DEMOGRAPHIC, SOCIECONOMIC, AND BIOPHYSICAL FACTORS AFFECTING LAND USE AND LAND COVER CHANGE IN THE NORTHERN ECUADORIAN AMAZON: FACTORS, STATISTICAL MODELS, AND SPATIAL EXPLICIT SIMULATIONS

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Introduction: Investigations of land cover/land use (LCLU) change and forest management are limited by a lack of understanding of how demographic and socio-economic factors combine with geographical and biophysical factors in affecting LCLU patterns and change trajectories. The Northern Ecuadorian Amazon (NEA) is a frontier region primarily transformed through household decisions at the farm-level regarding deforestation and agricultural extensification practices. Land conversion outcomes that result from household decisions are influenced by a complex set of exogenous and endogenous variables that contribute to the destruction of primary forest and the generation and retention of secondary forest and early successional vegetation.

Objectives: The specific aims of this research are (a) quantify deforestation and secondary forest succession in the Northern Ecuadorian Amazon, (b) determine the significance and magnitude of the effects of socio-economic, demographic, geographic and biophysical factors on deforestation and secondary forest succession at the farm level, and (c) use spatially-explicit models (i.e., Cellular Automata) to predict future LCLU patterns and land change scenarios interpreted within a policy-relevant context.

Data and Methods: Annual deforestation rates and proportion of secondary forest succession are quantified via satellite image processing of an assembled Landsat image time-series and geographic information system coverages of resources and geographic settings. A longitudinal socio-economic and demographic survey is used to describe the household characteristics of spontaneous colonists who have in-migrated into this frontier environment. This study uses statistical models (i.e., stepwise regression and spatial weighted regression) to associate deforestation and successional vegetation to farm and households characteristics. Two dependent variables are examined: deforested area and area in secondary forest between 1986 to 1996 and 1996 to 2002. Independent variables cover several domains, among them the *demographic composition and household life cycle* are represented by household size, proportion of persons in the household younger than 12 years old, number of males and females, and age of the head of household. Variables representing *accessibility* are represented by the distance traveled by primary road to the nearest town or market, distance traveled by secondary road to the nearest town or market, distance traveled by foot to the nearest road. *Socioeconomic* variables are represented by the percentage of people in the household with primary education, income or earnings per household per year in dollars, off-farm employment represents whether a member of the household worked outside of the finca or not, and tenancy type. *Biophysical* characteristics are represented by black soil, which indicates if the finca has a fertile type of soil and slope.

Cellular automata models (CA) are used to create spatial simulations of landscape change patterns by integrating the effects of urbanization and other land use changes on the absorption of land and the increasing fragmentation of forests and agricultural plots resulting from demographic change, increasing accessibility, and biophysical dynamics. CA are models are mathematical systems constructed from many simple identical components, which together are capable of complex behavior. CA involves a regular division of the space in cells, each one characterized by a state that represents the actual condition of the cell; the state changes according to a *transition function* that depends on the states of neighboring cells and of the cell itself. At the time t=0, cell are in states describing initial conditions. The CA evolves changing the state of all the cells simultaneously at discrete times departing from cell seeds.

Findings: The findings demonstrate the severity of deforestation, the incipient process of secondary forest succession, and the multitude of factors affecting LCLU. In the NEA we found that 116,640 hectares were deforested in the study area between 1986 and 1996 and 60,488 between 1996 and 2002, with annual deforestation rates of 1.31 % yr^{-1} and 1.03 % yr^{-1} respectively.