Structural Diversity in a Subtropical Forest: A Comparison of Individual Tree- and Pixel-based Approaches

Zhaoju Zheng[1], Yuan Zeng[2], Meredith Schuman[1], Bernhard Schmid[1], Michael Schaepman[1], Felix Morsdorf[1]

[1] Remote Sensing Laboratories, Department of Geography, University of Zurich, Switzerland
Email: zhaoju.zheng@geo.uzh.ch

[2] State Key Laboratory of Remote Sensing Science, Aerospace Information Research Institute, Chinese Academy of Sciences

Abstract

Forest structural diversity is an important dimension of biodiversity, affecting light availability, tree survival and growth, ecosystem functioning and habitat for forest-dwelling organisms. With increasing forest biodiversity loss, it is important to monitor forest structure efficiently. Compared to traditional field sampling, airborne light detection and ranging (LiDAR) provides an effective and consistent way to monitor the three-dimensional structure of forests at different spatial units, typically in the form of pixels or individual tree crowns (ITCs). However, few studies have explored the differences between the ITC- and pixel-based approaches to mapping functional traits and diversity by remote sensing of forest vegetation. In this study, we used the two approaches to assess structural diversity in a subtropical forest. We firstly retrieved three morphological traits — 95th quantile height (H95), leaf area index (LAI) and foliage height diversity (FHD) from ITCs and pixels based on airborne LiDAR data. Then we compared trait distributions, trait–trait relationships and functional diversity patterns derived from ITCs and similarly-sized pixels. In addition, we investigated how much variability in morphological traits would be lost with increasing pixel size. We found that H95 derived from 3m pixels were highly correlated with the ITC-based H95 (Pearson r = 0.95), while the consistencies of ITC- and 3m pixel-based LAI and FHD were lower. The pixel-based retrieval tended to yield higher H95 and FHD and lower LAI values than ITC-based measures. These differences increased with pixel size, and the distributions tended to become more clustered. The between-unit variation in morphological traits at different pixel sizes indicated that less relative variability in traits could be explained by larger pixels. The spatial patterns of ITC- and pixel-based structural diversity were similar, but the scale-dependency analysis showed that ITC-based functional richness increased faster with area at small neighborhood scales, indicating that increased within-community diversity could be better captured by the ITC-based approach. It should be noticed that the choice of spatial unit and retrieval approach might change the semantics and interpretation of the derived morphological traits. These in-depth comparisons will help to increase our understanding of the scaling between local-ground, regional-airborne and global-spaceborne observations of forest structural diversity.

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