

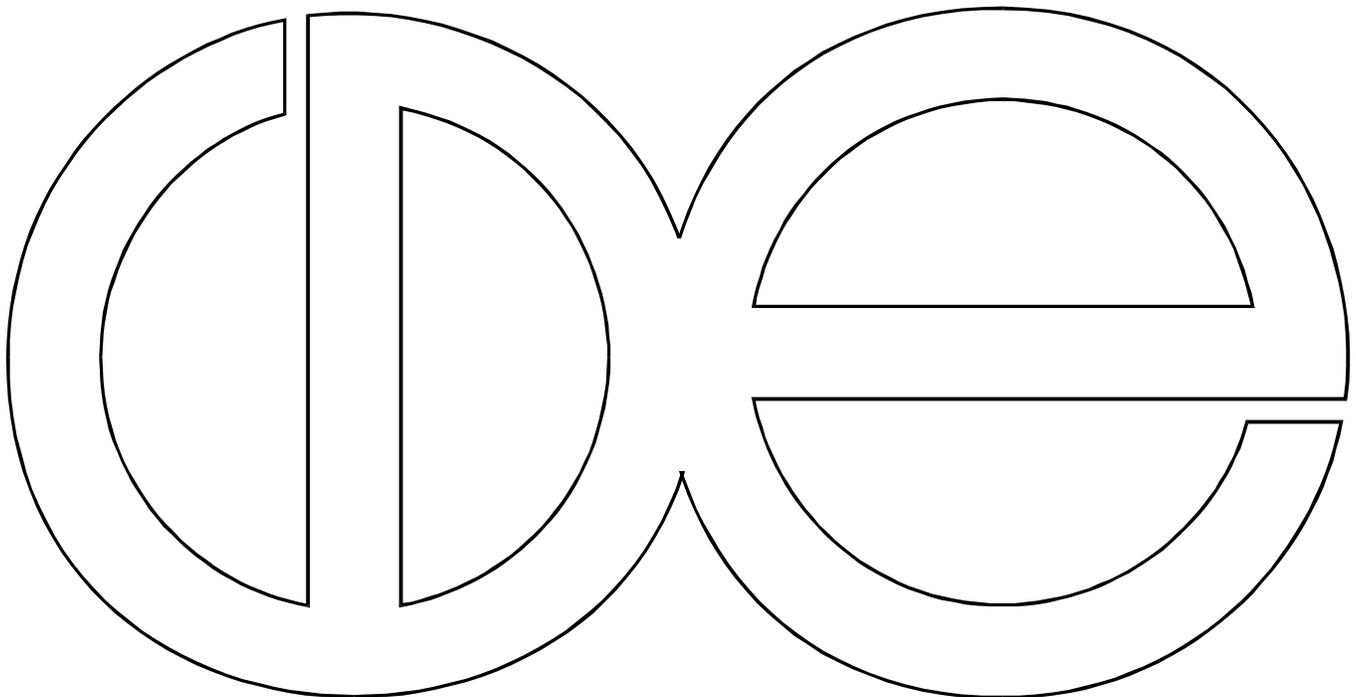
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**Bringing the Household Into the Population and  
Environment Debate: The Environmental  
Effects of Timing Migration According to the  
Household Life Cycle**

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**BRINGING THE HOUSEHOLD  
INTO THE POPULATION AND ENVIRONMENT DEBATE:  
THE ENVIRONMENTAL EFFECTS OF TIMING MIGRATION  
ACCORDING TO THE HOUSEHOLD LIFE CYCLE**

by

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## ABSTRACT

This paper is intended to enhance the literature on population and the environment by developing a model that takes into account age and gender composition of rural households in order to explain variation in the timing of migration and decisions about land use. In differently structured households, migration patterns may reduce or delay environmental degradation by limiting dependence on the productivity of the land, or these patterns may increase degradation by contributing to extensification with slash and burn methods or intensification with inappropriate inputs.

I show that the arguments that characterize the current population and environment debate capture the importance of migration on the agricultural frontier only marginally. Where migration is considered, researchers often ignore the changing capacity of a household's members to migrate, either permanently or temporarily, over the course of a household's life cycle and development. This framework is flawed because it assumes an idealized context with an indefinitely productive frontier or ignores the possibility that local conditions may pressure households into using temporary migration as a survival strategy, or as a means to obtain more advanced inputs. By recognizing the potential for migration patterns to continue after initial resettlement on the frontier, we should be able to better identify the emergence and persistence of land use patterns.

I formulate a model that considers how environmental change drives rural households to modify their income strategies, and the ways in which these strategies are conditioned by the household life cycle. Responses to change then influence future activities which perpetuate

environmental change, although at different rates, depending on what resources are available to the household in a given life cycle stage. The model emphasizes the producer/consumer ratio and human capital in a household, the household's social capital, the condition of the landholding, and the desirability of increasing land use relative to other strategies at a given time as factors that contribute to both the probability of migration and decisions about land use. In addition, changes in household activities that result from migration patterns at different life cycle stages are considered. These include changes in land management, use of inputs, extensification, or land acquisition.

