Multiscale Analysis of Landscape Heterogeneity: Scale Variance and Pattern Metrics

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Abstract

A major goal of landscape ecology is to understand the formation, dynamics, and maintenance of spatial heterogeneity. Spatial heterogeneity is the most fundamental characteristic of all landscapes, and scale multiplicity is inherent in spatial heterogeneity. Thus, multiscale analysis is imperative for understanding the structure, function and dynamics of landscapes. Although a number of methods have been used for multiscale analysis in landscape ecology since the 1980s, the effectiveness of many of them, including some commonly used ones, is not clear or questionable. In this paper, we discuss two approaches to multiscale analysis of landscape heterogeneity: the direct and indirect approaches. We will focus on scale variance and semivariance methods in the first approach and 17 landscape metrics in the second. The results show that scale variance is potentially a powerful method to detect and describe multiple-scale structures of landscapes, while semivariance analysis may often fail to do so especially if landscape variability is dominant at broad scales over fine scales. Landscape metrics respond to changing grain size rather differently, and these changes are reflective of the modifiable areal unit problem as well as multiple-scale structures in landscape pattern. Interestingly, some metrics (e.g., the number of patches, patch density, total edge, edge density, mean patch size, patch size coefficient of variation) exhibit consistent, predictable patterns over a wide range of grain sizes, whereas others (e.g., patch diversity, contagion, landscape fractal dimension) have nonlinear response curves. The two approaches to multiple-scale analysis are complementary, and their pros and cons still need to be further investigated systematically.