

Rural migration: The driving force behind tropical deforestation on the settlement frontier

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ABSTRACT

This paper reviews the state of knowledge and develops a conceptual model for researching frontier migration in the developing world with a focus on Latin America. Since only a small fraction of migrants move to forest frontiers, identifying people and place characteristics associated with this phenomenon could usefully inform policies aimed at forest conservation and rural development. Yet population scholars train their efforts on urban and international migration while land use/cover change researchers pay scant attention to these migration flows which directly antecede the most salient footprint of human occupation on the earth's surface: the conversion of forest to agricultural land.

INTRODUCTION

The migration literature has largely overlooked land use and land cover change (LUCC) as an outcome of rural-rural migration. All but a few million of the several hundred million people worldwide who migrate each year do so within the borders of their own countries; however, demographic research is distributed almost exactly the opposite way, with the vast majority of studies on immigration (and mainly to the developed world) or on rural-urban migration—usually based on survey data obtained only in destination areas (Bilsborrow, Oberai and Standing 1984; Boyle et al, 1998).

Similarly, LUCC research has yet to fully address key links to migration processes (Carr, 2004). Empirical studies from the political ecology and LUCC literature have discussed resource inequalities and macroeconomic dynamics at migration origin areas as underlying causes of migration, and thus, forest clearing (e.g., Hecht and Cockburn 1989; Fujisaka et al. 1996; Wood and Perz. 1996; Stonich 1993; Carr, 2005). A few of these studies have linked origin attributes at the household level to LUCC on the frontier through destination area surveys (e.g., Almeida 1992; Rudel and Horowitz 1993; Fujisaka, Crawford, Bell, Thomas and Hurtado 1996; Carr, 2003). However, detailed household and community-level research has yet to be conducted from settlers' origin regions to complement work in areas of frontier colonization. Thus, rural-rural migrants have been largely ignored, although they are the key migrants in population-environment relationships (Zimmerer, 2004; Bilsborrow 2002). The main initial questions are then twofold: (1) who migrates from rural areas of origin and (2) who chooses the agricultural frontier as their destination—that is, how are they different (selected) from those choosing other destinations?

A significant literature exists on the first question, drawing upon the migration theories of Sjaastad (1962), Lee (Lee 1966), and Todaro (1969), and cited in Shaw (1988), Ritchey (1976);

DeJong and Gardner (1981), Bilsborrow, et al. (Bilsborrow et al. 1984), Massey et al. (1993), and others. However, we know much less about the second question—the choice of migrant destination, particularly the choice to migrate to an agricultural frontier (Bilsborrow 2001b). This is due to both data and analysis limitations, with existing studies on the frontier based on survey data only from destination areas.

Addressing these questions has critical implications for theory and policy. Most people in rural Latin America never migrate, regardless of prevailing structural conditions and, of those who do, relatively few migrate to the frontier. Identifying community and household characteristics (including demographic, political, social, economic, and ecological factors) associated with frontier migration has key political relevance to environmental conservation and rural development. If place and personal qualities can be specified for the relatively small portion of people who migrate to the frontier, perhaps policy interventions could more effectively attenuate frontier migration flows or ameliorate their deleterious human and ecological outcomes.

THE CONTEXT BEHIND RURAL-FRONTIER MIGRATION

Most of the developing world falls within Zelinsky's (1971) second stage (of five) of his "mobility transition," characterized by massive movements from the countryside to cities and the colonization of rural frontiers. Consistent with the mobility transition, most migrants in the world are internal movers. Rural-urban migration does not appear to be as dominant a migration flow as the preponderance of literature on the topic would suggest. Few countries publish data on different types of internal migration flows (Elizaga 1965; Bilsborrow and Akin 1982). Nevertheless, disaggregated data are available for 14 countries from the 1970s and 1980s. Rural-urban migration dominated in only three of these countries and rural-rural migration was greater than rural-urban flows in 10 of the 14 (Bilsborrow 1998). Case studies further suggest that Africa and Asia remain at an earlier stage of migration, in which rural-rural migration dominates, whereas urban-urban migration is dominant in Latin America (Bilsborrow and Carr 2001).

From an ecological perspective, rural-rural migration in Latin America is of eminent importance. In Latin America, from the 1950s to the 1980s, a torrent of people flowed to the cities from rural areas while a trickle colonized rural frontiers (Cruz, 1992); however, following the debt crisis of the 1980s, the stream's course was altered, increasing flows to secondary cities and rural frontiers (Mougeot 1985; Altamirano, Hirabayashi, and Albó 1997). For the handful of Latin American countries for which there are data from recent decades (i.e., Brazil, Ecuador, Honduras, Peru), almost half of the internal migrants are urban-urban migrants, one-fifth are rural-urban migrants, and approximately another third are rural-rural or urban-rural migrants (United Nations 2001). This last third includes frontier colonists.

THE FRONTIER MIGRANT AND DEFORESTATION

While the proximate agents of deforestation in Asia have been logging operations, often in tandem with shifting cultivators, Africa has experienced rapid structural adjustments that have expanded export operations and rapid population growth that has attended the expansion of shifting cultivation (often on-farm). In Latin America, small farmer frontier colonization, and their subsequent land use, has been the primary proximate cause of forest clearing. Since data on the share of migrants to rural areas (and how much forest they are clearing) is unavailable for the region as a whole, I will briefly present several points supporting estimates that attribute the majority of tropical forest conversion in Latin America, and perhaps worldwide, to small farmers (i.e., at least as proximate agents) (World Bank 1991a; Houghton 1994; Myers 1994). Further, I will consider why most of these, as is widely thought, in Latin America are likely to be migrant colonists in particular—not just any small farmers (e.g., Rudel and Roper 1996; Bilborrow and Carr 2001; Geist and Lambdin 2001).

First, a large portion of forests in the developing world is located in protected areas, while only a fraction of the forest eligible for clearing remains within close proximity to long-settled agricultural communities or plantations (FAO 2001). Secondly, forests *outside* of protected areas are often, ironically, better protected than government-sponsored protected areas. Great care is taken to preserve communal woodlands, since timber resources for agricultural security and for fuel-wood are scarce in areas of high population density (e.g., Wallace 1995; Kalipeni 1999). In the case of a community where a small woodland reserve is shared, there is an incentive for community members to carefully monitor each other's use of the wood reserve. No such incentive exists for in a government-sponsored forest reserve.