To operationalize this model, I propose collecting a data set that includes event history calendars providing information on the life history of the household, its migration history, and its land use history. I then suggest using event history analysis to determine the hazard rate of the initiation of migration and changes in land use and labor supply. Together, these models can provide information about the way in which farmers are changing their income-generating strategies and the ways in which they are using land. By including the household life cycle, these models can also explain part of the variation in rates of deforestation due to small farmers and predict future rates of deforestation based on the types of households and migration patterns prevailing in a region.

The literature on population and the environment in developing countries has focused on the relative impact of *population growth* on rates of deforestation and degradation (UN 1994, Brown and Kane 1994, Ehrlich and Ehrlich 1990, Simon 1981). Where *population distribution* is considered, most work concentrates on the effects of urbanization and increasing market demand on resources (Mutlu 1989, Firebaugh 1984). The environmental impact of the migration patterns of rural households has been largely ignored, although permanent migration to a country's agricultural frontier and selective temporary migration from rural to urban areas continue to provide important survival strategies that influence land use decisions by small farmers.

This topic is important because even if rural-rural migration represents only a small portion of total migration in a country each year, the process can still have severe environmental consequences, particularly if migration flows encroach on fragile lands. Resettlement on the agricultural frontier is regarded popularly as the proximate cause of deforestation: small farmers around the world, and especially those in Latin America, are held accountable for a majority of the recent increase in deforestation (Crossette 1996, Margolis 1996). High levels of slash-and-burn practices are appearing in both the extensification of agriculture on current landholdings and the opening of new lands to farming. Farmers are seen as the chief proximate cause of deforestation, although large-scale, capital-intensive corporate farmers, cattle ranchers, and loggers also practice unsustainable land use. Specifically, the upswing in deforestation rates in recently settled areas is considered to be the outcome of a response by farmers to poor weather conditions and reduced enforcement of land use practices by government agencies. Other environmental problems like erosion, salinization, and contaminated water are also thought to be the result of a stream of rural

migrants putting constant pressure on an increasingly fragile resource base (UN 1994).

Permanent resettlement in newly incorporated areas is not the only form of migration that affects natural resource use patterns, however. In other rural households, *temporary migration* is a risk-diversifying economic survival strategy that creates less household dependence on agricultural yields. Over the course of a household's development, in fact, remittances from temporary wage labor can become the main source of household income. Consequently, land use can become less intensive (Massey et al. 1987). On the other hand, savings from remittances might be applied to extend a landholding in order to undertake specialized cultivation (Moran 1996).

These examples demonstrate the variation in possible outcomes for the environment that stem from decisions about migration. But how do we determine who is likely to migrate, and what the nature of that migration will be? Researchers have looked at institutional and local constraints that make some households more likely to succeed on a landholding than others depending on access to resources and the quality of a landholding (Wood and Wilson 1984, Moran 1983). The structure and age and gender composition of the household are considered neutral factors in these analyses. In contrast, I contend that the form of the household is fundamental in determining the household's capacity to respond to these external constraints. In other words, households will necessarily respond differently to a given set of social and economic arrangements because the labor, resources, and savings available in the household to respond to those arrangements will be determined largely by who is there. These differences are important if they lead to fluctuations in land use and environmental change.

In this paper I suggest a household life course model to explain variation in household level decisions about rural migration, consequent changes in household activities, and the resulting environmental impact. In addition to explaining variation, the model is also useful for predicting fluctuations in deforestation and other environmental indicators which result from the aging of rural households. In section I, I introduce the classical economists' perspective on the relationship between population and the environment and provide an overview of responses from other researchers. I contend that this debate has ignored a significant part of the variation in land use patterns by failing to consider the household's ability to use selective temporary migration or permanent migration at different household stages. In section II, I discuss the value of using a household-level analysis of rural migration decisions to sharpen this debate. I then provide a brief overview of household life cycle theory, describe some of its relevant weaknesses, and show how life course analysis overcomes some of these flaws. I then review three studies of migration in Latin America that have paid attention to the significance of the life cycle of households in shaping migration patterns and the consequent environmental impact of those patterns. In the last part of this section, I suggest how a similar life course model focused on the relationship between households and the changing environment could make the dynamic more explicit. In section III, I discuss previous efforts to develop models that identify different land use strategies over the course of a migrant household's development on the same plot. I use this as a springboard in section IV to suggest a research design that pulls together the arguments in earlier sections. This model will track migration and land use patterns across the life span of rural households. This research design can shed light on the environmental causes and consequences of temporary and

permanent migration and changes in household activities when these strategies are used in response to a system of constraints and incentives that govern land use. Finally, I offer a discussion of the model and conclude with a summary of the arguments made in this paper.

