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# POPULATION CHANGE, LAND USE, AND THE ENVIRONMENT IN THE ECUADORIAN AMAZON

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## I. Introduction

Population dynamics--growth, movement and changes in composition and characteristics--are among the many socioeconomic and institutional forces that are altering the face of the earth. The effects of these forces on tropical deforestation have become a major concern as pristine old-growth forests are converted to agricultural and other land uses. The focus on tropical forests is well justified, given the roles they appear to play in hydrological cycles and global climate change, and the high biodiversity they embody, with as much as 50% of all the planet's species living in them according to some estimates. Concern about the fate of the forests is thus tied to the important global ecological services they provide.

A growing body of research on the contemporary agricultural frontier has illuminated key factors leading to forest loss. Migrant farmers are identified as the major proximate actors in the ongoing process of deforestation in tropical rainforest areas throughout the developing world (World Bank, 1991; FAO, 2001). This is undoubtedly true in our study area, the Ecuadorian Amazon. However, it was the discovery of petroleum and the construction of roads to lay oil pipelines that opened up the area to an influx of land-hungry colonists. The loss of forest cover in the Ecuadorian Amazon -- at 1.8% per year, the highest of any country's Amazon-basin -- is of particular concern because of the region's extraordinarily high biodiversity. Research on land use suggests a dynamic, multi-dimensional nature of household decisions regarding land and other resources, and can propose how farm managers and owners respond to policies within larger political and economic forces.

The purpose of this paper is to summarize and review key findings from ongoing research of land use and land cover change (LULC) in the Ecuadorian Amazon based on a probability sample of farm plots as well as biophysical information collected via a time series of satellite images. We will examine key factors thought to be responsible for the decline in tropical forests, such as road construction, expansion of towns and communities, individual and household factors, and quality and quantity of landholdings. We will also briefly summarize remote sensing research and the results of studies on women's participation in agricultural work and deforestation, household income and wealth, and factors influencing in- and out-migration among migrant settler children.

The organization of this paper is as follows: Section II describes project objectives, section III the sample selection and data collection, and section IV key characteristics of the

sample population and how they have changed over time. Section V examines the main findings from studies of land use change based on the 1990 and 1999 data, and section VI findings from other studies on the settler population. Section VII discusses some of the broader issues pertaining to directions for future research and policy.

## II. Purpose of Project

### *Theoretical Approaches*

This paper stems from research based upon panel data from a probability sample of migrant settler plots in the Ecuadorian Amazon for which data were collected through household surveys in 1990 and 1999. The studies were conducted to help untangle the complicated and intricate population-environment interrelationships that have been recognized in a growing body of literature (e.g., Bilsborrow 1987, Marquette and Bilsborrow 1994, Jolly 1994, Moran et al. 1994, Wood and Skole 1998, Walsh et al. 1999). Various theoretical approaches have been proposed ranging from a neo-Malthusian view that population growth leads to environmental degradation through extensification of land use; a neoclassical economics framework focusing on the effects of population on labor supply, wages and prices; Boserupian responses of innovation and increased intensity of land use stimulated by increased population density; and a "regional political ecology" approach (Blaikie and Brookfield, 1987), in which resource use decisions of households are linked to broader socio-economic processes. The neo-Malthusian view and dependency theory approaches have received only modest support in the literature (Boserup, 1965, 1981; Marquette and Bilsborrow, 1994; Jolly, 1994), while Boserupian responses have been observed in a number of locales, but generally those with particularly propitious cultural and natural resource endowments (e.g., Netting, 1993, on the Kofar in Nigeria) or policy environments (e.g., Tiffen and Mortimore, 1994, on the Machakos district in Kenya; Lele and Stone, 1989, on three of six African countries). Because of the importance of the context in which population growth occurs on affecting the type of response, a more comprehensive approach is desirable in which the impacts of a growing and changing population on the environment are viewed as multifaceted and mediated by population, technology, geographical and biophysical characteristics, public policies and socio-cultural factors (Bilsborrow, 1987; Bilsborrow and Geores, 1992; Jolly, 1994). The regional political ecology approach integrates the complex and hierarchical nature of relationships among people, their institutions, and natural resources. In addition, the relevance of spatial patterns have been taken into account by explicitly locating individual actors within their physical landscape, thus relating resource use decisions to natural characteristics such as soil quality, terrain, and climate (Forman and Godron, 1986) as well as human-created infrastructure, including roads and what the roads lead to of interest.

### *Research Justification*

Frontier settlements in tropical forests from Brazil to Indonesia to Ghana have been a focus of research in recent decades, as agriculture frontiers have expanded into pristine forests. Economic approaches to understanding settler household behavior have emphasized the rational (or 'satisficing') decision-making processes of farm households in relation to available resources (land extent, soil, labor, technology, markets). These are complemented by a growing number of studies which examine household demographic features—characteristics of farm households that affect family labor supply, a vital resource

for most settlers in the labor-scarce, land-abundant frontier. Analyses of household composition, type of household and domestic cycle have been the focus of studies on deforestation in Ecuador (Marquette, 1995) and Brazil (Walker and Homma, 1996, and others cited below). Recent findings from Brazil highlight some of these combined economic, demographic and geographic approaches to modeling land use (McCracken et al, 1999; Moran et al, 2001; Perz, 2000).

In the case of Ecuador, several studies at the University of North Carolina, Chapel Hill (based on 1990 survey data, the baseline for the present study) shed light on similar processes. For these studies, a micro-level conceptual framework centers on the household to capture the complex confluence of forces that shape land use decisions by the 'land manager'. Three key categories of factors are: the natural resource base (land area, soil quality, terrain), local infrastructure and institutions (roads, transport, credit, technical assistance); and individual and household characteristics (household size and composition, labor supply, migrant origins, education). In the frontier, the abundance of land relative to labor encourages settlers to aspire over time to land-extensive and labor-saving activities, such as cattle-raising. At the same time, the particular risks of frontier farming lead settlers to minimize risk through diversifying crops on the farm and seeking other income sources off the farm. Drawing on this general approach, numerous studies have been undertaken on the determinants of plot-level deforestation and land use, women's roles in agriculture, settler income and livelihoods, and other topics. These studies are summarized in sections 5 and 6.