Third, recent colonists to the frontier must clear land soon after arriving to indicate occupancy to other would-be squatters and to open up land for agriculture (Southgate 1990; Angelsen 1999). Farmers will continue to clear forestland for crop expansion as the surrounding land becomes occupied by new settlers. Indeed, if a farmer can easily continue to expand landholdings and clear forest in new areas, it is a good bet that the farm is located in a recently-settled frontier with high transportation costs; marginal soils; scarcities of labor, technology, and capital; and insecure land tenure—all factors encouraging expansive cultivation (Barbier 1997; Pichón 1997).

Fourth, if land abundance encourages expansive forest clearing, it also encourages settlement initially. It makes little sense for a farmer in search of land to settle a region characterized by land *unavailability*, as in a long-settled population-dense community. Rather, a rural farmer in search of land will settle where land is available—at unoccupied forest margins. Rural migrants searching for wage labor, whether in other rural areas, towns, cities, or abroad, remove themselves from the deforestation cycle (except as consumers) unless they join the very small fraction of laborers in the timber or cattle industry. If migrants find work on large plantations, they may be more likely to contribute to net reforestation since with each new farmhand, one intensive farmer is gained, while one extensive farmer is lost.

Lastly, the share of the world's deforestation caused proximately by frontier colonist agriculture may be increasing. In many rural areas in recent decades, deforestation has accelerated even when rural population increase has decelerated, meaning forest clearing per farmer has increased (Carr, Bilborrow and Barbieri 2003). This suggests that agriculturists in areas of lower population density (i.e., frontier farmers and/or large ranchers) have been increasingly responsible for forest clearing.

In sum, the forest margin recedes a relatively small amount from the expansion of existing farms in population dense areas. Rather, it retreats mainly due to new farms established

by migrants in population sparse areas. In the former, agricultural expansion will occur primarily on the *internal frontier*, that is, through on-farm deforestation. In the latter, forest conversion is greatest on the *external frontier* (the vast forestland beyond the penumbra of the settled frontier), that is, through agricultural colonization (Figure 1.). The great contribution of frontier migrants to forest conversion is underrepresented in the migration literature. Although rural movers are a minority of all migrants, especially in Latin America because of great forest availability there, a greater proportion of Latin American rural migrants are likely to settle agricultural frontiers than in Asia and Africa. These rural migrants are the major driver behind deforestation in Latin America, home to twice the tropical forests of any major world region.

< Figure 1 about here >

LUCC MODELS AND RURAL-FRONTIER MIGRATION

The land use/cover change (LUCC) literature has yet to fully embrace the importance of migration in conceptual models of deforestation. Some recent conceptualizations of LUCC include migration as a factor in deforestation within a suite of underlying and proximate causes (Meyer and Turner 1992; Turner II, Moss and Skole 1993; Ojima, Galvin and BL Turner II 1994; Lambdin, Baulies, Bockstael, Fischer, Krug, Leemans et al. 1999; Geist and Lambdin 2001). The host of underlying causes of deforestation presented in the LUCC literature generally cites the following categories of determinants: demographic, economic, technological, policy/institutional, and social/cultural (e.g., Ledec 1985; Turner II and Meyer 1994; Rudel and Roper 1997; Kaimowitz and Angelsen 1998; Contreras-Hermosillo 2000; Bilsborrow and Carr 2001; Geist and Lambdin 2001). These models constitute useful frameworks for conceptualizing tropical deforestation *writ large*; however, they were not created for exploring the primary driver behind deforestation of the globe's largest forests—rural-frontier migration. I propose that demographic, political-economic, socio-economic, and ecological forces are all implicated in migration pushes and pulls (as well as in forest conversion following frontier settlement). I contend that, unlike standard contemporary models of LUCC (e.g., Geist and Lambdin, 2001), migration represents not just one of several “underlying” demographic drivers of deforestation, but rather is the primary underlying cause of small farmer frontier deforestation, as summarized in Figure 2.

< Figure 2 about here >

From a household perspective, the categorical cleaving of LUCC and migration belies the seamless nature of the two topics. Do households make decisions to migrate under the same types of contextual factors as they do to modify land use? Or, are the two phenomena governed by fundamentally different processes? LUCC is not an ultimate outcome, nor is migration. Destination areas often become origin areas in a matter of years in the context of a rural settlement frontier. This research addresses one iteration of a multi-cyclical process, since households may migrate to various such frontiers (or not).

Following Figure 3, a sizeable “LUCC” and peasant studies literature explores agricultural intensification, as noted in the arrow pointing from “land management” to

“agricultural intensification.” Similarly, the agricultural frontier literature researches the link between “land management” and “agricultural extensification.” Demographers examine the connections between “household responses”, “fertility regulation”, and “migration.” while economists study “household responses” and “off-farm labor.” Doctrinaire researchers may cleave these topics; households do not. Households respond in one or multiple ways simultaneously or sequentially over time, acting on their agency in reaction to demographic, political-economic, socio-economic, and ecological dynamics that affect them. Frontier deforestation results when people choose to migrate to a rural frontier. The iteration addressed here focuses on households who have decided to extensify agriculture following the decision to migrate from one rural place to another. The bold arrow in Figure 3 indicates a decision to migrate to a rural destination. Once that decision has been made, agricultural expansion is a likely subsequent response. This paper explores determinants of the decision to migrate to the frontier.

< Figure 3 about here >

As scant empirical data exists at the household or community levels on the determinants of out-migration to the frontier, the pertinent literature on determinants of out-migration in the developing world in general is explored. I organize the factors associated with frontier migration into the same four categories I have used to describe the determinants of frontier deforestation (Carr 2004): (1) demographic, (2) political-economic, (3) socio-economic, and (4) ecological. The paper concludes with a consideration of how an integrative perspective on migration and frontier LUCC can guide methods of data collection and analysis for future research.

