Multilevel determinants of indigenous land use in the Northern Ecuadorian Amazon: a cross-cultural study.

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I. Introduction

Tropical forests contain much of the world's biodiversity but are being deforested and degraded at a rapid rate (FAO, 2001), primarily through agricultural extensification and the actions of smallholder agriculturalists (Geist and Lambin, 2002). Significant attention has focused on the causes and consequences of land clearing and degradation by colonist farmers at the world's tropical forest frontiers (e.g., Walsh and Crews-Meyer, 2002). However few studies have systematically examined land use by the indigenous peoples who inhabit large areas of intact forest, despite widespread recognition of their important role in environmental conservation (Stevens, 1997). Many traditional indigenous land uses have historically been ecologically sustainable in the context of low population densities and isolation from external markets (Posey and Balée, 1989), but contemporary transformations of indigenous livelihoods include the adoption of unsustainable practices that resemble those of migrant colonists (e.g., Rudel et al., 2002), putting into question the long-term sustainability of indigenous forest management.

In this paper we focus on an important area of concern about biodiversity and indigenous peoples (the Amazon basin) and a key indigenous land use (smallholder agriculture). The highly biodiverse forests of the Amazon basin represent the world's largest tropical wilderness area, and are home to hundreds of thousands of indigenous people, many of whom maintain predominantly traditional lifestyles. Indigenous agriculture in the Amazon has historically taken the form of shifting cultivation, in which small agricultural plots are cleared from the forest, cultivated with a diverse mixture of crops, and eventually fallowed to return to forest (though management for food production continues) (Posey and Balée, 1989). As traditionally practiced, shifting cultivation has been found to maintain soil fertility, vegetative complexity, and biodiversity (Posey and Balée, 1989). However, interacting processes of market integration, acculturation, colonist encroachment, and infrastructure expansion have transformed indigenous livelihoods across Amazonia. One result has been the intensification and extensification (i.e., increases in intensity and area) of indigenous agriculture in some communities, including the introduction of cattle, cash crops, and external agricultural inputs (e.g., Vickers, 1993). For the future of indigenous livelihoods and Amazonian forests, it is important to understand the nature, magnitude, and causes of these changes.

We use data from a 2001 household survey (n = 500) and a linked community survey (n = 36) of five indigenous populations in the Northern Ecuadorian Amazon to model the determinants of agricultural land use, including the effects of socioeconomic, geographic, demographic and ecological variables on the extent and composition of agricultural plots. The use of multilevel models allows us to investigate the effects of community context on household decision making, including the role of ethnicity. Information from a parallel ethnographic field

data collection and an analysis of satellite imagery facilitate interpretation of the results. Previous research on this subject has relied primarily on qualitative case studies, although the work of Godoy (2001) and Coomes (Coomes et al., 2000) are important exceptions. This dataset offers several advantages over previous quantitative work: (1) a large sample size given the difficulties of fieldwork in this context, (2) a community data collection allowing multilevel modeling, (3) supplementary collection of ethnographic and remotely sensed data, and (4) cross-cultural data collection within one study area, allowing a test of the independent effect of ethnicity.

II. Background and Conceptual Model

This paper draws on research on land use and land cover change (LULCC), and on the cultural and political ecology of indigenous livelihoods. LULCC research has combined methods from spatial science and quantitative social science to study the pattern and drivers of deforestation and other land use changes, primarily in the developing world (Geist and Lambin, 2002). Interest has focused on households as the fundamental scale of land use decision-making. Studies of agrarian households at tropical forest frontiers have revealed the importance of land tenure, geographic accessibility, human capital, natural resource endowments, and household lifecycles and composition in determining land use (e.g., McCracken et al, 2002; Pan et al., 2004). Previous work at UNC led by Richard Bilsborrow and Steve Walsh has included panel data collection from a probability sample of colonist farms in the Northern Ecuadorian Amazon, and the linkage of these farms to land cover data extracted from remotely sensed imagery. This research has revealed rapid population growth, deforestation, and farm and forest fragmentation in the study area (Walsh et al, 2002), and raised questions about parallel changes in the indigenous communities of the surrounding forests and national parks.