## III. Data Collection

Data have been collected from a representative probability sample of migrant farm settler plots originally selected in 1990 and revisited in 1999, in the two northern Ecuadorian provinces of Sucumbios and Orrellana. In addition, a satellite time series has been collected and processed to show changes over time from the 1970's to 2000 at a regional scale. Selected remote sensing analyses will be discussed, but the focus will be on the survey data. In June 2000 a community-level survey of community leaders and informants was carried out in 55 communities in the region, providing data on towns and infrastructure–the context within which the migrant farmers are making land use decisions.

### *Study Area*

Ecuador comprises three distinct regions: the western coastal lowlands, the central highlands or Sierra, and the eastern Amazon lowlands (the "Oriente"), the northern portion constitutes our study region, in the current provinces of Sucumbios, Napo and Orellana. These Amazon lowlands, along with those east of the Andes in Peru, constitute one of the world's eleven "hot spots" of high biodiversity (Myers, 2000). Unfortunately, the region is suffering rapid deforestation associated with oil exploration and extraction and related population growth and socioeconomic change. According to census data from the government statistical office (e.g., INEC, 1991), the population of the Amazon region grew at over double the national rates during the last two intercensal periods, that is, at 8% per year in 1974-82 and at 6% per year in 1982-90. In fact, between our household surveys in 1990 and 1999, the (rural) population of the sample plots grew from 2761 to 4330, while forest cover fell from 55% to 33%. As the next census is not scheduled until November, 2001, there is no more recent information, although the only "national" demographic

survey ever carried out in Ecuador that included the Amazon region recently found its fertility to be far higher than elsewhere (TFR of 5.5 vs. 3.4 for the country as a whole (CEPAR, 2000). The region's population has increased considerably since the discovery of significant oil deposits in 1967 near Lago Agrio, and now accounts for about 5% of Ecuador's total population. While the peak of in-migration to the northern Oriente occurred in the late 1970's, data from our surveys indicate that in-migration as well as high natural population growth are both continuing. Almost half the region's population was born outside the Oriente, according to both the latest census (INEC, 1992) and our surveys.

Ecuador's northern Amazon has been settled mostly by migrant families coming from rural areas of the densely populated Sierra in search of farmland. The initial wave of migrants was closely linked to oil discoveries and extraction. In 1967, after decades of exploration, major oil reserves were identified in Sucumbios province near what would become later the town of Lago Agrio (Nueva Loja). Subsequently, since the early 1970's oil revenues have provided over half of Ecuador's export earnings and a similar share of central government revenues. Since the early 1970's, oil companies (rather than the government Ministry of Public Works, which builds roads elsewhere) have constructed roads into the forest lowlands to lay pipelines and connect wells to the pipeline network. This opened up vast forest areas to settlers. In contrast to Brazil, settlement has thus been almost exclusively *spontaneous,* rather than government-sponsored. Migrants settled along the oil roads, with successive arrivals claiming land behind the farms along the roads, forming successions of parallel lines of farms known as *respaldos*.

Once a group of settler families had moved into an area, they had to form "*precooperativas*" to ask the government Land Reform and Colonization Agency (IERAC) to come to survey their plots and delimit plot boundaries. This was the first step towards seeking a land title, which usually involved two further stages, first purchasing a temporary title ("*certificado de posesion*") and then later a permanent legal title, called an *escritura*. In the case of the Ecuadorian Amazon, unlike Brazil, large-scale commercial agriculture, ranching and logging have not played major roles, with most forest clearing at the hands of small farmers. This provides a better scenario for examining the roles of demographic factors relative to others in LULCC. The main ecological conditions of the study region should also be noted. Again, in contrast to Brazil, soil conditions are somewhat better yet highly variable: Pockets of high fertility volcanic soils and rich alluvial soils alternate with poor quality red soils with high acidity and aluminum toxicity throughout the study area. Ecuador's Amazon also benefits from a year-round growing season, requiring the use of slash and mulch clearing practices, with little burning. However, by the late 1990's there is growing evidence of micro-climate changes in some areas, perhaps due to the loss of vegetation (drier conditions in certain months than before), making possible burning.

***Household Data Collection***

The research is based upon panel data from a probability sample of migrant settler plots for which data were collected through household surveys in 1990 and 1999. A sample of 470 farm plots (referred to hereafter as the original "mother farms" or *fincas*) was selected in 1990 using a two-stage sampling procedure with lists of settlement areas by number of *fincas* together with property maps, available from the government land reform and colonization agency, IERAC, constituting the sample frame. The first stage (primary sampling unit) was the area (referred to as a "sector") which farmers were allowed to settle on. Farmers in a sector would then form a "*precooperativa*" to seek delimitation of their

plot boundaries from IERAC so they could later apply for land titles to their plots (usually 50 hectares—250m x 2km). In the sample frame, settlement sectors were listed in order of creation by number of *fincas.* These were cumulated, and sectors were then selected with systematic sampling, resulting in a first-stage sample of 64 sectors. In the second stage the number of *fincas* selected from each sample sector was based on the size of the sector (number of *fincas*) to ensure approximately equal probabilities of selection through PPS. The number of *fincas* selected per sector varied from 5 to 10. The total final sample size was 470. The most important characteristic of the sample is that it is a probability sample representative of the entire rural population of the main area of colonization in the Ecuadorian Amazon. (An estimated 5.9% of the rural population was included in the survey). Surveys of households in tropical rainforest regions in other countries have been based upon quota or convenience samples (e.g., along a road) and/or have significantly smaller sample sizes.

The original 1990 household survey used two questionnaires - one for the (usually male) economic head of the farm household and one for the spouse. The head's questionnaire covered land acquisition and titling, land use and agricultural production, agricultural inputs and technology, commercialization, livestock, hired labor, off-farm employment, technical assistance and credit received. The spouse's questionnaire included household composition, out-migration from the household and mortality, fertility and contraceptive use, illnesses and health care, dwelling quality, and household possessions. Both respondents were asked about their own migration and work history, future aspirations, and attitudes to life in the frontier. Despite the length of the questionnaire (interviews lasting often an hour each), the refusal rate was only 3%, although there were a number of other plots which did not report data since they did not yet have any agricultural activity (being bought by land speculators) or which, even with some activity, had no one living there. The final completed sample size was 418 household farm plots, located on 405 *fincas*.

