

Population and development in the Amazon: A longitudinal study of migrant settlers in the Northern Ecuadorian Amazon

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ABSTRACT

This paper examines changes over time for a full generation of migrant settlers in the Northern Ecuadorian Amazon (NEA). Data were collected from a 2014 household survey covering a subsample of households surveyed previously in 1990 and 1999. We observed changes in demographic behavior, land use, forest cover, and living conditions. As the frontier develops, human fertility is continuing to decline with contraceptive prevalence rising. Meanwhile, out-migration from colonist households, largely to destinations within the region, persists. More households have secure land tenure than in 1999, and are better off as measured by possession of assets. There is continued growth in pasture, largely at the expense of forest. Farms still serve as an important livelihood source for families, though growing cities in the NEA are creating more non-agricultural economic opportunities. Our findings provide a snapshot of demographic, economic, land use, and livelihood changes occurring in the NEA during the past quarter century, providing useful information for policymakers seeking to balance economic and environmental goals in order to promote sustainable development as well as protect biodiversity.

KEYWORDS: family planning, deforestation, livelihoods, migration

Población y desarrollo en la Amazonia: Un estudio longitudinal de colonos migrantes en la Amazonía norte del Ecuador

RESUMEN

Este artículo describe cambios para una generación de migrantes en la Amazonía norte del Ecuador (ANE). Nosotros realizamos una encuesta en el 2014 de un subgrupo de fincas que encuestamos en 1990 y 1999. Observamos cambios demográficos, del uso de la tierra, de la cubierta forestal, y de las condiciones de vida de este grupo. Encontramos que la fecundidad está disminuyendo y que el uso de planificación familiar está aumentando. La migración fuera de las fincas continúa, la mayoría a destinos en la ANE. Más fincas tienen los derechos de su tierra y las familias tienen más bienes. Desde 1999 ha habido conversión en las fincas de bosques a pasto. Las fincas son fuentes importantes de sustento de vida, pero las ciudades en crecimiento están creando otras oportunidades económicas. Nuestros resultados demuestran cambios significativos demográficos, económicos, del uso de la tierra, y de las condiciones de vida durante el periodo 1990-2014. Nuestro artículo provee información útil para líderes que quieran avanzar metas económicas y ambientales para promover el desarrollo sostenible y proteger la biodiversidad.

PALABRAS CLAVE: planificación familiar, deforestación, sustento de vida, migración

INTRODUCTION

The Northern Ecuadorian Amazon (NEA) is a critical biodiversity hotspot undergoing rapid change (Bass *et al.* 2010). Up until roughly 50 years ago, the region was largely uninhabited, aside from small indigenous populations. Since the discovery of oil in 1967, the region has received substantial human and financial inflows, the latter initially to build roads and pipelines to extract petroleum (Bilsborrow *et al.* 2004). The oil industry has grown, and is currently the major economic activity in the region. The industry accounts for large shares of foreign exchange earnings and government revenues, but is also a key source of pollution (Finer *et al.* 2008). Infrastructure developed to enable petroleum extraction has also facilitated human settlement deep in the NEA, opening up rainforest for agriculture. The growth of settlements in the NEA has coincided with changes in demographic, economic, land use, and livelihood choices, and has allowed for the exploration of various hypotheses concerning how population and resource interactions change over time in this forest frontier (Barbieri *et al.* 2005).

Forest frontiers around the world tend to have high human fertility rates (Carr 2004), which is also true in the NEA among indigenous inhabitants (Davis *et al.* 2015). The most recent analysis of human fertility among colonists (in-migrants from other parts of Ecuador) found substantially higher fertility rates in this population than in the rest of the country (Carr *et al.* 2006).

Households in frontier regions evolve over time through various stages, referred to as life cycles. These cycles reflect demographic and socioeconomic processes which have been theorized to be linked to changes in land use. Chayanov was one of the first to explore these patterns, positing that among peasant smallholders, household land use is a function of the dependency ratio of the household, whereby households with an abundance of labor relative to household size will adopt more labor-intensive agricultural practices, while households with less available labor relative to size will adopt less intensive practices (Chayanov 1986). However, it is possible that demographic changes may lead to the intensification of cultivation practices on existing land or to an expansion of agricultural activities onto marginal lands (Bilsborrow 1987). In the NEA, higher fertility is associated with land tenure insecurity and an increase in the amount of land devoted to pasture (Pan and López-Carr 2016). Household life cycle effects are seen as influencing land use decisions, especially in forest frontier settings like the NEA (Barbieri *et al.* 2005; Carr 2004).

