

Public Abstract

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Forestry

Spatially Explicit and Stochastic Forest Landscape Model of Fire Disturbance and Succession

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Fire disturbance plays an important role in shaping ecosystem dynamics and vegetation patterns in many forested landscapes. Simulation modeling is an effective tool to study such interactive dynamics over large areas and long time periods. This dissertation is dedicated to the modeling of fire disturbance in spatially explicit and stochastic forest landscape models. I chose LANDIS as my research model. My research includes both theoretical and technical aspects of modeling fire occurrence patterns and fire spread behavior. For modeling fire occurrence, I proposed a hierarchical fire frequency model in which the joint distribution of fire frequency is factorized into a series of conditional distributions. The model possesses great flexibility for simulating temporal variation in fire frequency for various forest ecosystems. For modeling fire spread, I implemented four representative fire spread simulation methods in LANDIS. I compared temporal and spatial fire patterns simulated using these four fire spread simulation methods under two fire occurrence process scenarios that are fuel-independent and fuel-dependent. Results demonstrated that the incorporation of fuel into fire occurrence modeling greatly changes simulated fire patterns. Lastly, I used point process modeling approach to study the effects of proximity to road, land cover, topography (slope, aspect, and elevation) on the probability of fire occurrence in the Missouri Ozark Highlands, where more than 90% of reported fires are human-caused. The spatial distribution of fire occurrence density, which is one of the results from point pattern modeling, can be further used in LANDIS as an input map for simulating fire occurrence.