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Understanding coupled natural and human systems on fire prone landscapes: integrating wildfire simulation into an agent based planning system.

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Agent-based models (ABM) allow users to examine the long-term effects of agent decisions in complex systems where multiple agents and processes interact. This framework has potential application to study the dynamics of coupled natural and human systems where multiple stimuli determine trajectories over both space and time. We used Envision, a landscape based ABM, to analyze long-term wildfire dynamics in a heterogeneous, multi-owner landscape in Oregon, USA. Landscape dynamics are affected by land management policies, actors decisions, and autonomous processes such as vegetation succession, wildfire, or at a broader scale, climate change. Key questions include: 1) How are landscape dynamics influenced by policies and institutions, and 2) How do land management policies and actor decisions interact to produce intended and unintended consequences with respect to wildfire on fire-prone landscapes. Applying Envision to address these questions required the development of a wildfire module that could accurately simulate wildfires on the heterogeneous landscapes within the study area in terms of replicating historical fire size distribution, spatial distribution and fire intensity. In this paper we describe the development and testing of a mechanistic fire simulation system within Envision and application of the model on a 3.2 million fire prone landscape in central Oregon USA. The core fire spread equations use the Minimum Travel Time algorithm developed by M Finney. The model operates on a daily time step and uses a fire prediction system based on the relationship between energy release component and historical fires. Specifically, daily wildfire probabilities and sizes are generated from statistical analyses of historical fires in relation to daily ERC values. The MTT was coupled with the vegetation dynamics module in Envision to allow communication between the respective subsystem and effectively model fire effects and vegetation dynamics after a wildfire. Canopy and surface fuels are modeled in a state and transition framework that accounts for succession, fire effects, and fuels management. Fire effects are modeled using simulated fire intensity (flame length) to calculate expected vegetation impacts for each vegetation state. This talk will describe the mechanics of the simulation system along with initial results of Envision simulations for the Central Oregon study area that explore the dynamics of wildfire, fuel management, and succession over time.