Evaluation of the similarity in tree community composition in a tropical rainforest using airborne LiDAR data

Abstract

Human activities in tropical forests, such as logging or shifting cultivation, largely affect forest biodiversity. These disturbances often create small patches of successional vegetation and heterogeneous spatial patterns. Airborne LiDAR can detect small-scale disturbances, which are undetectable by conventional remote sensing. Here, our aim was to evaluate the similarity in community composition of tree assemblages after human disturbances in a tropical rainforest in northern Borneo using small-footprint airborne LiDAR. We derived 16 variables related to the height distribution and canopy characteristics from airborne LiDAR data. The similarity in community composition among plots was calculated using ordination analysis (nonmetric multidimensional scaling) based on the number of trees of each species. LiDAR-derived variables were significantly correlated with the similarity in community composition; the strongest correlation was with the canopy laser penetration rate down to 1-m height above ground ($rs = -0.81$, $p < 0.001$). The predictive model for similarity in community composition developed using the canopy laser penetration rate at 0-m height and the maximum height had $R2adj = 0.71$ ($p < 0.001$). We applied this equation to the entire study area and compared the output with the human disturbance histories. A predictive map based on the equation suggested that the similarity in community composition changes in proportion to the degree of human disturbances. Our findings indicate that the similarity attributed to human disturbances in tropical forests can be predicted and monitored by means of airborne LiDAR. This approach could be combined with ground-based monitoring data to map the patterns of biodiversity in tropical rainforest.