A follow-up survey was carried out in 1999 on the same *fincas,* thus constituting a *panel survey of areas*. All households residing on the plots visited in 1990 were interviewed, both heads and spouses, as before. We were surprised to find that the number of households living on the plots to have increased enormously in the interim, through both subdivision among heirs and sales to in-migrants. In several sectors, parts of plots had become residential/urban lots (*solares*). A total of 950 questionnaires were administered to heads of household and 787 to the spouses of heads. This led to completed information for 823 farms (including all subdivisions of at least 0.5 ha.) as well as abbreviated data for 108 *solares;* another 19 of the original plots are now classified as schools, parts of plantations, or other land uses reflecting an increasingly complex mosaic of land use as towns and infrastructure expand in the region. Response rates for the head and spouse questionnaires were 93% and 97%, respectively, with the final completed sample being 768 farm household units. In addition, GPS readings, processed satellite imagery, roads, topography, soil and political maps were collected and integrated into a Geographic Information System, enabling the production of maps and spatial analyses of land use at larger scales.

***Community Data***

A second level of survey data was collected in 2000 from *communities* in the study area. The community sample was linked directly to the household sample by selecting communities based upon the frequency of responses of women interviewed in each sample

sector regarding where they or their family usually went for health care, to purchase food, to attend school, and to attend church. The spatial location of communities relative to that of sample sectors and households was therefore fundamental, as are the size of communities and the resulting availability of the four types of services/markets and other infrastructure. A representative sample of 58 communities linked to households throughout the study region was selected ranging in size from many with only a primary school, a small store or tienda, and possibly a church to the largest city in the Ecuadorian Amazon, Lago Agrio, with a population of about 30,000 in 1999. All of the significant towns were included in the survey by this procedure, as well as many small ones that also constituted "reference communities". Interviews were always conducted with more than one person in each community, usually in small groups to reduce respondent bias. Data were obtained on a range of topics, including population size and growth since 1990, in- and out-migration, main economic activities, principal crops and prices, land tenure and distribution, transportation linkages to large towns, fertility and health care, and a variety of facilities/infrastructure, including how long it had existed in the community.

***Biophysical data***

Although the Ecuadorian Amazon generally has better soils than the rest of Amazonia (e.g., much of Brazil) -- which is characterized by sedimentary soils of low fertility, high acidity, and aluminum toxicity -- it is still subject to a rapid decline of nutrients from agricultural use, particularly when the ground is not covered continuously by vegetation. Pockets of high fertility volcanic soils and rich alluvial riverine soils alternate with poor quality red soils throughout the study area. Much of the land is also surprisingly hilly and susceptible to soil erosion, and most is easily compacted by cattle. Data were collected in a satellite time series that extends from 1973 to 1999, mostly Landsat TM images (and now some 1999 Ikonos data). Standard geometric and radiometric corrections have been applied for image rectification, followed by land use classifications generated for information extraction and image change-detection for characterizing LULC dynamics. Analyses based on the bio-geo-physical data are not described here but are found in a number of presentations and papers by Walsh, Messina, et al elsewhere.

## IV. Characteristics of the Survey Population

### Household Demographic and SES Characteristics of Settlers[1]

The total population of the study site has risen from 2761 to 4330 persons between 1990 and 1999. Table 1 shows the agro-ecological zone of birth for heads of household in 1990 and 1999. In 1990, nearly 95% of household heads were born outside the Ecuadorian Amazon, while in 1999 this dropped to 85%. The most significant change was the increase from 4% to 10% of heads originating from the study area. However, in regard to overall population increase, Table 1 shows that between 1991-1999, 87% of "Recent Owners" migrated into the region. This is a clear indication that population change is still being controlled primarily by migration rather than natural population growth. We should also

[1] Statistics reported for the 1999 survey are based on a sample size of n=765, which reflects the number of surveys linking households and farms, unless otherwise noted.

point out that the 58 Recent Owners hailing from the Amazon region are primarily second-generation settlers–i.e., children of migrant farmers inheriting part of their parent's farm.

**Table 1: Birth Origin of Household Head 1990 vs. 1999 and Previous vs. Recent Owners, 1999**

| Location | 1990 | | 1999 | | 1999 | |
|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | Previous Owner (before 1990) | Recent Owner (1991-1999) |
| **Coast** | 79 | (19%) | 151 | (20%) | 55 (17%) | 96 (22%) |
| **Highland / Sierra** | 317 | (75%) | 508 | (66%) | 232 (72%) | 276 (63%) |
| **Southern Amazon & Columbia** | 7 | (2%) | 28 | (4%) | 17 (5%) | 11 (2%) |
| **Study Area** | 15 | (4%) | 78 | (10%) | 20 (6%) | 58 (13%) |
| **TOTAL** | **418** | | **765** | | **324** | **441** |

The number of households in the sample region has increased, corresponding to the region's growing population, but average household size has changed little. On average, frontier households remain considerably larger than households elsewhere in Ecuador (6.6 in 1990 for the sample versus 5.4 nationally, and 6.5 in 1999). Sex ratios (males/females) have moved towards equality (1.2 in 1990, 1.06 in 1999) and the dependency ratio[2] decreased from 0.84 in 1990 to 0.66 in 1999. The former may suggest that out-migration of daughters of settlers has slowed since 1990.

Overall, the population remains young, with little change in the mean age of household heads and spouses (44 and 39 in 1990, 43 and 37 in 1999, respectively). Education levels for heads and spouses increased between 1990 and 1999. Although only 7% of heads had no education in both years, the percent of heads having at least one year of secondary school rose from 5% to 13%.

## Institutional Factors and Infrastructure

The ability to obtain a title and secure a farm holding was much more effective in 1990 as indicated in Table 2. Here we see 50% of migrant farmers in 1990 with full legal title, a figure that dropped to 34% by 1999. Another 17% in 1999 have a certificate of possession or had their land surveyed, which provide some degree of security but does not legally allow resale, nor provide collateral for loans. This decline in the proportion of titled land holdings is attributable to the change in the Ecuadorian land-titling agency.[3] Fortunately, lack of legal title per se does not translate into tenure insecurity, does not seem to affect resale, or even directly affect land use. Many transactions involve an exchange among kin or friends, with implicit *de facto* contracts and rights of use.

[2] The Dependency Ratio is calculated as the number of children under 12 divided by the total number of adults.

[3] This change, in 1993, was from an effective agency (IERAC) working actively out of local offices in Lago Agrio and Coca to an ineffective agency (INDA) with less funds, operating only out of Quito offices.