Human migration in the NEA is a multilayered process, with individual, household, and community-level factors influencing migration decisions (Laurian *et al.* 1998). In particular, the story of migration in Ecuador's Amazon, as in many parts of the world, centers on individuals moving in

order to improve their economic situation (Bilsborrow *et al.* 1987; DeJong and Gardner 1981; Gray and Bilsborrow 2013; López-Carr 2012). Demographic factors, such as age and gender, have been found to be strong predictors of migration in the NEA, with younger individuals (ages 12–34) and women more likely to migrate (Barbieri and Carr 2005). The effect of education on migration remains more ambiguous (Barbieri *et al.* 2009). Migration decisions also reflect individual and household life cycles—many young people migrate to form new households, but are subsequently less likely to move again once settled (Caviglia-Harris *et al.* 2013).

Gender differences are pronounced in decisions about where to migrate. In the Amazonian context, when men migrate, they are more likely to go to other rural areas, often for manual agricultural work, whereas women are more likely to move to cities to pursue education or non-farm employment (Barbieri *et al.* 2009). The likelihood of migration has also been found to be positively related to distance from the nearest town, so those farther away are more likely to migrate. In contrast, those close to towns are more likely to maintain their residence and commute to urban jobs. Most of the out-migrants from colonist households observed in the 1990 and 1999 surveys remained within the NEA (Barbieri and Pan 2013).

Landholdings and land use often reflect the household life cycle stage and may also affect migration. Larger landholdings signify wealth, which could provide capital to facilitate out-migration (Bilsborrow 1987; Shaw 1974; Van Wey *et al.* 2012). Conversely, larger landholdings provide greater opportunities for farm labor, which tends to reduce out-migration in search of other livelihoods (Gray 2009). This latter hypothesis appears dominant among colonists in the NEA, as larger plot sizes are associated with a lower propensity to out-migrate (Barbieri *et al.* 2009).

Farmers in the NEA use land in a variety of ways, including forest, pasture, annual and perennial crops, and fallow land (which generally regrows into secondary forest). Deforestation is pervasive throughout the NEA, and has largely been the result of smallholder farm expansion (Bilsborrow *et al.* 2004; Pichon 1997), although occasional transitions of farms away from cattle ranching can be a source of reforestation through secondary forest growth (Rudel *et al.* 2002). In general, farms in the region have fragmented, whereby parcels are subdivided and passed on to children or sold to third parties (Pan and Bilsborrow 2005). Consequently, data from the two previous survey rounds show that plot sizes have decreased, although an increase in more intensive forms of agriculture as a share of land use, such as from cattle to crops or from low-value crops such as corn and rice to higher value ones such as vegetables and fruit trees, has not materialized. Landholders with even a modest amount of land have often chosen instead to deforest in order

to expand pasture (Bilsborrow *et al.* 2004). Research from the NEA and elsewhere in the Amazon suggests that possession of a land title is also linked to accelerated deforestation (Pan and Bilsborrow 2005; van Vliet *et al.* 2013).

Beyond household dynamics, it is clear that Protected Areas (PAs), such as national parks and patrimony forests, serve to promote the conservation of forests and native ecosystems, providing benefits to local communities (Naughton-Treves *et al.* 2005). In the NEA, PAs create different land management regimes that affect not only the area directly protected but also zones surrounding the PA (Mena *et al.* 2006). However, these effects are somewhat negated by large agroindustry complexes, such as African palm plantations, which promote tropical deforestation (Vijay *et al.* 2016) and in the NEA produce large-scale soil and water pollution (Castro *et al.* 2013; Mantilla 2012).

In this study we summarize key findings from the most recent round of a longitudinal household survey conducted in the NEA in 2014 and describe changes in the 15 years since the previous survey. Using our new household survey data, we explore human demographic, land use, and livelihood trends to follow up on earlier work that identified major changes between the first two rounds in 1990 and 1999 (Bilsborrow *et al.* 2004).

MATERIALS AND METHODS

To explore demographic, land use, and livelihood changes in the NEA, a longitudinal survey of farm plots owned by colonists was conducted in 1990 and 1999 (Bilsborrow *et al.* 2004) (Figure 1). The sample was selected for the 1990 survey, and was followed up in 1999. In 2014, a subsample of 1999 farm plots was resurveyed. Households in 1990 were selected through a two-stage sampling process. In the first stage, groups of farms called sectors were selected from a list (showing the number of farms per sector) provided by the Instituto Ecuatoriano de Reforma Agraria y Colonización. In the second stage, a cluster of contiguous farm plots (*finca madres*) of approximately 50 hectares were selected at random from each sample sector. Both sectors and the number of *finca madres* per sector were sampled using probabilities of selection proportional to estimated size (PPES). Earlier papers contain a more extensive discussion of the sampling procedures (Bilsborrow *et al.* 2004; Pichon 1997). The 1990 survey collected data from 418 farm households (found on 408 *finca madres*), while the 1999 study encountered 767 farm households plus 111 *solares* (small plots of less than 1 hectare)—reflecting a large increase due to land subdivision, resulting from both the formation of new farm households on existing farms through inheritance (allocations of land to sons and daughters reaching adulthood) and sales of portions of farms to in-migrants.

