Landscape Heterogeneity Effects on Scaling and Monitoring Large Areas Using Remote Sensing Data

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Abstract

Given the increasing rate of landscape change, researchers have realized that managing natural resources sustainably requires knowledge about ecosystems over more than one temporal and spatial scale. Monitoring ecosystem integrity implies sampling over long periods of time and space to identify any significant changes. Subsequently, remote sensing has become integral to many large-scale monitoring efforts. Nonetheless, there remain aspects related to scaling which limit the ability to detect landscape change with a maximal amount of inference. While successive analyses can be used to estimate errors, it is not clear how spatial reorganization resulting from scaling has diluted the signal of the processes embodied within the observed patterns. To achieve a maximal amount of inference, it is first necessary to match three scales: spatial heterogeneity, the scales of the ecological processes creating landscape heterogeneity, and the spatial and temporal resolutions of the image used in the analysis. We discuss the relationship between scale of spatial pattern, image analysis, and scale of process and how their interactions affect large-scale monitoring quality. In particular, we assert that the interactions between pattern and process need to be considered explicitly when designing large-scale monitoring to accurately describe ecological change. This study and others further support the suggestion that monitoring be coupled with spatio-temporal models to elucidate the mapping from pattern to process across scales. It is stressed that future research efforts be directed to understanding the characterization of space-time relationships implicit in pattern and that we move beyond the space-time duality approach to analysis.