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Estimation of Aboveground Biomass Across Forest Types at Different Degradation Levels in Central Kalimantan (Borneo) using LIDAR and Field Inventory Data

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Abstract

The quantification of tropical forest carbon stocks is a key challenge in creating a basic methodology for REDD (Reducing emissions from deforestation and degradation in developing countries). Small-footprint LiDAR (Light Detecting and Ranging) systems have proven to successfully estimate above ground biomass (AGB) in boreal and temperate forests. Their applicability to forest types of Central Kalimantan, Indonesia, were tested using two approaches: (1) linking single tree parameters via allometric equations, and (2) developing a multiple regression model at plot level using point cloud characteristics. Inventory data barely exist for Kalimantan's forests. In order to achieve the requirement of a high number of field plots the faster angle count sampling was applied. Fixed-area plots were used as a control and approved the use of the angle count method. 415 out of 1034 field-positioned trees could be identified in the LiDAR canopy height model. Diameter at breast height (DBH) measured in the field and LiDAR derived crown diameter and height could be successfully linked by allometric equations (lowland dipterocarp forest: R^2 = 0.63; peat swamp forest: R^2 = 0.77). TreeVaW, a tree detection software for LiDAR data, was used to identify individual tree parameters of whole LiDAR tracks. AGB values were generally underestimated due to the non-detectable understorey biomass. The plot level approach emerged as more adequate and effective than the single tree approach. Several AGB-predicting models were established for each forest type using statistical values of the laser canopy height distributions within a 1-ha-plot. The 65^{th} percentile and the total number of laser points explained 82 % of the variation in lowland dipterocarp forest plots (RMSE = 21.75 %). The best model for peat swamp forest could only explain 42 % of the AGB variation (RMSE = 34.88 %). Taking both types altogether explained 68 % (RMSE = 37.71 %). Regression application showed reasonable results in two control areas. The models have high potential to be implemented in REDD projects which will contribute to the protection of forest ecosystems throughout Kalimantan, to ensure a sustainable way of living for the local people and improve their living conditions by the means of fair payments from the industrialised countries.

Keywords: Aboveground biomass, forest inventory, Indonesia, LiDAR, REDD, tropical forest

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