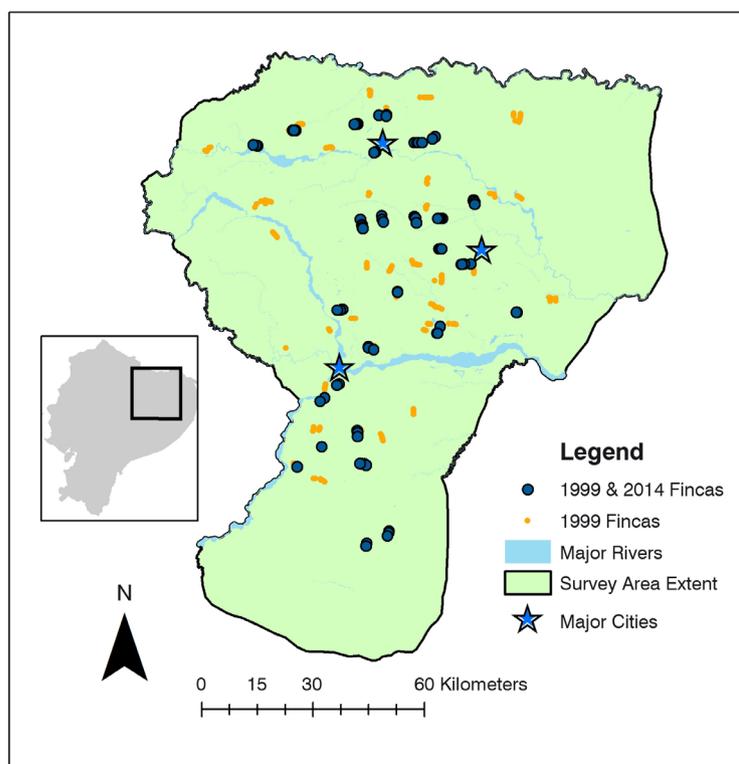


Figure 1. Map of the Northern Ecuadorian Amazon study region, showing its approximate location in northeastern Ecuador. This figure is in color in the electronic version.

This paper introduces data from a new survey conducted in July–August 2014 on a subsample of the completed 392 finca madres (complete original farms of 40–50 ha allocated to the initial settlers in the region) that were surveyed in 1999. Due to funding constraints, we were unable to resample all of the original sample. We selected this subsample to yield a similarly geographically diverse sample while excluding some of the less accessible settlement sectors (farthest from the two main cities of Coca and Lago Agrio). This enabled the fieldwork to reach a larger number of sectors than would have otherwise been possible, albeit with a loss of some representativeness of the sample. Overall, 232 households were sampled from 100 finca madres, covering roughly a quarter of the original sample.

The three surveys cover a panel of finca madres and are hence longitudinal for land but not necessarily for households. If a farm owner in 1999 was no longer present in 2014, the new owner(s) and household members were surveyed. Thus, we did not track down heads of household who left. We also encountered cases where new subdivisions and consolidations occurred on a surveyed farm since 1999, and interviewed all new households that formed as a result of these changes. As with the two previous surveys, male and female heads of household were interviewed separately. Household heads (generally male) were asked about land use and tenure, agricultural activities, while the spouse of the head (generally female) was asked to complete a household roster, as well as provide information on housing quality and assets, fertility, and health. If one of the two was not present, the other member was asked to respond to both questionnaires. Due to errors in the field, some households provided only the head's questionnaire. In total, data were collected from 232 head surveys and 185 spouse surveys.

This remainder of the paper is divided into a series of short descriptive results sections as follows. Household and community demographics are explored first, followed by fertility and family planning, migration and remittance patterns, land tenure and living conditions, and land use. At the end, we briefly discuss caveats, future needs and provisional policy implications.

