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Title: Simulating of Land Use Dynamics in Southeast Asia: A Cellular Automaton Approach

PI: Ronald R. Rindfuss (Sociology Department)

Co I's: Stephen Walsh (Geography Department)
Barbara Entwisle (Sociology Department)

Address for all three: Carolina Population Center
The University of North Carolina, Chapel Hill
123 W. Franklin Street
University Square; CB# 8120
Chapel Hill, NC 27616-3997

E-mail:
Ronald Rindfuss: ron_rindfuss@unc.edu
Stephen Walsh: swalsh@email.unc.edu
Barbara Entwisle: entwisle@unc.edu

Abstract:

This project, using recently developed cellular automaton modeling procedures and a temporally, substantively rich case study, is developing spatially-explicit model-based simulations of future LCLUC scenarios for Nang Rong, Thailand and the broader Southeast Asian region, including Vietnam, Cambodia, and China. The research draws heavily on recent work in remote sensing, demography, sociology, complexity theory, and related social and biophysical disciplines. The scenarios are based on empirically observed relationships in the following areas: a) history and spatial pattern of village settlement; b) road development, expansion of available vehicles, and changing geographic accessibility; c) migration and household formation; d) land titling and linkages to investment in various land uses; e) climate and monsoon history; f) global economic factors, including world cassava prices and the 1997 economic crisis; and g) electrification, and the accompanying rise in TV viewership and consumerism. Results of the simulations will be used to examine the spatial distribution and composition of LCLUC.

The project exploits a rich collection of interlinked data sets for Nang Rong, some of which were developed under previous NASA funding. There is a collection of previously analyzed Landsat images (TM and MSS) dating back to 1973. Other remotely sensed data available includes AVHRR, SPOT, and SAR, as well as aerial photos dating back to the1950s. Community and household level surveys are available for 1984, 1994, and 2000. Out-migrants have been followed, and in-migrants added to the data set. Digital coverages showing roads, rivers, elevation, soil types and other spatial-thematic data are available within our GIS. Daily precipitation and temperature data are available since 1965. Human dimensions and Landsat derived land use data can be linked at the village level for 1984, 1994, and 2000, and at the household level for approximately 9,000 households in 2000.

After developing, calibrating, and validating the cellular automaton modeling scenarios for Nang Rong through the use of a deep satellite time series, spatially explicit LCLUC patterns will be derived for the period 1950- 2020. We will increase the extent of our geographic reach into the surrounding region, including Cambodia, China, and Vietnam, by relating LCLUC patterns in these countries and their drivers to our scenarios for Nang Rong. These are countries with significant extant forest coverage, some of which has likely been preserved due to their difficult political and social histories in the past 50 years. While prediction is difficult, it seems that at least a sub-set of these countries is poised for substantial social and economic change, with resulting implications for LCLUC and the carbon cycle.

Keywords:

1. Research Fields: Biogeography, Demographics, Land Use Modeling
2. Geographic Area/Biome: Cropland, Southeast Asia
3. Remote Sensing: Aerial Photography, AVHRR, Landsat
4. Methods/Scales: Data Fusion, GIS, Local Scale

Questions, goals, approaches:

NASA ESE scientific questions addressed by the project: a) what are the changes in land cover/use; b) what are the causes of LCLUC; and c) what are the consequences of LCLUC.

Proportion of the project that involves social science: 75%

Proportion of the project that involves the following themes:
Carbon: 25%
Water: 25%
Nutrients: 25%
GOFC: 50%

Goals for project period (9/1/01-8/31/02), as projected in our proposal, and progress towards meeting those goals:

1. Complete spatial data entry. The spatial data entry has been completed.
2. Statistical analyses proposed as background for the CA model. Analysis is well underway on the biophysical, social and spatial factors related to village settlement patterns. A preliminary animation has been developed. A paper based on these analyses is planned, but we do not anticipate it will be completed during the current project period. Analysis on monsoonal variability has begun. We expect an interim report by the end of summer, and then we will relate it to the use of marginally suitable sites. Work on land titling has not yet begun. It is awaiting the cleaning of the recent round of social surveys which is occurring under a NIH funded project. A very simple and preliminary CA model has been developed for Nang Rong, based on some work that Messina and Walsh did in Ecuador. We are just beginning to evaluate this model. At present we do not see any gaps, issues or problems in reaching our proposed goals.

Original approach/method: Our proposed approach was two-fold. First we would use appropriate statistical analyses to develop rules to be used in the CA modeling. Then we would use CA modeling techniques. We have not made any modifications or adjustments to these methods. But we have added consideration of agent-based models for some of the modeling work. If our evaluation of the agent-based models is positive, we will incorporate them into the overall modeling effort.

Progress Report

First, we have had a good beginning. This may not sound significant, but our project, like so many in the LCLUC program, involves key project members from different disciplines, with diverse skills, different jargon sets, and located at different institutions. The team members have been identified and their roles established. A listserve has been created to keep everyone informed, allow for the free exchange of ideas, and to fix project terminology as needed. In March 20002, we hosted a workshop for project members.. A 'To Do' List was constructed which outlined tasks that needed to be completed, persons responsible for completing those tasks, and due dates for each.

The spatial data entry has been completed. The task was large in terms of production issues, but no significant theoretical or methodological problems occurred.

A village settlement pattern animation has been developed, and analysis has been proceeding on factors affecting village settlement patterns.

The analysis of monsoonal variability is underway.

A very preliminary CA model has been built, and we are examining its functionality.

Conclusions:
We have no conclusions in this, the first year, of our project.