable from 12,200 to 400 points/m2, with a gradual decrease to 50 points/m2 and for intervals thereafter and a more pronounced decline at densities below 10 points/m2. Metrics that described the crown density and volume of the crown emerged as the strongest predictors of DBH across most point densities, while metrics describing the gap fraction and vertical canopy structure contributed minimally to models at all point densities.****Conclusion:** **Overall, these findings hold significant implications, particularly for the precise estimation of DBH and stem volume at the individual tree level. They demonstrate the potential of cost-effective ULS sensors for rapid and frequent plantation forest assessment, thereby enhancing the application of ULS technology in plantation forest management.** |