Savanna-Fire Model: Combined effects of tree-tree establishment competition and spatially explicit fire on the spatial pattern of trees in Savannas

Savannas are characterized by discontinuous tree layer superimposed on a continuous grass layer. They occur across a wide range of climatic, edaphic, and ecological conditions, covering approximately one fifth of the earth's land area. In some countries, these grass-dominated ecosystems are a principal biotic resource playing important roles in both the configuration of natural landscapes and in local economies.

Identifying the mechanisms that facilitate tree-grass coexistence in savannas has remained a persistent challenge in ecology and is known as the "savanna problem." Recent empirical work suggests that both tree-tree competition and fire are key factors in semi-arid to mesic savannas. Fire is a natural feature of many savannas and is also frequently used by humans as a management tool. Fire primarily affects juvenile tree mortality rates, with adults being largely fire resistant. In a previous paper a minimalistic stochastic cellular automata was developed to study the individual and combined effects of competition and fire on savannas.

The model was implemented on a square lattice with periodic boundary conditions. Each site on the lattice could be in one of two states: grass-occupied or tree-occupied. The model showed the relevance of the combined effects of nearby competing adults trees, stochastic fire, and grazing on tree density and pattern formation in savannas. However, fire was modeled in spatially implicit and uncorrelated way and tree development was modeled as an instantaneous transition from seed to adult tree. In the present work, a model is proposed to combine the previous savanna model with the Drossel-Schwabl forest fire model, therefore representing fire in a spatially explicit manner. We use the model to explore how the pattern of fire spread, coupled with an explicit, fire-vulnerable tree life stage, affects tree density and spatial pattern.

Join us for refreshments in CAB 549 immediately following the Seminar

CENTRE FOR MATHEMATICAL BIOLOGY
MATHEMATICAL & STATISTICAL SCIENCES
UNIVERSITY OF ALBERTA