Integrated Assessment and Projection of Land-Use/Cover Change in the Southern Yucatán Peninsular Region of Mexico

Steven M. Manson
Graduate School of Geography
Clark University
950 Main Street
Worcester MA 01610

Voice: 508 793 7336
Fax: 508 793 8881
smanson@clarku.edu
www.clarku.edu/~smanson

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Broad research goals: This research develops a scenario-driven integrated model to project trends of tropical deforestation and cultivation and their effect on carbon sequestration in the southern Yucatán peninsular region of Mexico. The study is conducted as an integrated assessment: it is policy relevant global change research that addresses the complex interactions among socioeconomic and biophysical systems. The research addresses three themes: 1) the distinct temporal and spatial patterns of deforestation and cultivation; 2) the complexity of, and relationships among, socioeconomic and environmental factors and 3) the value of information and the role of uncertainty.

Geographical area: the southern Yucatan peninsular region in Mexico. The study site is roughly 18000 km^2 with about 30 000 inhabitants in over two hundred settlements.

Temporal period: 1970 to 2010.

Spatiotemporal resolution: varies, most typical simulation runs are at a spatial resolution of 900 m^2, 10000 m^2, or 1 km^2. Temporal resolution is generally a one model year iteration, although longer intervals are modeled to reduce computational periods and shorter periods are possible.

Agent decision making factors: broadly speaking, the model draws together several bodies of theory to create a conceptual framework from different disciplines by considering land-use/cover change as the result of land manager decision making in the context of the biophysical environment and socioeconomic institutions. Decision making is largely within a rational actor framework with bounded rationality extensions. While many institutions are at work in the southern Yucatan peninsular region, the model focuses on large scale land tenure, subsidies, and the market. Ecological modeling focuses on secondary succession, pest invasion, and changes in agricultural suitability. Other, more static, factors include slope, aspect, precipitation, hydrology, and infrastructure.

Actors and types of land-use/cover change modeled: largely deforestation and attendant cultivation. In addition to the institutions mentioned above, the model focus on land-managers, generally small holder farming household, with some exploratory extensions to rancher and intermediaries seeking to facilitate new kinds of production.

Methods: The prototype simulation model couples an agent-based model and generalized cellular automata to create an agent-based DSS, or ADSS. Agent-based approaches are used to combine empirical and theoretical models of actor behavior in resource-use situations and are used here to embody the actor and institution components of the conceptual framework. Decision making analogs include simple heuristics, estimated parameter models, and genetic program approximations of bounded rationality. The use of cellular automata in ecological models suggests the use of generalized cellular automata to represent the environment. By coupling generalized cellular automata and agent-based models, the ADSS is a good means of operationalizing the actor-institution-environment framework and offers a powerful approach to understanding and projecting environmental change.

Calibration/Validation: The model is calibrated and validated with remotely sensed imagery and socioeconomic data, namely household surveys, archival research, and geographic information system layers of land-use/cover and biophysical characteristics derived from satellite imagery and other spatial data. The bulk of this data is from the larger LCLUC-SYPR project of which the PI is part. A suite of validation techniques is employed, including Kappa Index of Agreement, fractal dimension, contagion , a multi-resolution goodness of fit metric, and a Monte Carlo uncertainty analysis.