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Estimating tree species diversity in the savannah using NDVI and woody canopy cover

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Abstract

Remote sensing applications in biodiversity research often rely on the establishment of relationships between spectral information from the image and tree species diversity measured in the field. Most studies have used normalized difference vegetation index (NDVI) to estimate tree species diversity on the basis that it is sensitive to primary productivity, which defines spatial variation in plant diversity. The NDVI signal is influenced by photosynthetically active vegetation which, in the savannah, includes woody canopy foliage and grasses. The question is whether the relationship between NDVI and tree species diversity in the savanna depends on the woody cover percentage. This study explored the relationship between woody canopy cover (WCC) and tree species diversity in the savannah woodland of southern Africa and also investigated whether there is a significant interaction between seasonal NDVI and WCC in the factorial model when estimating tree species diversity. To fulfil our aim, we followed stratified random sampling approach and surveyed tree species in 68 plots of 90 m ×90 m across the study area. Within each plot, all trees with diameter at breast height of>10 cm were sampled and Shannon index-a common measure of species diversity which considers both species richness and abundance - was used to quantify tree species diversity. We then extracted WCC in each plot from existing fractional woody cover product produced from Synthetic Aperture Radar (SAR) data. Factorial regression model was used to determine the interaction effect between NDVI and WCC when estimating tree species diversity. Results from regression analysis showed that (i) WCC has a highly significant relationship with tree species diversity ($r^2 = 0.21$; $p < 0.01$), (ii) the interaction between the NDVI and WCC is not significant, however, the factorial model significantly reduced the error of prediction (RMSE =0.47, $p < 0.05$) compared to NDVI (RMSE =0.49) or WCC (RMSE =0.49) model during the senescence period. The result justifies our assertion that combining NDVI with WCC will be optimal for biodiversity estimation during the senescence period.