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Modelling the shrub encroachment in a grassland with a Cellular Automata Model

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Abstract Arid and semi-arid grasslands of southwestern North America have changed dramatically over the last 150 years as a result of shrub encroachment, i.e. the increase in density, cover and biomass of indigenous shrubby plants in grasslands. Numerous studies have documented the expansion of shrublands in the southwestern American grasslands; in particular shrub encroachment has occurred strongly in part of the northern Chihuahuan desert since 1860. This encroachment has been simulated using an ecohydrological Cellular Automata model, CATGraSS. It is a spatially distributed model driven by spatially explicit irradiance and runs on a fine-resolution gridded domain. Plant competition is modelled by keeping track of mortality and establishment of plants; both are calculated probabilistically based on soil moisture stress. For this study CATGraSS has been improved with a stochastic fire module and a grazing function. The model has been implemented in a small area in Sevilleta National Wildlife Refuge (SNWR), characterized by two vegetation types (grass savanna and creosote bush shrub), considering as encroachment causes the fire return period increase, the grazing increase, the seed dispersal caused by animals, the role of wind direction and plant type competition. The model is able to reproduce the encroachment that has occurred in SNWR, simulating an increase of the shrub from 2% in 1860 to the current shrub percentage, 42%, and highlighting among the most influential factors the reduced fire frequency and the increased grazing intensity.

Key words shrub encroachment; cellular automata; ecohydrology