**Table 2: Land Tenure**

| Location | 1990 | | 1999 | |
|---|---|---|---|---|
| | N | (%) | N | (%) |
| **Full Title** | 208 | (50%) | 259 | (34%) |
| **Certificate of Possession / Provisional Title** | 179 | (43%) | 94 | (12%) |
| **Surveyed only** | X | | 40 | (5%) |
| **No Title or Claim** | 27 | (7%) | 372 | (49%) |
| **TOTAL** | **416** | | **765** | |

For both years, family labor remains the greatest contributor to farm production. However, there has been a significant shift from hiring labor on essentially intact fincas to selling household labor via off-farm employment (OFE). Table 3 demonstrates this, with a decrease from 60% to 41% in farms hiring outside labor and an increase from 35% to 51% in the percentage of households with one or more members engaged in OFE. Participation in OFE is affected negatively by plot size and positively by education and consumption aspirations (Murphy, 1997). In addition to farm households (the focus of this paper), 108 non-farm residential households (*solares*) found on sample fincas in 1999 were interviewed, with 95% reporting OFE. This is a significant change from 1990, which was characterized by a labor-shortage, and indicates the growth of urban areas and the increased integration of rural and urban production systems, which is also evident in the data collected in the community-level survey.

Another change affecting the landscape is the reduction in technical assistance. In 1990, 32% of households reported having received technical assistance but by 1999, this fell to 19%--probably due to cuts in government programs. On the other hand, the use of bank credit has remained about the same, with 18% of the sample population reporting loans.

**Table 3: Labor, Technical Assistance, and Credit**

| Location | 1990 | | 1999 | |
|---|---|---|---|---|
| | N | (%) | N | (%) |
| **Hired Labor** | 243 | (60%) | 315 | (41%) |
| **OFE** | 143 | (35%) | 390 | (51%) |
| **Received Technical Assistance** | 135 | (32%) | 146 | (19%) |
| **Received Credit** | 78 | (18%) | 172<br>136 | (22%)<br>(18%)[1] |

1 – Farmers reporting loans between 1991-1999

Road infrastructure has improved in the study site, both through expansion and paving of primary roads and grading and construction of secondary roads. While in 1990 45% of farms reported primary or secondary road access, in 1999, 63% of farms reported such access (in part due to subdivisions of farms being concentrated along roads, but also due to expansion of roads, as 51% reported the construction or improvement of roads affecting them since 1990).

Table 4 compares the change in distance between farms, roads, and markets. Distances

for each measure have decreased considerably, lending credence to the improved road infrastructure. Accessibility to markets is probably a key factor in land use. Distance along a road served by buses is one modest obstacle: travel by canoe, however is expensive and inconvenient, while travel by foot over muddy paths to second line farms (2 km from the road) or those further away is arduous. Thus, non-road travel faced by half the sample is likely to be reflected in land use and agricultural production.

**Table 4: Distance Measures**

| | **1990 (N = 418 HH's)** | **1999 (N = 765 HH's)** |
|---|---|---|
| **Average Total Distance to Market** | 28.2 Km | 20.4 Km |
| **Road Distance to Market** | 24.2 Km (N=394) | 19.0 Km (N=734) |
| **Walking Distance to Road** | 5.3 Km (N=214) | 2.6 Km (N=357) |
| **Distance by Canoe to Market** | 34.1 Km (N=35) | 18.7 Km (N=30) |

In 1990, over half of the colonists interviewed had purchased their plots from another settler, while the other half were the original settlers, and had acquired their farms from IERAC. Among "Recent Owners" in the 1999 survey (N=441), 52% had acquired their farms by buying them from another colonist or bank, 24% had inherited it, 13% were renting, and the remainder were occupying the plot or acquired the farm though other means. Less than 2% of the farms acquired between 1990 and 1999 were adjudicated through the government land agency.

## Natural Resource Base

The distribution of plot sizes is depicted in Table 5. The fragmentation of farm plots by 1999 is due to subdivision. Heads subdivide for various reasons, such as to provide an inheritance for children, lending parcels to recently migrated family members (brothers, uncles, cousins, etc.), and renting out parcels to seek additional income through rent.

**Table 5: Plot Size**

| **Size (Ha)** | **1990** | | **1999 (N=765)** | |
|---|---|---|---|---|
| | **N** | **(%)** | **N** | **(%)** |
| **< 5** | 9 | (2 %) | 191 | (25 %) |
| **5 - 9.9** | 8 | (2 %) | 106 | (14 %) |
| **10 – 19.9** | 20 | (5 %) | 89 | (12 %) |
| **20 – 29.9** | 34 | (8 %) | 79 | (10 %) |
| **30 – 49.9** | 174 | (42 %) | 201 | (26 %) |
| **50 – 89.9** | 166 | (40 %) | 98 | (13 %) |
| **≥ 90** | 7 | (2 %) | 1 | (0.1 %) |
| **Mean plot size** | 43.6 | | 23.3 | |

Edaphic factors such as soil and topography usually affect agricultural practices. Since the plots are the same in 1990 and 1999, major differences should not be found. However, subdivision of farms appear concentrated on areas with good soils and flat land, as the share reporting black/fertile soil rose from 44% to 58%, while those reporting hilly land fell from 31% to 10%.

## Land Use

Overall land use patterns in the sample reveal a process of continuing extensification over time, with the cultivated area increasing at the expense of forest cover. In 1990, an average plot was 44 ha with 24 ha (56%) in forest, 7 ha in pasture, 7 ha in perennial crops, 3 ha in annual crops, and the remaining 3 ha in fallow or swamp. By 1999, the average plot (with much more variation) was 23 ha, with only a third or 7.5 ha in forest, 4 ha in pasture, 5.5 ha in perennial crops, 3 ha in annual crops, 2 ha in fallow, and 1 ha of swamp.

Coffee is less common in 1999 with only 82% of farms growing any (alone or inter-cropped), versus nearly universal growing in 1990, doubtless due partly to coffee prices dropping in the 1990´s. Most farms grow annual crops for family consumption and not for market sale, so the areas tend to change little, although those raising corn fell from 45% in 1990 to 25% in 1999.

Cattle ownership is expected to spread over time in areas on the agricultural frontier, which has been generally observed in Latin America (Carr and Bilsborrow, 2000). Cattle are a desirable, multi-purpose asset that provides milk, cash income, a form of savings, and collateral that can be used to secure loans. But this expansion has not occurred in Ecuador, probably due to the process of plot fragmentation that made many farms too small to support extensive land use practices such as cattle raising. Table 6 shows 57% of farms owning cattle in 1990, two-thirds owning fewer than 8 head, in contrast to 41% of farms in 1999 owning cattle, 80% with fewer than 9 head. From the data in Table 6, we can find that 29% of the farms with fewer than 30 ha had cattle versus 57% of those with more than 30 ha. The total number of cattle on all sample plots fell from about 2800 in 1990 to 2100 in 1999.