FACTORS ASSOCIATED WITH MIGRATION TO THE AGRICULTURAL FRONTIER IN THE LATIN AMERICAN TROPICS

1 Demographic Factors

As with frontier LUCC determinants, a significant component of the demographic literature is predicated on household responses to population pressures. A seminal contribution to understanding these responses was produced by Davis (1963). Based on a review of historical processes in Japan and Europe, Davis proposed that rural households may respond to population pressures by reducing fertility through postponement of marriage and increased celibacy, increased regulation of fertility within marriage, and/or increasing abortions. Davis considered out-migration a last resort if these responses proved inadequate. He also proposed that the various responses may occur simultaneously (or “multiphasically”), and that the more one response occurs—and the more the effects of population pressures on the land are thereby relieved—the less likely other responses are to occur. Several studies have supported his theory with some modifications.¹ What remains to be understood is when and where frontier migration

¹ In support of Davis’ hypothesis, Friedlander (1969) found that fertility reduction preceded out-migration in pre-industrial France, as scarce employment opportunities in French urban centers dissuaded rural-urban migration. Based on this, he hypothesized that fertility will decline to the extent that communities are constrained in relieving population pressures through out-migration (Friedlander 1969). For evidence across the developing world in support of Davis’s hypothesis, see Bilsborrow and Carr (2001), and Bilsborrow and Ogendo (1992).

occurs as a response to population pressures, a phenomenon first set in motion in migrant origin areas.

a Origin area population pressures. Population pressure has long been theorized to be an important factor driving rural out-migration. Plato wrote of migration as a means to balance population and food supplies.² A doubling of the population during the coming decades in the developing world on dwindling agricultural land portends unprecedented migration flows in the coming decades. Consistent with this trend, scholars have identified the importance of rural population pressure, exacerbated by land consolidation and scarce job opportunities, as a central migration push (e.g., Mehta 1987; Meyer 1993; Bravo-Ureta, Quiroga and Brea 1996). Although some researchers have recognized the impact of rural in-migration on local environments, largely ignored are the conditions that produce pushes in origin areas and how these conditions, and responses to them, differ across regions, communities, and households.

Population pressure in origin areas has been cited as a factor behind out-migration to the frontier in many places, including the Dominican Republic (e.g., Zweifler 1994); Panama (Heckandon and Mc Kay 1984); Brazil (e.g., Moran 1981; Almeida 1992; Wood and Perz 1996); Guatemala (e.g., Schwartz 1995; Castellon 1996; Sader, Reining, Sever and Soza 1997; Carr 2000); Costa Rica (Carvajal and Geithman 1976); Ecuador (e.g., Bilsborrow, Mc Devitt, Kossoudji and Fuller 1987; Rudel and Richards 1990; Pichón 1992; Bravo-Ureta et al. 1996); Honduras (e.g., Stonich 1989); Nicaragua (Barraclough and Scott 1987); and in the tropics in general (Bilsborrow 1992; Barbier 1997; Rudel and Roper 1997; Bilsborrow and Carr 2001).

In each of the cases referenced above, not only was high population density generally a push factor in origin areas (along with land scarcity and rural unemployment possibilities), low population density was a pull to the frontier. For example, population pressure in southern Brazil in the early 1970s was a principal factor in spurring colonist farmer migration to Rondonia and other frontier states (e.g., Amapá, Amazonas, Pará, and Roraima) in the Brazilian Amazon region during the latter half of the 20th century (Skole, Chomentowski and Nobre 1994). Demographic pressure, coupled with land consolidation, meant that, by 1972, 72% of farms in Brazil were smaller than “the recommended size” for family well-being (Wood and Perz 1996). The trans-Amazonian highway and its attendant colonization were hailed as solutions to overpopulation in Northeast Brazil (e.g., Moran 1983; Almeida 1992). Decades of land consolidation and high fertility in the Ecuadorian highlands, as in Brazil, led to land pressures and induced colonization of that country’s Amazonian region (e.g., Rudel 1983; Pichón 1992). Where population pressures were reduced by land reform, out-migration decreased (Bravo-Ureta et al. 1996).

Similarly, in Guatemala, Bilsborrow and Stupp (1997) report that population growth, exacerbated by one of the world’s most skewed land distributions, resulted in a doubling of small farms between 1964 and 1979, primarily in the densely populated altiplano. They conclude that land fragmentation from high fertility and lack of rural employment are related to past and projected future patterns of migration from rural areas. Similar conditions have pushed thousands of landless Q’eqch’í Maya from the highlands of the *departamento* of Alta Verapaz to the north slope of the largest national park in the country, Sierra de las Minas National Park

² Plato argued in his *Laws* (5, 735) that the wise statesman will “purge” the “body politic” of a “plague” of rebellious, hungry people by shipping them abroad, and gave the euphemistic title of emigration to their evacuation.

(Castellon 1996) as well as to the Maya Biosphere Reserve in Petén (e.g., Schwartz 1995; Sader et al. 1997; Carr 2000).

b Household demographic characteristics. While an expanding literature attests to the importance of household and individual characteristics in general (e.g. Mulder 1993), few studies have examined such factors in relation to frontier migration specifically. A large amount of knowledge has now been accumulated, however, regarding rural out-migration determinants in developing regions.

Young, unmarried, or recently-married adults are the most likely to migrate, often to establish an independent household (Carvajal and Geithman 1974; Perez 1985; Root and De Jong 1991; Almeida 1992; Chant 1992; Cruz 1992; Eastwood 1993; Ram and Singh 1994; De Jong 1996). Furthermore, migration is often gender-specific, and intra-household hierarchies and gendered division of labor have emerged as important factors affecting household and gender-specific migration patterns (Lawson 1998). For example, women frequently outnumber men in urban migration streams in Latin American due to the changing gender divisions of labor in the international economy and the expanding role of women in industrial production (Marcoux 1990; Chant 1992; Bravo-Ureta et al. 1996; Laurian, Bilsborrow and Murphy 1998; Lawson 1998; Bilsborrow 2001b). Women are also much more likely than men to migrate to accompany their spouse (Bravo-Ureta et al. 1996; Laurian et al. 1998). Conversely, migration to the frontier is sometimes initiated by men who establish a farm before bringing the family to settle (Townsend and Acosta 1987; Laurian et al. 1998). Although potential causal relations have not yet examined fertility and frontier migration, that frontier households have larger families than households in sending regions suggests demands to feed children is a plausible migration push from land-scarce rural regions (e.g., Weil 1981; Rundquist and Brown 1989; Murphy, Marquette, Pichón and Bilsborrow 1999).

