Mapping forest structure of Afromontane forest remnants by airborne laser scanning

Hari Adhikari[1,2,*], Janne Heiskanen[1,2], Petri Pellikka[1,2]

1 Earth Change Observation Laboratory, Department of Geosciences and Geography, University of Helsinki, Finland
2 Institute for Atmospheric and Earth System Research, Faculty of Science, University of Helsinki, Finland

* Correspondence: hari.adhikari@helsinki.fi; Tel.: +358-44-989-9584

Abstract

The tropical montane forests are threatened and fragmented by land use change but are still important reservoirs of carbon and biodiversity. Furthermore, the montane forests capture moisture and store precipitation on the hilltops, and hence have central role in the hydrological cycle. However, depending on the topographic position and degree of degradation, the extant montane forests remnants can have considerable differences in forest structure. This work aimed (1) to analyze how well tree size inequality, described by Gini-coefficient, can be predicted by two airborne laser scanning (ALS) data sets acquired from different altitudes using two different sensors; (2) to study if prediction models are improved by including tree species sensitive seasonal metrics based on Landsat time series; (3) to generate Gini-coefficient maps for the forest remnants and study differences between the three forest remnants, and indigenous and plantation forests within the remnants. The study area is located in the northernmost part of the Eastern Arc Mountains of Kenya and Tanzania, and the highest hilltops reach over 2200 m in elevation. Most of the forest area has been cleared for croplands and agroforestry, and remnant forest are the patches of indigenous and plantation forest. The field measurements were carried out in a total of 85 circular 0.1 ha sample plots in 2013–2015 and ALS flights were conducted in 2013 and 2014–2015. We observed that Gini-coefficient was predicted more accurately by using ALS data set with higher point density. Furthermore, the models were improved when including additional Landsat seasonal metrics. Gini coefficient maps at 30 m x 30 m resolution were predicted using beta regression (R^2 = 0.57). The mean Gini-coefficients for indigenous forests in Ngangao, Yale and Vuria were 0.55, 0.48 and 0.46, respectively. The single species plantation forests (Cypress, Pine, Eucalyptus and Acacia) of the same forest remnants showed less variation in Gini-coefficient (0.44, 0.46, and 0.46, respectively). The results demonstrate feasibility of ALS data for mapping forest structure of different forest within Afromontane forest remnants.

Keywords: Forest structure, Gini coefficient, LiDAR, Landsat