**Table 6: Cattle and Pasture Land by Plot Size, 1990 vs. 1999**

| Plot Size (Ha) | 1990 | | | | 1999 | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Own Cattle (N) | Mean No. Head | Mean Pasture[1] | N | Own Cattle (N) | Mean Heads | Mean Pasture[1,2] |
| **< 10** | 17 | 3 | 1.6 | 0.6 | 297 | 60 | 2.5 | 1.5 |
| **10 – 19.9** | 20 | 8 | 3.3 | 3.8 | 89 | 39 | 3.8 | 6.4 |
| **20 – 29.9** | 34 | 16 | 6.5 | 5.8 | 79 | 35 | 4.4 | 9.2 |
| **30 – 49.9** | 172 | 103 | 8.3 | 9.8 | 201 | 121 | 8.7 | 13.8 |
| **≥ 50** | 170 | 106 | 17.0 | 16.6 | 99 | 56 | 10.5 | 19.0 |
| **Total** | **413** | **236** | **11.9** | **12.3** | **765** | **311** | **6.8** | **10.9** |

1 – Among farms owning cattle; 2 – Includes area in fallow and swamp

## V. Main Findings on the Determinants of Land Use, 1990 and 1999

***Studies on Land Use***

Pichón and Bilsborrow carried out analyses of the determinants of land-use by migrant settler households based on the 1990 survey data. They examined the effects of the head's characteristics, family size, location of plot, plot size and natural resource conditions using Seemingly Unrelated Regression Equations, SPSS clustering and multinomial Tobit methods (Pichón, 1993, 1997; Pichón and Bilsborrow, 1999). The dependent variables used were the proportions of land in four different forms of land use (forest, pasture, perennial crops and annual crops). Pan and Bilsborrow conducted similar studies based on the 1999 data.

***1990 Findings***

Several early studies explored the determinants of household-level land clearing using a various statistical techniques. Ordinary least squares (OLS) regression models examined the effects of land, household labor and other factors on the percentage of the settler household plot cleared, finding better soil associated with more cleared land, and distance from roads and towns (access to markets) with less clearing. More involvement in off-farm work was found associated with a lower cleared area, suggesting possible substitution of off-farm activity (wages) for on-farm income.

Pichón (1997) extended this single-variable model to one in which land is viewed as allocated by a farm household to several, specific uses: annual crops, perennial crops, pasture (for cattle), and the remaining areas left in forest. He showed that studying the effects of settlers on land use requires examining more than just the total cleared area, but also the specific combinations of land uses. He this estimated a system of four regression equations, to simultaneously model: (1) Annual crops, (2) Perennial crops, (3) Pasture/fallow, and (4) Forest. The results are similar to those reported below in Pichón and Bilsborrow (1999), and therefore not discussed here.

***1999 Findings***

In research based on the 1999 survey data, Pan and Bilsborrow (2000) characterized land use changes from 1990 to 1999 using data on land use reported in 1999 at the *finca* level. Taff and Bilsborrow (2000) examined the inequality of landholdings in 1999 based in part on Gini coefficients, work which has been extended by Pan, Bilsborrow and Taff recently, leading to estimates of Gini values for 1999 of 0.50 and 0.48, depending on how rental land is treated. Due to the greatly increased number of farm subdivisions since 1990, and the original IERAC policy of allocating equal size plots of about 50 Ha to each family starting in the 1970's, we expect to document a significant increase in landholding inequality from 1990 to 1999. This would be the first such demonstration in a frontier area of a developing country as far as we know.

Pan et al (PAA 2001) examined the determinants of land use in 1999 at the household level based upon a general linear multivariate model using a set of four censored dependent variables (hectares of land in pasture, forest, perennial crops, and annual crops). The cross-sectional model is similar to that of Pichón, and most results were similar. However, a few changed, suggesting both stability and change over time in the factors affecting LULC. In general, demographic factors (children, age and place of head's birth) have strong effects on the relative shares of perennial and annual crops; farm characteristics (black soil, flat

topography, and distance) exhibit strong effects more generally; land tenure and duration of settlement affects perennials and annuals; and labor inputs (household labor, hired labor, and off-farm employment) affect all land uses equally.

***Preliminary Comparisons of Findings over Time***

A more sensitive analysis of the factors causing changes in land use over time requires the analysis of longitudinal or panel data linking households, plots, or *fincas* over time. This analysis has not yet been performed, and is complicated by the task of linking data sets over time. However, it is possible to make a few preliminary comparisons that may provide insight into some of the changing dynamics of land use in the Ecuadorian Amazon in 1990-1999. To compare the results, one must recognize that there are differences in the definitions of dependent variable and a few independent variables that need to be taken into account (Table 7). The major differences result from the definitions of the dependent variables, which are proportions in Pichón and areas in ha in Pan et al. Thus plot size for the 1999 analysis is a control variable, which should not affect the comparability of results for the remaining variables. A few variables (not shown) were also included in the Pichon model that we exclude in the 1999 model because of suspicions regarding their endogeneity.

Table 7 provides a preliminary look at similar variables used in each of the models and their effects on land use. Demographic variables such as region of origin, education and household size do not have consistent effects over time, with number of consumers in 1990 having a strong negative relationship with forest cover, as theoretically expected by Malthusians, but not in 1999. However, the signs of the modest effects of Children in 1999 are as expected, as children eat annual crops but not coffee. The overall weakness of demographic variables in 1999 may result from their effects being already captured by other included variables, notably household labor and plot size (reduced by subdivisions, linked to population pressure).

The different effects of ecological factors such as soil and topography may also be due to subdivisions since flatter areas tend to be closer to roads and more likely to experience subdivisions. The distance variables continue to be the most powerful factors of all, especially the effects of walking distance on forest cover. Plot size has been discussed above, with its effects in the 1999 model functioning mainly as a control variable, with larger plots having more land in all forms of land use. Duration of residence has fairly consistent effects, as does owning additional land (better measured in 1999). Having legal title to the land appears to have different effects, but this may be due to its being correlated with duration of residence. The last three variables measure labor availability on the farm and off. The results for the two time periods are nearly identical, indicating the importance of labor availability in land use decisions of these migrant farmers living in essentially a labor-scarce environment. Thus both more household labor and hired labor is linked to more land in annual and perennial crops, but not to pasture land, as is expected given the low labor demands of raising cattle. And the more household labor is allocated to off-farm employment, the less is available to work the land, resulting in fewer perennial crops (coffee requires a lot of labor to pick the beans by hand) and more land in forest.