2 Political-economic Factors

a Macro-economic factors. Unlike the modest literature on demographic determinants of migration, a rich literature exists on economic and political rural-frontier migration determinants. As economist Adam Smith (1863) and migration theorist Ernest George Ravenstein (1889) posited over a century ago, spatial inequalities inherent in economic and political structures induce populations to flow from low-wage to high-wage areas, while distance exerts a negative influence due to economic costs and socio-political barriers. Smith hypothesized that migration is a crucial mechanism by which people improve their welfare by moving from places of labor surplus and depressed wages to areas of labor scarcity and high wages (Smith 1863). Classical economist coevals such as David Ricardo considered such mobility as crucial to development (Ricardo 1887). Later, Lewis (1954) and others elaborated on this theme by describing migration as an equilibrating mechanism through which labor is transferred (Lewis 1954).

In recent decades, several studies from the developing world have further supported these theories (e.g., Gardner 1981; Mollett 1991). Using census data from 98 countries around the world, Larson and Mundlak (1997) found that the magnitude of the differences in average income was a significant determinant of the pace of off-farm migration. Latin America offers numerous examples to support this hypothesis (e.g., Adams 1965; Carvajal and Geithman 1974; Arévalo, Macció and De Lombardi 1981; Regional Employment Program for Latin America and

the Caribbean. 1983; Mörner and Sims 1985; Morrison and May 1989; Lezama 1991; Castillo 1995; Bravo-Ureta et al. 1996; Bajraj, Bravo and Tapinos 1997).

A notable migration push for rural Latin Americans is the unequal land distribution that has left more than half of Latin American agricultural workers landless (Barraclough 1991). This landlessness stems in part from population growth, as discussed above; unequal land concentration and joblessness represent two key factors as well (e.g., Findley 1987; Barraclough 1991; Brown 1991; Stonich 1993). Some studies have observed that when people have land, out-migration is attenuated (Johnston and Clark 1982; Wood 1982; Findley 1987; Mehta 1987; Marcoux 1990; Mc Nicoll and Cain 1990; Bravo-Ureta et al. 1996; De Jong and Winsten 1996). Others have noted that migration streams are larger to destinations where the available forestland is greater (Amacher, Cruz, Grebner and WF 1999).

b Institutional factors. Institutional interventions may modify national-level economic patterns so as to favor certain migration movements over others (e.g., Geiger 1975). For example, government investments in city infrastructure and subsidies directed towards the urban consumer have encouraged rural-urban migration throughout the developing world (as hypothesized by Zelinsky, 1971). Conversely, institutional policies have also favored the modernization of the rural sector, pushing small farmers from their land.

Rural-urban migration overwhelmingly dominated debates about internal mobility in Latin America until the 1980s (Cruz 1992; Bilsborrow and Carr 2001). Following the debt crisis of the 1980s, the stream's course was altered, increasing flows to secondary cities and rural frontiers (Mougeot 1985; Altamirano, Hirabayashi and Albó 1997). A common push behind frontier colonization involves rural landlessness associated with an expanding commercial agricultural sector. Pulls to the frontier include access via road construction, which reduces the resistance of distance; the availability of cheap farmland; and government incentives promoting agricultural settlement. These factors appear recurrently throughout the literature on frontier colonization (Martine 1981; Moran 1984; Schmink and Wood 1984; Findley 1988; Jones 1990; Lisansky 1990; Almeida 1992; Cruz 1992; Kummer 1992; Pichón 1992; Bilsborrow and Geores 1994; Browder 1994; Brown and Sierra 1994; Barbier 1997; Locher 1997; Rudel and Roper 1997; Sader et al. 1997; Angelsen 1999).

The literature on the colonization of the Amazon basin illustrates the role of institutional policies as push and pull migration factors. Starting in the early 1960s, Brazilian national policy promoted a westward expansion to tap Amazonia's unexploited resources (Pool and Stamos 1987; Foresta 1992). Restructuring was implemented to pay international loans (Martine 1990). As a result, the agro-export sector expanded such that the nationwide cropland area in soy ballooned six-fold in the 1970s, covering more than ten times the area than all other crops except oranges and wheat, and commanding half the global soy market by the 1980s (Skole et al. 1994). During this time, rural household income streams evaporated as machine-intensive soy replaced labor-intensive coffee in Paraná, Mato Grosso, and Mato Grosso do Sul (Goza 1994). As a result, Paraná—which had grown at a 6% annual rate between 1940 and 1970—led Brazil in *out-migration* in the 1970s and 1980s (-3.5% annually according to Martine, (1988). Many migrants settled in cities, but hundreds of thousands colonized the frontier regions of Rondonia (Browder 1994; Goza 1994). A key policy promoting frontier colonization was the National Integration Program, which sponsored the construction of the Trans-Amazon Highway (Moran 1983; Fearnside 1986). The infrastructure provided by colonization increased the value of land on the frontier and attracted new interest groups to the area, in addition to settlers (Almeida 1992).

Political incentives also fostered the colonization of the western periphery of the Amazon basin. For example, the 1979 "Law of National Security" promoted bolstering the security of Ecuador's Amazon region by populating frontiers with military forces and civilian settlements (Pichón 1992). The resulting influx of migrants has attended an almost 2% per annum rate of deforestation in Ecuador's Amazon, the highest of any Amazonian nation. Fewer than 100 km to the north, in the Colombian Amazon, institutional subsidies and investments in infrastructure spawned a land market distortion whereby the existing farmland was overpriced, while frontier land remained under-priced, leading to population movements to frontier regions and rapid forest clearing (Heath and Binswanger 1996). As property rights were established on the frontier, rising land rents forced poor households to move on, bought out by wealthy landowners (Heath and Binswanger 1996).

