Mapping forest vegetation and fuels with Gradient Nearest Neighbor imputation in three western ecoregions

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Abstract: Accurate regional maps of vegetation and fuels are increasingly needed for assessing fire hazard, planning fuel management, modeling the behavior and effects of prescribed burns and wildfires, and many other applications in landscape analysis and management. To be useful to land managers, these maps must accurately portray a large number of vegetation and fuel attributes across large, heterogeneous, multi-ownership landscapes. We investigated use of the Gradient Nearest Neighbor (GNN) method for mapping vegetation and fuels in three contrasting ecoregions in the Western US. The GNN method uses multivariate direct gradient analysis to link field plot data, satellite imagery, and maps of environmental variables in a raster GIS database. Individual pixels are associated with forest inventory plots that have the most similar spectral and environmental characteristics. A suite of detailed plot variables is then imputed to each pixel, allowing simultaneous and consistent predicting of a wide range of vegetation attributes. Research objectives were: (1) investigate GNN for mapping fuel characteristics, species composition, and forest structure; (2) compare results across three contrasting environmentally heterogeneous, multi-ownership landscapes; (3) quantify environmental and disturbance factors associated with regional variation in these landscapes. In all study areas, environmental gradients – especially climate – were most strongly correlated with gradients in species composition, whereas variation in forest structure was most strongly associated with Landsat variables. The major factor limiting map accuracy was the inherent capability of Landsat imagery for discriminating forest structure attributes. GNN map accuracy for forest structure measures was better in OR than in WA or CA. Landsat TM data have reduced capabilities for discriminating many forest attributes in sparse-canopy forests due to mixed reflectance signals within pixels. In contrast, species predictions were most accurate in CA and WA, where environmental gradients were longer and stronger than in OR. GNN imputation maps portray a variety of variables and classifications to meet different objectives, while maintaining the full range of variability of mapped variables at the regional scale, and the covariance of multiple variables at the local (pixel) scale. The maps are well suited to applications where these traits are important, but these advantages may come at the cost of lower prediction accuracy for local sites. In general, the GNN maps are appropriate for planning and policy applications, but are insufficiently accurate to support project-level decisions. The GNN maps have been linked to the Fuel Characteristic Classification System, and include all fuel and vegetation layers required to support fire risk assessment using FLAMMAP and FARSITE.

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