**Table 7. Multivariate analyses of land use patterns. (1990 results from Pichón and Bilsborrow 1999; 1999 results from Pan et al 2001)**

| 1990 vs. 1999 Variable Definition | Perennial Crops | Annual Crops | Pasture | Forest |
|---|---|---|---|---|
| **Non-Native (90) vs.** | + ** | - * | NS | NS |
| **Born in Oriente (99)** | NS | + * | - * | NS |
| **Education of Head** | NS | + *** | + *** | NS |
| | NS | NS | NS | - *** |
| **Consumers (90) vs.** | + *** | NS | + * | - *** |
| **Children (99)** | - * | + * | NS | NS |
| **Good Soil (90) vs.** | + ** | + ** | NS | - *** |
| **Black Soil (99)** | NS | + *** | NS | NS |
| **Hilly (90) vs.** | NS | - *** | - *** | + *** |
| **Flat (99) Terrain** | NS | + *** | NS | - *** |
| **Plot Size (ha)** | - *** | - * | + * | + *** |
| | + * | + *** | + *** | + *** |
| **Road Distance to Market (km)** | - *** | NS | NS | + ** |
| | NS | NS | - *** | + *** |
| **KM Walking to Road (90) vs.** | - *** | - ** | - ** | + *** |
| **Need to Walk (99)** | NS | NS | - *** | + * |
| **Years Living on the Farm** | NS | NS | + *** | - * |
| | + *** | NS | + *** | - *** |
| **Title** | - *** | - *** | NS | + ** |
| | NS | NS | + *** | - *** |
| **Own Multiple Plots (90) vs.** | NS | NS | - *** | + *** |
| **Ha of Additional Land (99)** | - *** | - *** | NS | NS |
| **Household Labor** | + *** | + ** | NS | - *** |
| | + *** | + * | + * | - * |
| **Hired Labor** | + *** | + ** | NS | - *** |
| | + *** | NS | + *** | - *** |
| **Off-Farm Employment:** | - *** | NS | - *** | + *** |
| **Months (90) vs. Earnings (99)** | - *** | NS | NS | + *** |

Statistical significance: * p<0.05; ** p<0.01; *** p<0.001; NS = Not Significant.

## VI. Related Results

Several studies utilizing the 1990 household survey data as well as the satellite imagery time series data have also enhanced our knowledge about population and its relationships with the environment in the Ecuadorian Amazon.

***Women's Agricultural Activities in the Amazon***

Thapa et al (1996) examined the link between women's roles in frontier agriculture and tropical deforestation (area cleared and proportion of land devoted to different forms of agriculture). In the Ecuadorian Amazon it was found that women are almost always involved to some degree in agriculture, from decisions about land use to active participation

in planting, harvesting, care of the family garden or "huerta" or small animals such as chickens, etc. But the extent of this involvement varies greatly. The authors fit a 2-equation recursive model that predicts person-months of hired labor in equation 1, and an indicator of women's involvement in planting, harvesting or both on the farm in equation 2. The model is developed based upon a review of the limited literature on the determinants of women's agricultural work, to hypothesize that women's participation in agricultural activities on the frontier depends upon:

(1) Land use - both total area cleared and the proportion of land in crops,
(2) Household on- and off-farm income,
(3) Household consumption needs - household size and composition,
(4) Other household labor on the farm (most adult males),
(5) Number of children living on the farm, and
(6) Individual characteristics of the woman, such as her age, education, and previous experience working on a farm.

(1) and (3) indicate the demand for farm labor, including that of women, while (2) indicates whether it is necessary for women to work and (4) – (5) indicate other sources of family labor that may substitute for women (and vise versa).

The findings indicate that total land cleared was not an important variable, but the area devoted to crop cultivation was strongly associated with the participation of women. Off-farm income and labor hired from the outside had the expected (significant) negative effects on women's participation. Both reflect the decreased need for women to participate in farm labor, but the latter also reflects the household's ability to hire labor and replace women's labor with hired (male) labor. Two unexpected findings were that an increase in children *increased* women's participation and that the total number of adults did not affect it. The former indicates that women are burdened by duel roles of bearing and raising children while simultaneously participating in agricultural work. A woman's individual characteristics are also important-- higher age and education have the expected negative effects, since on the frontier older or more educated women tend to have others around to work or find other forms of employment suitable to their education level. Previous agricultural experience for women, such as in her place of previous residence before coming to the Oriente, had a strong positive effect on participation.

***Settler Fertility***

Thapa and Bilsborrow (1995) conducted an analysis of fertility among settler women and explored possible changes in fertility over time. They found the mean number of "children ever born" (CEB) for all settler women was 4.9, twice that for Ecuador as a whole (2.5) and higher than that of rural Ecuador (5.5) (CEPAR, 1988, Cuadro 3.8). The total fertility rate (TFR) for settler women, estimated using indirect methods, was 8.0 children per women. The effects of frontier residence per se on fertility were explored by comparing estimates of completed fertility among three groups of wives in frontier households: (1) those who had completed childbearing before migration (group 1); (2) those who had started child-bearing before migration but completed it only after migration to the Amazon; and (3) those who had started and were continuing child-bearing in the Amazon. Completed fertility was estimated by summing the total number of "children ever born" (CEB) to women in the different age groups and their "desired number of additional children." Older women (group 1) reported 8.5 estimated completed births, a figure higher

than the 7.2 for group 2, and much higher than the 4.3 estimated for group 3. The results cast doubt on the belief that frontier settlement and the access to land it provides stimulate fertility, and suggests instead that women's family size desires are determined earlier in life, and indeed that migrant women are selected for lower fertility. An alternative explanation is that since women in groups 2 and 3 tend to be younger, their lower fertility may indicate that, on the frontier as elsewhere, women with slightly higher education and changing aspirations desire smaller families. Indeed, better educated (generally younger) frontier women have significantly fewer CEB (mean of 3.2) than women with no education (8.2). Further work is needed to clarify both levels of frontier fertility and their relationship to migration and education.

In any case, the study also found that settler women lack access to modern family planning services since there were only a few scattered health centers and no family planning agency in the region in 1990 (a private clinic of CEMOPLAF was opened in Lago Agrio in 1998). Only 36% use any contraceptive method, usually sterilization or rhythm, though over half of the women reported not wanting any more children. Infant and child mortality is high as well, which usually contributes to higher fertility.