Policy incentives to frontier colonization have been noted throughout Middle America as well. For example, in the Dominican Republic, government construction of access roads opened up frontier settlement by agricultural colonists and logging interests (Brothers 1995). Similarly, in southern Honduras (De Walt, Stonich and Hamilton 1993; Stonich 1993; Humphries 1998) and Nicaragua (e.g., Barraclough and Scott 1987), frontier deforestation was spurred by government promotion of the expansion of cattle ranching and plantations of cotton and sugar cane, both for export, on lowland areas with good soils. Smallholders were then forced to migrate to nearby mountain slopes to establish new farms. Likewise, in Costa Rica, robust immigration to the capital city of San Jose evaporated in the early 1980s, turning negative in favor of frontier migration (Cruz 1992). The debt crisis of the 1980s, precipitated by the rise of oil prices in 1979, had the effect of contracting lending due to soaring interest rates, depressing urban wages, and desiccating urban employment sources. As a result, from 1979 to 1984, sparsely populated rural areas nationwide grew 3% while the rest of the country lost population, including densely populated rural areas (at -2.5% annually) (Cruz 1992). Meanwhile, institutional pulls to the frontier were already written into national laws approved in the first third of the 20th century, permitting all citizens to solicit state lands, legalizing all land occupations, granting title to invaders of private property, and compensating existing owners with government lands (Meyer 1993). Other regions, including Guatemala's Petén, offer a further example of economic and political incentives to frontier deforestation (Schwartz 1990; Carr 2000).

3 Socio-economic Factors

a Household socio-economic characteristics. Macro-level institutional and political factors may determine the level of pressures to migrate, the relative advantage to migration, the overall magnitude of migration, and the timing of migration; but, micro-level factors impact *who* migrates. After all, decisions to migrate are made at the micro level and are usually household decisions (De Jong and Gardner 1981; Gardner 1981). Indeed, most people *do not* migrate despite huge income differentials across regions, supporting the notion of migrant selection (Brown, Horton and Wittick 1970; Goldscheider 1971). Thus, Wood (1982); Bilborrow and colleagues (1984); Massey (1990); Findley and Li (1999), and others, have argued for an approach that integrates economic and other factors embodied in perceived "place utility" with

structural factors inherent in the context within which migration decisions are made (Wolpert 1965; Wolpert 1966; Bible and Brown 1981).³

The standard microeconomics approach hypothesizes that people compare their earnings in their place of origin with their expected earnings at possible destinations in making their migration decisions (Sjaastad 1962; Todaro 1969). According to this human capital model, potential migrants will make decisions based on the economic costs and benefits of migration. (Sjaastad 1962; DaVanzo 1981a) Human capital is affected by individual characteristics such as education, age, sex, and work experience (De Jong and Gardner 1981; DaVanzo 1981b) An extension of the human capital model is proffered by Todaro (1969). According to Todaro's model of rural-urban migration, the decision to migrate includes an expected stream of income, which will depend on wages at the destination area and a subjective estimate of the probability of getting employment that provides those wages at the destination (Todaro 1969). Todaro's thesis, with some modification, is generally supported by the literature on rural out-migration and rural-rural migration in the developing world in general, and in Latin America, specifically (Lee 1966; Todaro 1969; Goldstein 1979; DaVanzo 1981b; Massey 1990; Stark 1991). For example, income and land ownership differentials were important determinants of off-farm migration in several cases from the Latin American migration literature (Mörner and Sims 1985; Morrison and May 1989; Castillo 1995; Bajraj et al. 1997).

In addition to micro-economic, demographic, and structural contexts already discussed, characteristics of the rural household that may encourage migration include a desire to improve the quality of life (with respect to education, health care, public works, entertainment, etc.) (Boyle, 2004). Factors encouraging retention may include satisfaction with the above factors, a "pleasant" home life, ties to family and friends, and dependency on children's labor (Goldscheider 1971; Goldstein 1979; DaVanzo 1981b; Oberai and Bilsborrow 1984; Massey 1990; Stark and Taylor 1991; Bilsborrow 2001a).

While the literature on household migration determinants in general is massive, it is virtually non-existent for rural-rural migration. The relatively modest literature that does exist suggests that the migration determinants for rural-rural migrants are similar to those for rural out-migrants in general, with a few important exceptions. First, for rural-rural migrants, reconciling wage differentials may not be the primary aim of the move as much as household security. In other words, their strategy in an uncertain environment is survival rather than accumulation. Following household survival strategy, rural migration is a way for the household to maximize its chance for survival in an uncertain environment (Arguello 1981)⁴

The rural-frontier migrant farm household is sacrificing the potential for improving their lot in almost every aspect except for the chance to acquire land. Thus, it is unsurprising that the frontier LUCC literature cites land scarcity as an important migration push and land abundance

³ Wolpert (1965; 1966) conceptualized place utility as the perceived utility of current locations relative to the perception of the utility of other places. Wolpert further argued that another factor, threshold formation, must be accounted for. Threshold formation constitutes the stresses in the current place of residence relative to the potential migrant's threshold for stress (Wolpert 1965).

⁴ A similar theory is that of the "new economics of labor migration" which considers migration as a means for the household to spread risks by providing an alternative source of income against, for example, crop failure, illness, or uncertain credit (Stark and Bloom 1985; Stark 1991; Stark and Taylor 1991). As this theory concerns individual migration as a means of diversifying household risk, it is only peripherally related to the migration of complete households to the frontier. But it could serve as a useful heuristic as applied to the phenomenon of initial male-only "prospective" migration to the frontier that, in some cases, precedes household migration to the frontier.

as a crucial pull for colonists throughout Latin America. For example, it is generally hypothesized that the rural landless migrate more, and are more likely to migrate to the frontier, than those with land or those who can readily increase income through cash crops (Marcoux 1990). Land is crucial; when people have land, out-migration is attenuated (Johnston and Clark 1982; Wood 1982; Findley 1987; Mehta 1987; Marcoux 1990; Mc Nicoll and Cain 1990; Bravo-Ureta et al. 1996; De Jong and Winsten 1996). Similarly, research on frontier colonization has consistently found that land is the primary pull factor to the frontier (e.g., Henkel 1994; Fujisaka et al. 1996).