RESULTS

Household and demographic changes

As expected, settler populations in the NEA are changing, with increases in average age as well as decreases in mean household size. Between 1999 and 2014, the mean age for male and female heads of household interviewed increased by roughly six years for males (to a mean of 49) and seven years for females (to a mean of 44) (Table 1). The total dependency ratio fell from 0.87 in 1999 to 0.54 in 2014. A demographic maturation is also evident in the modest decline in the sex

Table 1. Household demographic characteristics in the Northern Ecuadorian Amazon surveyed in 1990, 1999 and 2014. Overall statistics are calculated based on entire survey population, excluding out-migrants after they left. Dependency ratio is calculated as proportion of population age 0–14 and 65+ divided by the population age 15–64. Sex ratio is calculated as the number of men divided by the number of women. Population share by age group is based on persons in farm households as well as *solares*. Highest level of education completed is calculated among individuals age 12 and above. Regarding household share by province, Orellana Province was created from a portion of Napo province in 1998, during the period of our study. As a result, the two provinces are considered a single area for the purposes of classifying households.

	1990	1999	2014
Total population size (persons)	2761	4334	875
Overall demographic statistics			
Dependency ratio	1.00	0.87	0.54
Sex ratio	1.21	1.17	1.15
Average household size	6.82	5.68	4.55
Mean age (years)			
Head of household	43.7	43.3	48.8
Spouse of head	38.7	37.4	44.0
Population share by age group (%)			
0–12	40.3	38.4	23.7
13–64	55.6	58.9	69.0
65+	4.1	2.7	7.3
Birth origin of head (%)			
Coast	18.9	18.2	19.2
Highlands/Sierra	72.7	68.0	59.3
Amazon/Colombia	8.4	12.2	21.5
Other country	0.0	1.5	0.0
Highest level of education completed (%)			
Primary incomplete or below	44.0	32.9	19.0
Primary complete	41.1	41.1	27.2
Secondary incomplete	11.3	20.3	25.5
Secondary complete or above	3.6	5.6	28.3
Share of households by province (%)			
Napo/Orellana	41.5	45.9	42.1
Sucumbios	58.5	54.1	57.8

ratio from the more male-dominated population typical of early frontier settlement.

Roughly one generation has passed in the 24 years since the first survey in 1990. Since that time, the original children have had the opportunity to start their own households, with many choosing to remain in the Amazon. Thus, 21% of household heads were born in the Amazon, a substantial increase from previous surveys (Table 1). This was accompanied by a drop in the proportion of heads born in the Sierra, suggesting that in-migration from the Ecuadorian highlands has slowed. Household members are also increasingly well-educated—28% completed secondary school by 2014, and only 19%

had less than a primary school education, reflecting substantial improvements in educational attainment compared to the two previous surveys.

Fertility and family planning

Desires about future childbearing have remained roughly constant during the past quarter century (Table 2). When women of reproductive age were asked whether they would like to have another child, roughly one-in-four in each survey responded affirmatively, while around 70% said they wanted no more. This is somewhat surprising in light of the fact that the population of women of reproductive age is older in this survey than in previous studies, implying that they are more likely to be closer to completing their desired childbearing.

However, the use of family planning increased substantially since 1990, from 35% to 63% in 2014 (Table 2). Among family planning users, modern methods are becoming more popular, notably injections rising from 4% to 26%, while use

of the rhythm method fell from 28% to only 3% in 2014. Still, the most widely used method in 2014, as in both the earlier surveys continued to be female sterilization at 31%. Use of “other” methods, especially implants, rose rapidly.

Strong desires to avoid childbearing along with the substantial increase in family planning use has resulted in continuing fertility decline, with the reduction in children ever born particularly pronounced among younger cohorts. While our small sample does not allow us to calculate a reliable total fertility rate in 2014, a continuing decline among migrant settlers is evident from data on children ever born for the three survey years. Women who were ending their reproductive life cycles at the time of the 2014 survey (ages 45–49) had nearly two fewer children on average than similarly aged women in 1999.

Migration and remittances

Migration is an important demographic process in the NEA, involving internal population redistribution. Our results reflect so-called long-term or permanent migration, where individuals have left their farms to establish a residence in another location. In fact, only three of our 137 migrants in the study moved elsewhere for at least six months and then returned to their farm. Our survey questionnaire did not ask about short-term, seasonal or temporary migrants, only those moving to change their place of residence for at least six months. This study only documents permanent location changes and does not examine short-term movements to/from farms. For instance, individuals who live in urban areas may return to their farms of origin to help with crop harvesting on some weekends or holidays, a phenomenon we did not record.