***Household Income and Wealth***

Murphy et al (1997) examined the determinants of income and assets among migrant farmers in the Ecuadorian Amazon. They hypothesized that settler income and wealth result from a combination of individual settler characteristics (e.g. family size, education, farming experience, and initial capital), available natural resources (e.g. more land of better quality and participation in off-farm employment), access to government services, and proximity to markets and services. A series of Pearson correlation coefficients indicated that household wealth was significantly and positively associated with household income, number of adult male and female workers, duration of residence, education level, size of plot and proportion of plot in pasture. Household wealth was negatively associated with proportion of plot in crops and proximity to roads and towns.

These correlations helped formulate a multivariate model to predict household income and wealth as a function of household characteristics, natural resources, type of off-farm employment, government assistance, and access to markets and services. Model results for household characteristics confirmed the positive influence of education, land ownership and duration of residence on household income, but the number of male and female laborers in the household were not found to be significant. This was unexpected, especially for male laborers, but might be due to the availability of labor-saving technology, land use practices, and substitutability of women and children. Natural resources, such as plot size and soil, were both significant and positive since land quantity and quality are clear indicators of wealth. However, flat land was not found to be significant mostly due to the fact that the primary cash crop (coffee) can be grown on slopes. Three types of OFE (work with petroleum companies, agriculture, and ownership of a private business) were positively associated with household income and highly significant. However, the parameter for agricultural work was much smaller, which is consistent with the reasoning that agricultural work is low paying, sporadic, and unreliable. Government assistance, which was measured as receipt of credit / loans and receipt of technical assistance, was not a major indicator of household income. Technical assistance was very uncommon, which weakens the signal for the effect and credits were an inconsistent measure since indebted households might either report high income from sales of cattle or short-term work that

year to pay the debt, or low income resulting from illness or other setbacks that lead to the reliance on loans. Finally, market access indicators (distance by foot to the road and distance by road to the market) were highly significant and negative. Distance by foot and road both increase the cost of transporting good as well as serve as barriers to other forms of employment.

***Out-Migration from Settler Households***

Laurian and colleagues (1998) used data from the 1990 survey to examine the out-migration of members of migrant settler households. Since this referred almost exclusively to young adults (children of migrants), this basically became a study of their decisions to remain in the household or migrate to other regions within the Ecuadorian Amazon or outside it. This research was based on a sub-sample of settler households containing all actual and "potential migrants" aged 12-24 at the time of migration prior to 1990 (158 migrants and 343 non-migrant children). It thus refers to the decisions of sons and daughters to migrate away or not, among those who lived in the Amazon at any time in the 1970's or 1980's. This required reconstructing household composition for each year in the past based on data on household membership by age, out-migration, in-migration, and deaths of household members since arrival in the Amazon. A multivariate analysis was performed to predict migration decisions separately by males and females, in a sense following Ravenstein's laws of migration (1889) about gender differences. The model comprised four categories of explanatory variables to predict whether the son or daughter migrated: (1) Individual-level characteristics (sex, age, education, marital status, farm and non-farm work experience), (2) household demographic and socioeconomic characteristics (numbers of children, siblings in the same age group, and adults in the household; education and off-farm work experience of head; persons per room--space, and household wealth); (3) migration network and access variables (number of previous migrants from household, number of trips to Quito of woman respondent in past year, proximity to roads and towns); and (4) farm agricultural assets (land area, land use, soil quality).

The main finding is that individual characteristics are the most important determinants of out-migration. Women and older youths (above 18 versus younger) were found more likely to migrate than men and younger youths. In fact, daughters who out-migrated were also much younger than sons who had left. The higher out-migration of daughters was explained as due to the lack of economic opportunities on farms, given the greater agricultural roles of men in most cases. Previous work experience was linked to out-migration of females but not males. Surprisingly, single children were less likely to migrate than married ones, perhaps because of a tendency of the latter to migrate together. Also surprising was that women were more likely to migrate if they had less education, though no such result was observed for males. This may indicate that households in which daughters have more education are of higher socio-economic status and can more easily support their unmarried daughters until marriage.

Household characteristics were also found important, but in some unexpected ways. First, the effect of household size is negative--i.e. bigger families have less out-migration. One possible explanation presented by the authors is that this may be due to the desire for companionship (of siblings in the same age group) on the frontier, which is more likely in larger families. Household wealth and density were not found to be significant determinants of migration. Migration networks are important, but more for sons than daughters, suggesting that household heads assist their sons more than their daughters. Land use and

land value variables had little effect on migration away from the frontier household.

***Remote Sensing Models***

The UNC group is also investigating the changing nature of the Oriente landscape at scales higher than that of households and fincas. Walsh and colleagues have assembled and analyzed a time-series of satellite imagery comprised of Landsat MSS and TM scenes from 1973, 1986, 1989, 1996, and 1999. Once images containing clouds were dropped, the remaining areas were classified into four land cover categories: 1) urban/barren, 2) pasture/agriculture, 3) successional/medium density forest, and 4) primary/high density forest. After each of the images was resampled to 30 x 30 m for compatibility, Fragstats (McGarigal and Marks 1993) was used to generate pattern metrics for both the landscape as well as individual classes to quantify spatial organization and composition. Table 8 summarizes the several pattern metrics measures for the Northern Intensive Study Area around Lago Agrio for 1973, 1986, 1989, 1996, and 1999.

**Table 8. Landscape level pattern metrics by year of analysis, Northern ISA.**

| | **1973** | **1986** | **1989** | **1996** | **1999** |
|---|---|---|---|---|---|
| Number of Patches | 6607 | 9710 | 9997 | 11,523 | 8371 |
| Patch Density (#/100 ha) | 9.85 | 14.47 | 14.90 | 17.18 | 21.48 |
| Mean Patch Size (ha) | 10.16 | 6.91 | 6.71 | 5.82 | 8.02 |
| Edge Density (m/ha) | 49.90 | 96.42 | 107.75 | 112.68 | 98.71 |

Comparing the metrics over time, it is apparent that in 1973 the Northern ISA was dominated by high density forest at over 80% of the land cover, with average patch size over 50 ha (as opposed to 1-3 ha for the other three land cover types). In sharp contrast, by 1986 only half the landscape was covered by high density forest, with a third occupied by pasture/agriculture. At this point high density forest still had the fewest, but largest patches (and lowest patch density). Three years later, the preponderance of high density forest was further reduced, with pasture/agriculture increasing to 40% of the total land cover. By 1996, the conversion from a landscape dominated by high density forest to one dominated by pasture/agriculture was complete. High density forest constituted a third of the landscape, while pasture/agriculture represented 45%. The remaining land cover was evenly distributed between the other two classes (urban/barren and medium density forest, which included coffee and secondary forest), although these latter classes, by far, had the greatest number of patches and the greatest patch density, indicative of potential future change. By 1996 the largest patches were pasture/agriculture, having replaced high density forest. Visual inspection of the classified images reveals the traditional piano key fragmentation or fishbone pattern of deforestation in Ecuador, as observed in other Amazonian areas such as Rondonia, Brazil.