Few of these studies, however, support this relation through formal survey data from representative samples of colonists and none has linked surveys in origin areas with field research on deforestation on the frontier. Based on a survey at the destination area only, Fujisaka and colleagues (1996), found that, of households who were repeat frontier migrants in Amazonia or Acre, over half cited lack of land as the main reason for migrating, compared to only 10% indicating lack of plantation work.⁵ Another study from the Brazilian Amazon on rural-urban migration, included a rare design of field work in both origin and destination areas. Informants cited land acquisition as the primary pull for frontier migrants versus the desire to enjoy improved public infrastructure and education as the main goal for urban migrants (Henkel 1994).

Similarly, in the Dominican Republic, rural-urban migrants were more motivated to improve their income than migrants to rural areas who considered land acquisition more important (Carvajal and Geithman 1976). Lastly, regarding rural-rural migration in Mérida state, Venezuela, 85% of non-migrants successfully applied for credit compared to 21% of migrants (Eastwood 1993). It is interesting to note in this latter study that most wished to stay in the area of origin, suggesting that they felt that migration was a necessary survival strategy (Eastwood 1993), as is generally hypothesized (Rudel and Horowitz 1993). Other studies, however, suggests that the rural landless are not always positively selected in rural-frontier migration. Rudel and Horowitz (1993), for example, found that migrants to the southern Amazon had not been the poorest persons in their areas of origin, suggesting that they were motivated by improving their well-being rather than by necessity. Similarly, in the Ecuadorian Amazon, out-migrants were poorer than non-migrants (Laurian et al. 1998) as cattle ownership (a proxy for capital accumulation) retained children, while more crops encouraged children to out-migrate (Laurian et al. 1998).

While a lack of data makes generalizable household characteristics associated with frontier migration unclear, the choice by frontier migrants to seek land rather than wage labor suggests household selectivity. Thus, the question becomes: which of the household socio-economic characteristics elaborated in the literature on household migration determinants (e.g., education, employment experience, level of economic security, and the experience of family and friends who have migrated) most strongly relate to decisions to migrate to the frontier and what processes (e.g., social networks) facilitate them?

b Migration networks. In addition to the many pushes and pulls mentioned above, migrants are drawn to destinations where family and friends reside (Entwisle, Walsh, Rindfuss and Chamrathirong 1998; Laurian et al. 1998). Migration networks may assuage the stress

⁵ Nevertheless, approximately three-quarters of Trans-Amazon colonists required some kind of wage labor to survive once on the frontier. When jobs evaporated and forest resources were depleted, colonists were left with few options but to out-migrate (Hecht and Cockburn 1989).

associated with migration (e.g., Lee 1966; Trewartha 1969; Goldscheider 1971; Alonso 1978; Hugo 1981; Lee 1985; Massey 1990; Root and De Jong 1991). The extent and quality of information received from friends or relatives are thus important migration destination determinants (Massey 1990; Stark 1991; Stark and Taylor 1991). Conversely, strong local community ties (e.g., Abeysekera 1984; Bilsborrow et al. 1987) may favor retention. The importance of migrant networks is found in several examples of migration in Latin America. For example, 37% of out-migrants from the Ecuadorian Oriente region came from households with previous migrants compared to 19% of non-migrant households (Laurian et al. 1998). Similarly, Guatemalan refugees in Mexico during the 1980s and 1990s enjoyed long contact with neighboring Maya groups sharing linguistic and even familial affiliation prior to migrating, thus directing family and friends to those destinations (Aguayo, Christensen, O' Dogherty and Varese 1987; Hamilton and Chinchilla 1991).

c Education. Rural-frontier migrants are also selected for educational achievement and job and farming skills. Educational achievement is mentioned as an important determinant of migration in the broader migration literature (Goldscheider 1971; Gardner 1981; DaVanzo 1981a; Oberai and Bilsborrow 1984; Mehta 1987; Root and De Jong 1991). Several studies from Latin America suggest that rural-frontier migrants are less educated than non-migrants and migrants to other destinations. For example, examining migration among towns and small cities, Mougeot (1985) found that lower education was associated with selecting rural destinations. He hypothesized that these migrants move where they can best compete in the work force, perceiving themselves as less capable of competing in urban areas (Mougeot 1985). Similarly, Carvajal found that in rural areas of the Dominican Republic, education is associated with migrant retention; while the reverse is true for urban out-migration (Carvajal and Geithman 1976). Research in the Ecuadorian Amazon found that out-migrants from the frontier tend to have fewer years of schooling than the national average (Laurian et al. 1998). Lastly, mixed results were found in Mérida state, Venezuela: no significant difference was found in educational achievement between rural-rural migrants and non-migrants, yet migrants did have higher achievement motivation (Eastwood 1993).

In sum, household selectivity is a central theme in migration research, yet a paucity of data exists on this topic for rural-frontier migration. Limited data suggest that, in contrast to non-migrants and migrants to other destinations, rural-frontier migrants are poorer, less educated, and have less wage-labor experience. As a result, they aim for household security in the form of land, rather than competing against better skilled laborers in urban or international destinations. Other potential selectivity characteristics merit further research, including ethnicity (Hawrylyshyn 1977), religion (Guest and Uden 1994), and the topic of the next section, ecological change.

4 Ecological Factors

Throughout human history, hunter-gatherer tribes, shifting cultivators, and even modern agricultural farms have moved once the natural resource base was depleted (Wolpert 1966). Yet most studies on environmentally-induced migration concern displaced persons, mainly internationally (refugees), due to natural disasters (e.g., IOMRPG 1992; Hugo 1995; Kane 1995).