While motivations for out-migrating from their settler farms in the NEA are multifaceted, there are several recurring patterns regarding gender, age, and education. As found in previous studies on migration in the NEA (Barbieri *et al.* 2009; Laurian *et al.* 1998), females continued to be more likely than males to migrate from their farm households, and comprised the majority of our migrant population (60% of out-migrants aged 12+ were female), despite the fact that the comparably-aged survey population was 56% male (Table 3). Migrants also tended to be younger than non-migrants, the mean age of migrants was 24, while it was 35 in the non-migrant population (among persons age 12 or above). Migrants also are better educated on average than non-migrants — 62% of migrants had greater than primary-level schooling compared to 47% of non-migrants.

Migration in the NEA continues to be highly gendered. While men and women shared three major motivations for migrating in our survey: employment, education, and accompanying a relative, these reasons differed by gender (Table 4). Males were more likely to migrate for employment,

Table 2. Fertility and family planning use in households surveyed in the Northern Ecuadorian Amazon in 1990, 1999 and 2014. Samples for questions on desiring another child and currently using family planning reflect only female heads of household who are of reproductive age. The sample for the question on method of family planning includes only female heads of household who currently use family planning.

	1990	1999	2014
Desire another child (%)			
Yes	22.2	24.2	26.2
No	68.9	71.7	67.0
Uncertain	8.9	4.1	6.8
Currently using FP (%)	34.8	44.4	63.1
Sample size (women)	270	467	103
Method of family planning used (%)			
Pill	21.3	24.6	16.9
IUD	12.8	5.3	0.0
Injection	4.3	8.2	26.2
Female sterilization	31.9	25.6	30.8
Rhythm method	27.7	20.8	3.1
Other	2.1	15.5	23.1
Sample size (women)	94	207	65
Children ever born, by age group			
12-14	0.01	0.03	0.00
15-19	0.27	0.39	0.28
20-24	1.37	1.57	0.82
25-29	3.08	2.92	1.71
30-34	4.51	3.88	2.06
35-39	6.01	5.18	3.68
40-44	8.80	6.45	3.95
45-49	8.97	7.36	5.48
Sample size (women)	636	1050	223

Table 3. Migrant vs. non-migrant descriptive statistics for households surveyed in the Northern Ecuadorian Amazon in 2014. Migrant statistics are presented for individuals age 12 and above at time of migration. Non-migrant statistics are presented only for individuals age 12 and above at the time of the median migration event, which took place in 2009. This is in order to facilitate more consistent comparison between migrants and non-migrants. Mean age and age groups for non-migrants reflect their ages as of 2009. Education values for non-migrants were measured at the time of the survey, whereas education values for migrants reflect attainment at time of migrant's departure.

	Migrant	Non-migrant
Female (%)	60.4	44.0
Mean age (years)	24.1	35.5
Age groups (%)		
12-19	38.8	25.3
20-34	50.0	27.6
35+	10.9	47.1
Level of education (%)		
Primary incomplete or below	6.0	21.9
Primary complete	32.1	31.5
Secondary incomplete	20.9	13.9
Secondary complete or above	41.0	32.7
Sample size (persons)	134	562

Table 4. Migrant descriptive statistics for households surveyed in the Northern Ecuadorian Amazon in 2014. Statistics below are based on all migrants age 12 and above in surveyed households. Three return migrants are excluded from statistics. Median remittance totals include only migrants that sent remittances.

	Males	Females
Sex (%)	39.6	60.4
Mean age at departure	26.7	22.4
Age at departure (% by gender)		
12-19	20.8	50.6
20-34	60.4	43.2
35+	18.9	6.2
Migrant destinations (%)		
Rural Amazon	44.2	40.5
Urban Amazon	32.7	27.8
Elsewhere	23.1	31.6
Educational attainment (%)		
Primary incomplete or below	1.9	8.6
Primary complete	37.7	28.4
Secondary incomplete	17.0	23.5
Secondary complete or above	43.4	39.5
Main reason for departure (top 3 choices listed; %)		
Accompany spouse/relative	37.7	43.2
Employment	45.3	23.5
Education	3.8	21.0
Other	13.2	12.3
Any remittances sent in past year (%)	35.8	24.7
Median remittance amount sent in past year (USD)	\$2,500	\$600

while females were more likely to migrate for education. Migration to accompany a spouse did not differ much by gender. Migrant demographics reflect these motivations. For instance, as women left to pursue education, they tended to leave at earlier ages than men; 51% of female migrants were age 12-19 at time of departure. However, we found no clear patterns with regard to education level and reason for departure. Overall, women were more likely than men to leave the Amazon (32% versus 23%), often to urban centers in Ecuador's Sierra. Within the Amazon, men were more likely to migrate to rural areas, largely for work.