We also draw on case studies and ethnographic work from the fields of cultural and political ecology. Cultural ecologists have documented the diversity of management practices, cultivars, and social relations that constitute indigenous systems of shifting cultivation, as well as the intricate agroecological knowledge that underlies them (Posey and Balée, 1989). Political and cultural ecologists have also described the mechanisms of change in these systems, including articulation with processes of acculturation, market integration, colonist encroachment, and natural resource extraction (Gross et al., 1979; Hammond et al, 1995; Santos et al, 1997). Previous work at UNC by Flora Lu Holt has detailed the common property institutions that support forest management by the Huaorani in our study area (Lu, 2001). Also relevant is the work of Godoy (2001), who has used household data from indigenous forest peoples in Honduras and Bolivia to model determinants of forest clearing, private time preference, household production, and plant and animal knowledge. Most other work in this field has been limited by small sample sizes and minimal quantitative analyses; our dataset offers several advantages, as described above.

In conceptualizing land use decision-making by indigenous households, we adopt an interdisciplinary approach. In our study area, land use decisions are made most often by (usually male) household heads in consultation with other adult members of the household, and with an awareness of possibilities to participate in external markets and of alternative economic opportunities. These decisions are made in particular local, regional, and national contexts, which are critical to understanding household land use (Shivakoti et al., 1999). To fully describe the nature of the household and the local context, we will construct a series of demographic, socio-economic, ecological and geographical variables at both household and community scales

(as the regional and national context do not vary in our study area). The use of multilevel models allows us to test many of these effects simultaneously.

III. Study Area and Data Collection

The study area is located in the Northern Ecuadorian Amazon where, following the initiation of oil exploration in the 1970s, spontaneous colonization from highland and coastal Ecuador has led to significant deforestation, urbanization, and displacement of indigenous peoples (Walsh et al, 2002). The study includes the main colonization area centered on the cities of Coca and Lago Agrio (where previous work at UNC has focused), as well as surrounding areas of largely intact lowland tropical forest such as Yasuni National Park and the Cuyabeno Wildlife Reserve. A sample of thirty-six indigenous communities was selected to be representative of the range of assimilation and market contact and to include communities from all five of the largest indigenous populations of the region (the Quichua, Shuar, Huaorani, Cofan and Secoya). Considerable diversity exists within and among these groups, including in their history and current strategies for interaction with other groups, oil companies, and colonists.

In the first phase of the study, household and community surveys along with an intensive ethnographic data collection were conducted in eight communities representing the five ethnicities. In the second phase of the study, household and community surveys were conducted in twenty-eight additional communities. Household data collection consisted of an interview with the household head (usually male) covering topics such as land use and market participation, and a separate interview with the head's spouse including questions on household composition, fertility, and household goods. Community-level interviews were conducted with a leader in each sampled community and focused on community history, infrastructure, and geographic accessibility. Global Positioning System (GPS) points were also collected at the locations of community infrastructure, sampled households, and household agricultural plots. These points have been integrated with Landsat satellite imagery and other coverages into a Geographic Information System (GIS), which will provide additional information about land use and geographic accessibility.

IV. Analysis and Hypotheses

We will model household and community-level determinants of the extent and composition of household agricultural plots using multilevel models (Goldstein, 2003). The total extent of household agricultural plots (cultivated area) will be our primary measure of the impact of indigenous households on land cover, but we will also explore other dependent variables including area of particular crops, area cleared in the last year, and diversity of crops planted. Examining the composition of plots will give us insight into tradeoffs between subsistence and commercial food production, and the effects of extensification and intensification on agrodiversity.

At the household level, we predict that cultivated area will increase with (1) household size (particularly the number of adult men), due to labor availability and nutritional requirements; (2) education of the household head, due to improved knowledge of opportunities to participate in external markets; (3) residence time in the community; and (4) age of the household head. We expect that cultivated area will decrease with participation in off-farm labor by members of the households, due to substitution effects and lower labor availability. At the community level, we predict that cultivated area will increase with (1) geographic accessibility, due to access to markets for crops sales, (2) natural resource endowments in the form of good

soil and flat lands; and (3) Shuar ethnicity, as the Shuar in this region are themselves colonists who migrated from the southern Ecuadorian Amazon. Conversely, we expect that cultivated area will decrease with Huaorani ethnicity, as they are the most traditional and unacculturated group in the region. Ethnicity and accessibility may mediate the effects of household factors, such as household size and composition; we will test for these cross-level interaction effects. In preliminary models incorporating only household-level variables, age, adult men, and education have the predicted effects on cultivated area, whereas residence time and participation in wage labor do not have significant effects; these effects may differ once community level variables have been included.

In conclusion, this unique dataset offers us the opportunity to begin to answer an important set of questions about transformations of indigenous land use, questions that have heretofore not been approached using these methods. We are optimistic that the results will have practical value for policy-makers, indigenous peoples and conservationists grappling with issues of biodiversity loss and human welfare in the Amazon and elsewhere.

VI. References

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