



Spatial Stochastic Models for Landscape Degradation and Deforestation in Bolivia and Brazil

Ph.D. Advisor: Simon Levin

Career Path: Postdoctoral Associate, University of Maryland

Contact Information: nleslie@umd.edu

Nandi Leslie

Human activities have transformed many forest ecosystems into a mosaic of forested, degraded, and used lands. The ecosystems which emerge on old fields and abandoned sites tend to resist reestablishment of pioneer tree species due to loss of seed viability and low propagule availability. The regrowth capacity is further depleted in proportion to the type, intensity, and duration of the previous landscape-use. I examine the geographical information systems data-sets of subregions of the Chiquitano Forest in the Bolivian lowlands and the Brazilian Amazon. These areas have been heavily influenced by forest fragmentation and degradation. In this dissertation, I describe the recent history of land use in these regions. Furthermore, basing my recommendations on mathematical models, I give possible solutions to reduce the current decline in biomass in these regions by means of changing the current landscape conversion rates and road networks. I propose several stochastic spatial models for habitat conversion that are motivated by land cover change in the dry and rain forests of the Bolivian lowlands and the Brazilian Amazon, respectively. In Chapter 2, I present models which examine the landscape level impact of land-use activities by utilizing the interactions between agricultural/industrial use and soil and plant community dynamics. Furthermore, I develop a land-use model based on conversion of forested land by two land-use types. In Chapter 3, I develop an additional model which incorporates geographical features from Landsat imagery for Santa Cruz, Bolivia and the Brazilian Amazon into the inputs of the model. With ideas from fields including the theory of interacting particle systems, spatial statistics, and mean field and pair approximation analysis, I examine the spatio-temporal patterns that arise from the models.

The diagrams below are simulations of the landscape initialized with the 1986 data-set of the subregion of Santa Cruz for simulation years 1989, 1992, 1994, 1996, 1998, 2000, and 2020, where white and black sites are deforested and forested areas respectively. These regions are 440 km square. The patterns closely resemble those from the data-set. This model which incorporates the parameter, distance to roads, is a great predictor of spatiotemporal dynamics of this region.