The motivations migrants have for leaving are also reflected in data on sending remittances. Males were more likely to send remittances than females, in line with their being more likely than females to leave for employment. Moreover, males sent higher amounts, a median of \$2,500 USD per year, compared to \$600 per year for females (Table 4). We also asked respondent families whether they had sent any money to support out-migrants from their households, but only 12% said they had.

Land tenure and living conditions

Following changes in land tenure policies and procedures, the proportion of migrant settler households with secure land titles declined dramatically during the 1990s, but this process has reversed since 1999. As of 2014, 69% of households possessed a formal land title (Table 5), doubling the proportion in 1999 while at the same time the proportion with no title fell by half from 48% to 24%. In addition, asset ownership, an important indicator of household wealth, increased markedly since 1990 and 1999 (Figure 2). The vast majority of households now own a television (76%), a radio (66%), and a refrigerator (77%).

Despite rapid economic growth in the region, including infrastructure such as roads and electricity networks, most rural homes still lack access to modern water and sanitation systems. Only 7% of sample households were attached to a sewer system—the remainder used latrines or had no system at all for disposing of human waste. By and large, households were unable to regularly access safe drinking water as the vast majority (88%) found it at least sometimes necessary to boil and/or otherwise treat their water before drinking.

Land use

Two primary patterns of land use change, deforestation and farm fragmentation, continue to be pervasive. The 1999 survey found a strong trend towards smaller farm sizes due to subdivision, as well as reduced forest cover, which opened up a greater proportion of land for agriculture (Bilsborrow *et al.* 2004). These two trends have continued since. There has been a substantial reduction in mean farm size from 46.5 ha in 1990 to 25.3 ha in 1999, and to 19.8 ha in 2014, though the smaller and less isolated subsample in the 2014 survey

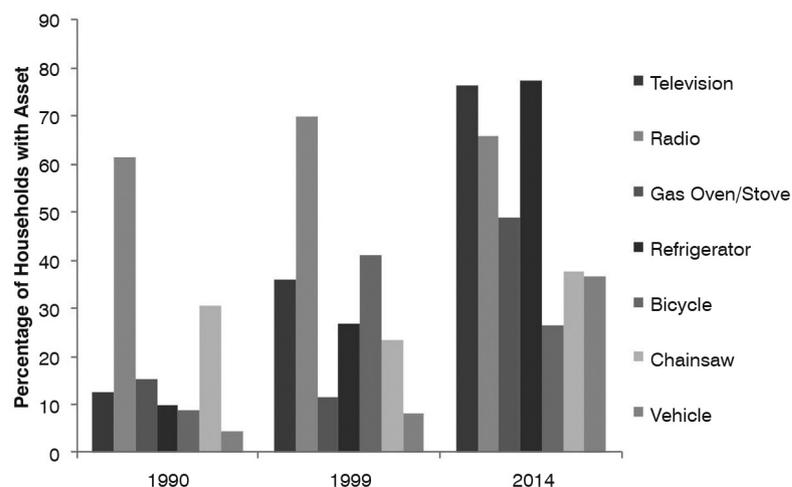


Figure 2. Possession of specific assets among surveyed households in the Northern Ecuadorian Amazon in 1990, 1999 and 2014.

Table 5. Land tenure arrangements by household surveyed in the Northern Ecuadorian Amazon in 1990, 1999 and 2014. N indicates sample size (number of households).

Document type	1990		1999		2014	
	N	%	N	%	N	%
Full title	208	50.2	262	34.2	122	68.9
Certificate of possession/provisional title	179	43.2	97	12.7	4	2.3
Surveyed only	-		42	5.5	8	4.5
No title or claim	27	6.5	365	47.7	43	24.3
Total plots	414		766		177	

may account for part of the most recent drop (Table 6).¹ In 2014, 45% of farms were 1-10 ha, while the proportion of plots >50 ha fell to under 10%. The survey did not inquire about land use on plots smaller than 1 ha.

Overall, plot size is linked to land use choices. Annual and perennial crops, which are more intensive forms of land use than cattle raising, account for a higher proportion of land area on smaller plots, providing evidence of intensification as a response to land scarcity. Larger plots had greater proportions of land in both pasture and forest cover, and unsurprisingly, were more likely to have cattle present and more cattle on the farm.