Much less research exists on migration promoted by gradual environmental deterioration (Lonergan 1998; The Natural Heritage Institute 1998).⁶

Similarly, most research on how people respond to changing environmental conditions has not focused on migration (e.g., Bilborrow 1987; Panayatou 1994), but rather has concentrated on agricultural intensification or extensification (Turner II and Ali 1996; Moran, Brondizio, Tucker, Silva-Forsberg, Falesi and McCracken 2000). When migration is induced by poverty and malnutrition from declining agricultural yields, which in turn results from environmental degradation, then environmental change is an important underlying cause (World Bank 1991b).

The scant research on environmentally induced migration is inconsistent with global estimates highlighting the phenomenon's importance. An area of about 1.2 billion hectares, nearly the size of India and China together, has endured modest to severe soil degradation since World War II. Over three-quarters of this degradation has taken place in developing countries. As a result, yields and harvests have declined in many regions, especially sub-Saharan Africa, resulting in massive numbers of environmentally-induced migrants (Swain 1996). In the case of peasant households, improving existing agricultural land for the long term must be weighed against the option of simply abandoning that land and migrating to the frontier, or to another place where wage labor can replace subsistence and market production (Barbier 1997); many choose migration. In fact, 25 million people are estimated to be environmentally displaced worldwide according to the UN High Commissioner on Refugees (UNHCR-IOMRPG 1996). Likewise, Lonergan (1998) estimates that of the 80 million migrants worldwide in 1990, as many as 25 million migrated for environmental reasons.

Some examples of environmentally induced migration are found in Brazil and elsewhere in Latin America. Poor households in Brazil, following declining yields during recent decades, have migrated to marginal upland areas in the Amazon, resulting in land abandonment and out-migration (Heath and Binswanger 1996).⁷ The fact that Rondonian soils were reputed to be of much better than average quality compared to those in much of the Amazon region was a pull-factor for migration to that area (Martine 1990). More recently, poor soil, drier climate, and land disputes have led to considerable land degradation, farm abandonment and the sale of ranches to large landholders on the Brazilian frontier (Schneider 1993). Land degradation resulted in up to 80% of pastureland in Brazil's Amazonia being abandoned by the early 1980s, as farmers migrated to cities (Browder 1997) or to new frontiers (Hecht 1983). Soil degradation in the western basin of the Amazon may also have been a factor in out-migration. A household survey from the Ecuadorian Amazon determined that males are more likely to leave if the plot has poor soil (Murphy et al. 1999).

Several examples of ecological deterioration promoting out-migration also exist in Middle America. For example, in Las Auyumas, Dominican Republic, settlers had cleared almost all of the original forests in the community by the early 1940s, and soil fertility began to decline. As predicted by Boserup (1965), fallow rotations were shortened in response to increasing population density by the 1960s, reducing the nutrient regeneration of the soils. By the early 1980s, soil productivity had fallen dramatically and much of the young male population

⁶ Some exceptions include research on climatic change and migration from Oceania (i.e., Moore and Smith 1995), in general (e.g., Kritz 1991), and in reference to drought (e.g., Findley 1994).

⁷ Conversely, Zimmerer (1989; 1993) and Collins (1987) present an interesting case from highland Peru in which environmental degradation *followed* out-migration due to a decrease in rural labor, which had maintained agricultural terraces.

had out-migrated (Zweifler 1994). Similarly, Cruz (1992) reports that in Costa Rica, the debt crisis of the 1980s precipitated rural poverty, which linked directly to land degradation and, finally, out-migration to the frontier. Lastly, Nietschmann's (Nietschmann 1973; Nietschmann 1979; Carr forthcoming) work in Nicaragua describes how environmental degradation spurred out-migration of Miskito families following the disappearance of over-exploited tree and gold resources.

I have discussed rural out-migration in the developing world, with a specific emphasis on agricultural colonization zones as a destination within a conceptual framework of underlying demographic, political, social, economic, and ecological factors involved. This migration flow, though small in relative numbers, is of critical importance to environmental conservation and rural development but is largely overlooked in the demographic literature. The following section summarizes the findings from the literature and discusses the importance of the topic for future research and for policy.

CONCLUSION

I have argued for the importance of studying rural-rural migration in order to more fully understand the process of deforestation in the tropics. The reverse is also true: exploring land use change can help illuminate migration processes and determinants. The process driving deforestation in the tropics is cyclical: resource pressure among rural populations induces out-migration, but land use adaptations to population and resource pressures generally precede demographic responses (e.g. Bilsborrow, 1987). Therefore, the relative success of rural households in adapting to changing conditions by modifying land use and strategies of resource use is a critical determinant of out-migration and, ultimately, deforestation in both origin and destination areas.

Boserup (1965), Turner II (1977), and other population-environment scholars have described how farm families respond to land pressures, such as land scarcity, land degradation, and population growth, through agricultural intensification. Davis (1963) and Bilsborrow (1987) have added how, at greater levels of population density, families may also respond demographically through fertility reduction, and out-migration. A major result of out-migration in recent decades has been dramatic land cover change at recently colonized forest margins in the tropics, where population pressures and resource scarcity have not reached a point of inducing significant intensification or demographic responses among farmers. Indeed, it is this very low population density that permits extensive agricultural practices and massive deforestation. Nevertheless, population pressure and/or resource scarcity in colonists' areas of origin likely encourage intensification, as elaborated by Boserup and others, and ultimately spur out-migration, as discussed by Bilsborrow, to sparsely settled forests.

The importance of dynamics that spur out-migration in origin areas is discussed by some scholars mentioned here, specifically Bilsborrow and Geores (1994) and Pichón (1992) in Ecuador, Wood and Perz (1996) in Brazil, Castellón (1997) in Guatemala, and several others (e.g. Pichón 1992; Bilsborrow 1992; Houghton 1994; Wood and Perz 1996; Barbier 1997). Indeed it is axiomatic that human intrusion necessarily antecedes deforestation on an agricultural frontier. The phenomenon of small farmer colonization and deforestation in tropical resource frontiers is more multi-scaled, organic, and cyclical than is often portrayed in the literature.

What has been largely ignored is how household reactions to their human and physical environment in one place may affect land cover change in another place.

