How does spatial resolution affect Gradient Nearest Neighbor vegetation maps?

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Introduction

Landscape ecologists now have access to tools and data that are conducive to framing vegetation across large regions at the spatial resolution and with great geographic and taxonomic detail. However, the information does not always get aggregated and communicated for analysis and interpretation across regions. We address this issue by integrating field data from a vegetation survey with the Gradient Nearest Neighbor (GNN) method to estimate vegetation attributes at the regional scale. In the coastal province of Oregon, USA (fig. 1), we compared GNN maps at four spatial resolutions: 0.1 ha (25m x 25m), 1 ha (100m x 100m), 9 ha, and 100 ha (fig. 3). Larger grid-cells (i.e., increased grain-size) were coarser, less accurate, and increasingly poor estimators of ground vegetation conditions at larger scales.

Methods

We compared GNN maps of four spatial resolutions: 0.1 ha (25m x 25m), 1 ha (100m x 100m), 9 ha, and 100 ha (fig. 3). Vegetation data were from 806 field plots established by regional forest inventories (fig. 1). Response variables were basal area of tree species and size-class (0-25, 25-50, 50-75, 75-100, >100 cm DBH). Exploratory statistics were from 32 grid-cells representing topographic, geologic, climate, and landform geography (table 1). We iterated the exploratory analysis with 10%, 1%, 10%, and 1% of the data (fig. 1). Gradient nearest neighbor maps were generated from the 806 field plots and the exploratory analyses. Values from the original 0.1 ha plots were resampled to 1 ha grids to 9 ha, and 100 ha (fig. 3). Larger grid-cells (i.e., increased grain-size) were coarser, less accurate, and increasingly poor estimators of ground vegetation conditions at larger scales.

Results

Explanatory power of gradient models

Maps of species composition and productivity were derived from the resampled input grids. We compared GNN maps at four spatial resolutions: 0.1 ha (25m x 25m), 1 ha (100m x 100m), 9 ha, and 100 ha (fig. 3). Larger grid-cells (i.e., increased grain-size) were coarser, less accurate, and increasingly poor estimators of ground vegetation conditions at larger scales.

Dominant gradients in vegetation and environment

Table 2 presents a descriptive statistic for observed (ground data) and GNN-predicted vegetation at the site level. The resemblance of landscape composition at the regional level is very closely matched at 1 ha and declined with increasing grain-size for the ‘open’ class. Resemblance was greatest at 1 ha for ‘medium mixed’ and ‘medium conifer,’ and at 9 ha for ‘small conifer.’ Resemblances of other classes were weaker and imputed by resolution.

Local prediction accuracy

The site prediction accuracy was consistently higher for 0.1 ha models compared to larger scale models. Prediction accuracy for seven tree species was worst at 0.1 ha (fig. 5). The relationship between accuracy and grain-size differed among species.

Conclusions

The results of our study have implications for the GNN method for generating regional vegetation maps. The GNN method performs well at fine spatial resolutions and is not generalizable to other scales or spatial extents. However, the importance of spatial resolution is not overemphasized, and the method may be used for vegetation mapping at larger spatial scales.