Land use trends observed between 1990 and 1999 largely continued to 2014 (Figure 3). Since 1999, forest cover has

continued to decline, although deforestation of new areas decreased. In 1990, roughly 60% of total land in sample farms was primary forest, which rapidly fell to 45% in 1999. By 2014, primary forest cover fell to 28% on the survey farms, implying a slower annual absolute loss of forest cover, although with similar rates of forest loss in both time periods. This slowdown in forest loss is in line with other estimates of forest change in the NEA over a similar time period (Holland *et al.* 2014).

Primary forest is being replaced with two other land cover types: pasture and secondary forest. Pasture has grown, from 20% in 1999 to 33% of sample farm land in 2014 (Figure 3). Two out of every five (41%) households owned cattle, highlighting the demand for pasture and the importance of livestock rearing as a livelihood strategy. Additionally, on larger farms, more land is being left fallow, resulting in secondary forest growth, from around 11% of total farm area in 1999 to 21% by 2014. Land devoted to crops has stayed relatively stable between the three surveys, at roughly 15-20% of land cover. Within cropland, the share devoted to annual versus perennial crops has also not changed substantially.

¹ Due to data coding errors, in 23 households the sum of land areas assigned to each use (crops, pasture, forest, etc.) did not match the total area of land that the household reported owning in a different section of the questionnaire. To address these discrepancies, we assumed data regarding specific uses is likely to be more precise than the overall plot total. In these cases, we adopted one of two responses depending on the direction of the error. For households that had a greater area of land allocated to different uses than the total reported, the total area of land owned was adjusted to equal the sum of land areas allocated by use. Households that reported less land (>2 ha difference) allocated to different uses than was reported in the total were dropped from the analysis since we could not know how to impute the difference to specific uses. These adjustments left us with 180 farms used in the analysis reported here.

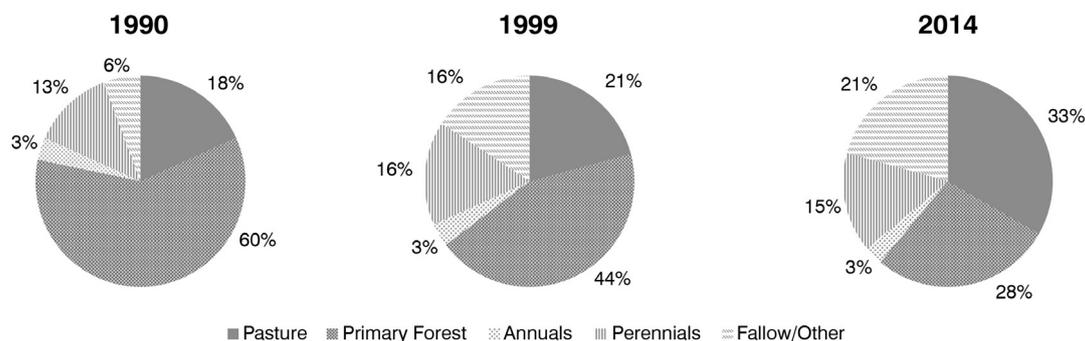


Figure 3. Share of land use among surveyed households in the Northern Ecuadorian Amazon in 1990, 1999 and 2014.

Table 6. Share of land use by overall plot size in households surveyed in the Northern Ecuadorian Amazon in 2014. Land use values are indicated in Ha and percentage of property area.

Plot size category	N plots	Share of survey plots	Mean plot size	Land use type										Cattle ownership	
				Annuals ^a		Perennials ^b		Pasture		Primary forest		Fallow/other ^c		Own cattle	Mean N cattle ^d
Ha		%	Ha	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
1-4.9	47	26.1	2.7	0.3	9.8	0.9	33.3	0.7	25.3	0.4	14.4	0.5	17.1	21.3	3.0
5-9.9	34	18.9	6.8	0.4	6.1	2.7	40.0	1.3	19.6	0.8	11.5	1.5	22.8	17.6	3.2
10-19.9	25	13.9	12.6	0.4	3.1	2.7	21.2	4.6	36.9	2.1	16.6	2.8	22.2	44.0	4.4
20-29.9	24	13.3	24.3	1.6	6.6	3.1	12.9	9.0	37.1	3.6	14.8	7.0	28.7	62.5	4.6
30-49.9	33	18.3	41.5	0.3	0.8	4.3	10.3	16.4	39.5	13.8	33.3	6.7	16.1	72.7	7.8
>50	17	9.4	55.9	0.6	1.1	7.7	13.8	13.6	24.3	21.6	38.6	12.4	22.2	47.1	7.1
Average/total	180	100	19.8	0.5	2.7	3.0	15.3	6.6	33.1	5.6	28.2	4.1	20.8	41.1	5.5

a. Annual crops include rice, maize, yucca, and bananas.

b. Perennial crops include coffee, cacao, African palm, palmito, naranjilla, and sugar cane.

c. Fallow/other category includes secondary forest, "other" forest, land marked as fallow, and swamp.

d. Among households that own cattle on surveyed farms.