Studying migration and land use as discrete subjects of inquiry precludes a comprehensive understanding of the process by which rural households attempt to maximize resource access. Migration fronts are as important as migration frontiers when considering the determinants of tropical deforestation. Farmers are not clearing forest if the area was settled a hundred years ago, they are clearing forest where forest exists, in remote agricultural frontiers, often in and around protected areas. So why people migrate to the frontier is as essential a question to address as what they are doing once they are there.

If we are interested in understanding variables that influence land use and land cover change, we must inquire not only how people are managing land, but why people come to be there in the first place. Researching only variability in forest clearing at the farm level in the destination area does not provide the whole picture. Even if farmers continue to grow crops, we cannot be sure that, with changing markets and transport infrastructure, they will grow the same crops in the same manner. For example, recent Geographic Information Systems (GIS) modeling efforts may boast a high degree of accuracy given current conditions. But if origin conditions, not currently in models, change, so will frontier LUCC. A more critical question regarding land use change over time is understanding why farmers migrate to agricultural frontiers initially and how this process leads to the penetration of large cattle ranching, export agriculture, and further colonization.

In examining the outcome of deforestation, then, it may be useful to distinguish between internal and external frontiers. Internal frontiers represent the forest remaining on existing farms. We can understand changes in the internal frontier by examining farmer land use. The external frontier represents the vast unoccupied forest beyond the last farms of an agricultural frontier. This is where the main potential for significant deforestation remains. We can better understand the potential for deforestation on the external frontier only by researching migration to that frontier.

Both land use on the frontier and migration may be conceptualized under the same broad categories (as in Figure 2): demographic, economic and political, socio-economic, and ecological. Processes immediately affecting the former constitute proximate factors. Dynamics determining the latter constitute underlying factors (with frontier deforestation as the ultimate outcome). From the perspective of the household, when dramatic deforestation occurs on the frontier, it is because families responded to resource inequalities by extensifying their agriculture, only they are doing so not in their residence of origin, where they are unable, but rather in areas in remote forested areas where they are able. Land use is not an ultimate denouement, nor is migration. Households will make decisions over and over again, changing their land use, migrating, seeking off-farm employment, etc., in cyclical iterations of migration and LUCC. The demographic, political, economic, social, and ecological dynamics driving rural-rural migration must be better understood before policy is properly informed in efforts to alter this migration stream critical to the future of tropical forest conservation and rural development.

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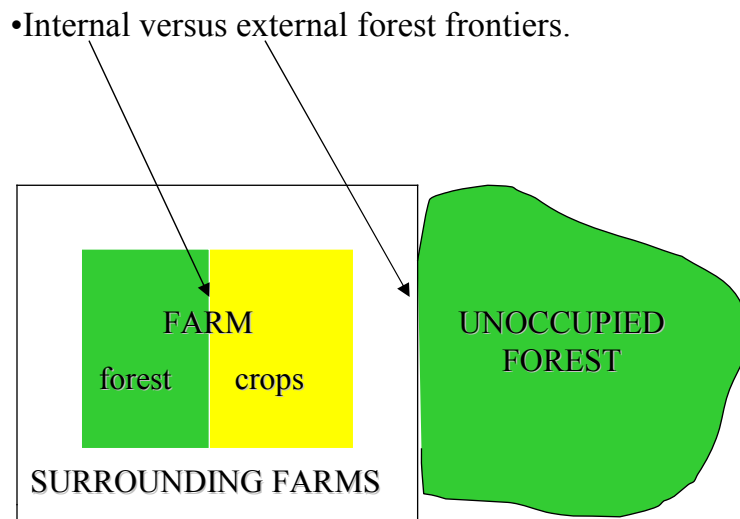
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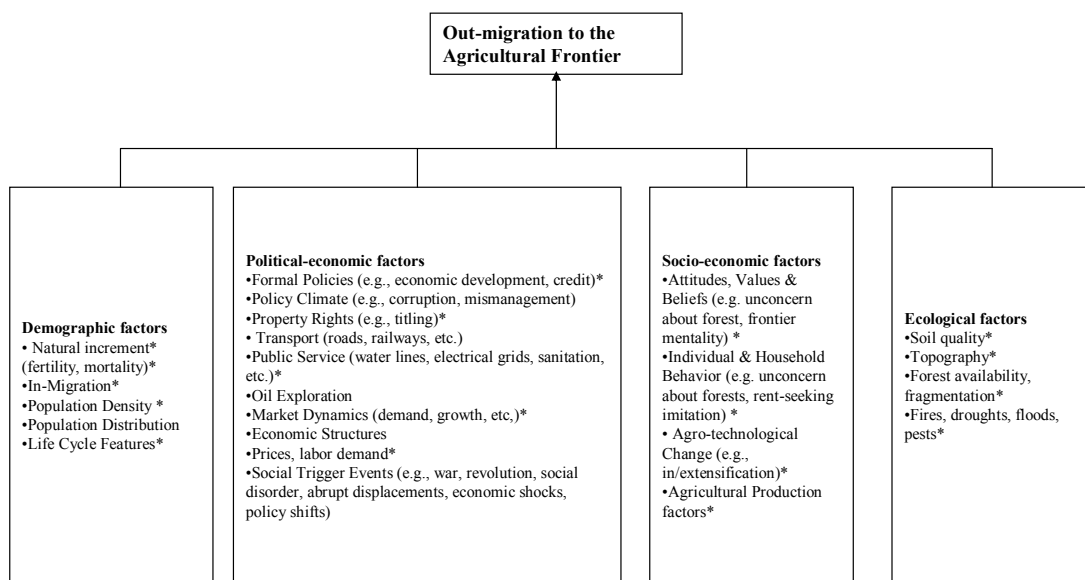
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FIGURES

Figure 1. Internal versus external forest frontiers.



**Figure 2. Factors affecting a necessary underlying cause of deforestation in an agricultural colonization frontier:
Out-Migration to the frontier**



*Can be measured at the household/farm level. All of these variables can be measured at larger scales of analysis as well, and all of them, of course, are hypothesized to affect household migration decisions.

Figure 3. Rural household responses and frontier LUCC