## VII. Research Gaps and Policy Implications

We begin with some considerations of broad gaps in research, then proceed to a brief exegesis of policy issues and conundra. Despite increasing interest in the linkages between demographic processes and the environment, research in the area still suffers from

inadequate data (small and/unrepresentative samples) and tends to be narrowly focused in terms of discipline. The latter limits the potential for comparing, contrasting and validating the results at different scales. Thus the UNC project has benefited substantially from the close collaboration of geographers, working at a regional scale with satellite imagery, and demographers/economists/planners operating primarily at the level of the household. Similar collaborations are under way at several other American and Brazilian universities focusing on Brazil. Nevertheless, despite interesting findings, they are often circumscribed by limited data sets. At the same time, a larger literature on land tenure, agrarian structures and poverty in Latin America ignores the environment (i.e., deJanvry, 1981), and indeed ignores the rainforest frontiers, having evolved before interest surged about tropical deforestation. Ecological studies have also neglected socio-economic factors, while socio-economic-political analyses have neglected demographic and ecological factors. Thus within the natural sciences, research on deforestation elucidates ecological processes but neglects the human dimension (i.e., Uhl and Jordan, 1984).

A better marriage of data sets and techniques developed by physical geographers and social scientists is needed to advance the frontiers of knowledge. A number of methodological issues and opportunities exist in this context that go beyond simply geo-referencing the location of farm households, but these cannot be discussed here.

Statistical approaches to investigating the linkages between demographic and other factors at the household level and land clearing and land use have also been sub-optimal to date, and need to move on in the next generation of empirical research. Thus the theoretical approach of political ecology calls for a statistical analysis of LULC at multiple levels, in which the broader context of land use decisions by migrant settler households is taken into account. Thus the effects of the local socio-economic environment, captured by community characteristics--such as the presence of schools, health facilities, sawmills, oil camps, and electricity--as well as linkages from the farm via road networks, distances to markets, and even higher level political decisions and economic conditions in the region are relevant. The relatively new statistical methodology of multi-level modeling needs to be applied to the study of land use decisions on the frontier to permit investigating quantitatively the relevance of potential policy-relevant factors (measured at the community level, not lower levels) and, at the same time, by including them in the model, to provide more valid estimates of the effects of individual and household level factors on LULC by controlling for higher level factors. This is a field of statistical modeling in its infancy, but important results have already been observed in models of the determinants of fertility (Entwisle, 1996; DeGraff et al, 1998; Angeles and Mroz, 2001).

It is also desirable to go beyond strictly cross-sectional modeling of land use decisions, which only provide a hint of structural relationships over time. What we really care about are what are the factors that affect land use over time, which evidently can best be investigated using data on changes in land use over time. This evidently requires longitudinal data on households, communities and regions, which has yet to be adequately compiled much less analyzed. We have compiled a body of panel data for representative plots of land in Ecuador from the 1990 and 1999 household surveys and the 2000 community survey which we hope to use soon to carry out analyses of the determinants of *changes in land use* over time. Several other projects are doing this as well on areas of Brazil.

While ongoing efforts using longitudinal data sets and better statistical methodology should lead to more valid policy-relevant findings, time marches on, people continue to cut

down and depredate forests and suffer from poverty at the same time on the rainforest frontier, so policy decisions need to be made now, even if they need to be modified later in the light of new results. Policy considerations should be distinguished as between those pertaining to the *existing population* living in the tropical rainforest environment and those relating to *why people continue to migrate* to those regions in the first place. Our research on Ecuador has included many explanatory variables and elucidated many policy-relevant findings, discussed in the individual papers, but only a few variables can be briefly mentioned here.

First, demographic factors are important, even though they are not the most important. In the Oriente of Ecuador, family size is directly linked to clearing forests, indicating (along with survey results on family size desires, being much lower than actual fertility) the desirability of improving the availability of family planning and health services in the region. This will by no means solve the problem of deforestation, but will reduce endogenous pressures of population growth on existing fincas, as well as meet the needs of women. Given the dispersion of the population, despite growth in the past decade, methods need to be found for doing this in a cost-effective manner.

Second, settler families are mostly very poor, and struggling to survive in a difficult environment. Government priorities in general need to be altered to provide more technical assistance and incentives to rural populations in general in Ecuador (where poverty is highest). This involves also commercialization and local community empowerment, in which some NGO's are assisting, but much more needs to be done.

The trick is how to improve agricultural prospects without destroying what is left of the environment. The new Ley Forestal of Ecuador seems to provide incentives to farmers to maintain forest patches on their land, which is promising but still seeking funding and approval by the legislature. Building more roads should facilitate commercialization of products, but given that road access has been found to be the most powerful determinant of land clearing on settler farms, building and improving more roads must be done with extreme care, and should be undertaken only in the context of a long-term plan for the whole region, which recognizes the need to protect conservation areas and indigenous lands. Such a plan does not exist, and the continuing search for oil and rights of access to establish wells and pipelines even in those areas is a major threat to the remaining intact areas, which embody extraordinary biodiversity.

Going beyond this is the larger issue of why people migrate to the Ecuadorian Amazon in the first place. While the availability and enticement of land is a factor in attracting migrants, the quality of land is generally poor for agriculture and the climactic conditions of life onerous. Thus the greater issue is why do so many people who end up in the Amazon leave their places of origin? From a research perspective, this a study of migration processes and determinants based on specialized, linked data sets on households, communities and regions in places of origin as well as destination (Bilsborrow et al, 1984; Bilsborrow et al, 1997). Such data have not been compiled, on Ecuador or any other developing country as far as we know. Meanwhile, nevertheless, there is a very strong presumption that most migrants move because of poverty and lack of land, in Ecuador as well as throughout Latin America and elsewhere, and that this is in turn directly linked to prevailing land distribution and land tenure regimes that lead to extreme inequality in landholdings and urban bias in development policies. Altering these policies requires an entirely different development paradigm that has existed to date.

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