DISCUSSION

As development in the NEA continues, the region is beginning to resemble the rest of the country as measured by demographic and economic behavior. Fewer babies are being born, more migration to urban areas is occurring, farm plots are becoming smaller, and households are growing modestly wealthier. In addition, secure land tenure is becoming more widespread. These developments are largely positive for colonists, many of whom moved to the Amazon in order to seek better lives beginning in the 1970s and continuing albeit at a slower pace.

Demographic changes in the region reflect the effects of the 1999 population aging and passing through its life cycle over 15 years, with the increase in mean age of 6-7 years reflecting the countervailing effect of some of the children becoming household heads as they are allocated parts of the original finca madre plots, plus some continuing in-migrant families taking over plots from the aging 1999 heads. Such aging results in a changing overall age structure, with a sharp

drop in the share of young people and an increase in the share of the working adult-age population.

Regarding fertility and family planning, we note that use of modern family planning methods including injectables, implants and sterilization grew, suggesting that family planning services are increasingly available and affordable in the NEA. The increase in contraceptive use, along with constant desires about childbearing suggest that the unmet need for family planning services has fallen considerably for colonist women in the NEA during the past 24 years. These trends are also confirmed by the fall in children ever born. Collectively, these trends suggest that women are often beginning childbearing later. Thus, downward trends in fertility observed in the early 1990s appear to have continued into the 21st century.

Additionally, living standards in this region are improving, though vary widely between households. Remittances are being driven largely by a small proportion of male migrants. This is due to the fact that more male than female migrants

in our sample are likely to be employed in general, and in particular by petroleum companies, which often pay higher wages than other employers. Moreover, data on asset ownership show significant gains in wealth accumulation. However, some of this apparent increase might be due to the 2014 sample being a bit less dispersed than the earlier samples (i.e., closer to urban centers).

While the quality of life for colonists has improved in many ways since 1999, the same cannot be said for forests. Our survey confirms that despite recent slowdowns in forest loss, the NEA overall continues to experience a high deforestation rate as forest is being converted into pasture. Previous studies exploring cattle ownership in the Amazon associated possession and number of livestock with household wealth, suggesting that cattle will continue to proliferate as the region becomes more affluent (Caviglia-Harris 2005; Murphy *et al.* 1997). Unless the Ecuadorian government develops stronger policies to protect forests, this valuable ecosystem is likely to continue to be further degraded. Nevertheless, some of our findings have positive implications for forest health, including broad declines in fertility and continuing rural-urban migration, which are likely to reduce human pressures on the environment.

In the NEA, household livelihood dynamics are strongly affected by exogenous factors, such as the price of oil and the level of government investment in social development projects. While our article centers on household changes across time, many of these changes are partly the result of government policy choices to promote development in the NEA, including expanded access to education and health services. However, adverse impacts of other development policies to promote forest resource extraction are also felt within and among households, such as on women's health (San Sebastián *et al.* 2002), deforestation and biodiversity loss (Castro *et al.* 2013), and human rights violations (Latorre *et al.* 2015). Policy choices, such as the use of payments for environmental services (PES) to discourage land clearing, may also help change land use trajectories, although the use of PES in the NEA remains in its infancy and it is too early to tell whether these efforts will be successful in preventing forest cover loss (De Koning *et al.* 2011). Other policies to increase local action by households and communities to monitor and reconstruct their environment should be developed.

CONCLUSIONS

The results of this quarter-century retrospective illustrate that livelihood patterns for NEA settlers are diversifying as the region continues to change demographically, economically, and environmentally. Future larger-scale surveys of settler households are likely to record populations that are increasingly older, urban, and mobile and who are less

likely to rely on traditional agricultural activities, particularly growing crops, for their livelihoods. How the government and local communities respond to the recent fall in the price of oil, which has reduced financing for social development projects and left people with fewer work opportunities, will be crucial to determining future demographic, economic, and environmental trends in the region. Future studies should seek to understand how policy choices interact with household demographic, migration, and land use decisions in the NEA, particularly as the region continues to become more economically diversified and less reliant on agriculture. Given the importance of the Ecuadorian Amazon landscape as a provider of livelihood opportunities as well as critical ecosystem services, policymakers must work to strike a careful balance between development to accommodate growing and shifting populations in the region as well as the need to ensure remaining forests are sufficiently protected from agricultural and extractive activities.

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