## **I. The Current Framework of the Population and Environment Debate**

In this section, I review four schools of thought that characterize the population and environment debate. Although each argument presents an increasingly complex relationship between population, the environment, and mediating institutions, the set of arguments fails to consider the evolving capacities of the rural household. To the extent that differences in household composition and stages in the life cycle create differences in land use, these arguments fail to explain a component of fluctuations in resource use and environmental change. Therefore, while a review of these arguments is important for understanding the ways in which human behavior at the aggregate level is perceived to determine environmental change, I conclude that the debate is inadequate without a model that includes rural households as a set of heterogeneous and evolving decisionmaking units.

### Classical Economics

Classical economists argue that no amount of technological inputs can ever augment a fixed amount of resources to match population increase sufficiently. Drawing on the Malthusian perspective, the classical economist contends that if population exceeds the carrying capacity of the earth, *mortality* rates will increase until population declines to a sustainable level. *Fertility* rates will not decline naturally because people in poverty will continue to have children in order to mine natural resources directly until the economy can provide for them otherwise. In empirical

studies, investigators have found what they identify as a direct positive correlation between population growth and deforestation rates. Classical economists therefore support family planning and other fertility reducing measures in order to reduce strain on the environment (Jolly 1991).

Brown and Kane (1994) represent this perspective. They argue that in the next century the exponential growth rate in developing countries will far exceed the earth's capacity to produce an adequate food supply for everyone. This imminent crisis results from conditions in two realms: population control and agricultural development. High fertility rates continue unabated in developing countries that are caught in the second stage of the demographic transition because of a lack of economic development that would create the conditions in which a decline in fertility would be desirable for families. Instead of completing the three-stage transition by moving from a population regime with high fertility rates and high, fluctuating rates of mortality to a regime with low fertility and mortality, these countries are in a "demographic trap" characterized by high fertility and declining mortality rates. Brown and Kane argue that the resulting population increase begins to "overwhelm local life-support systems, making it impossible to sustain the economic and social gains that are counted on to reduce births<sup>1</sup> (p. 55)." This perspective assumes that economic and social development are necessary and sufficient to create the conditions that replace the desire to have more children in order to ensure security in old age. In

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<sup>1</sup>Although Brown and Kane do not elaborate on this point, the argument is reminiscent of the Coale-Hoover (1958) model of population growth and development. In this model, countries with high rates of population growth are stymied in their efforts to accumulate savings for productive investment because a large proportion of the gross domestic product goes to wages and consumption (including education). Where the population is increasing and product is stagnant or increasing at a slower rate, individuals experience a lower standard of living. In addition, rates of productivity must remain high in order to generate the capital to create jobs for an growing labor force. In the absence of increased productivity and higher per capita income, economic development will be too slow to give rise to the conditions that foster reduced fertility.

the absence of those conditions, foreign or international agencies intervene to provide contraceptives and family planning information, but in the 1980's the United States withdrew funding from the International Planned Parenthood Federation and the United Nations Population Fund for two reasons. First, the agencies provided funding for abortion services. Second, the Reagan Administration supported the neoclassical argument that population growth would decline naturally in the presence of functioning markets, so that the policy emphasis should be on getting prices "right" in the international market. Thus, to the extent that the strong presence of family planning programs, countries that lack those services may be less likely to begin or continue a decline in fertility.

At the same time, according to Brown and Kane, population growth strains the capacity of natural resources. Human populations can no longer rely on new technologies to increase crop production because most of the recent innovations in agriculture have been applied universally, and no new methods are expected to provide a panacea in the near future. Nor can cropland expansion initiatives significantly increase the amount of arable land available; soils in these areas are too fragile for long-term intensive production. As the maximum capacity of the land for agricultural purposes is approached, the amount of land available is actually shrinking, as farm land is incorporated into urban areas or converted to housing development sites to accommodate population increase.

Because of these factors, in Brown and Kane's terms, the surplus production of the earth's natural resources is no longer sufficient to satisfy the basic needs of a large share of the human population. People draw on the earth's capital, exploiting nonrenewable resources or resources

that cannot be renewed at the pace at which they are being used currently. The earth's capacity to provide food, water, and energy will decrease in absolute terms, as well as in terms relative to the size of the population. At the individual level, Brown and Kane see a typical rural land use pattern:

The sequence of events that leads to environmental degradation is all too familiar to environmentalists. It begins when the firewood demands of a growing population exceed the sustainable yield of local forests, leading to deforestation. As firewood becomes scarce, cow dung and crop residues are burned for fuel, depriving the land of nutrients and organic matter. Livestock numbers expand more or less apace with the human population, eventually exceeding grazing capacity. The combination of deforestation and overgrazing increases rainfall runoff and soil erosion, simultaneously reducing aquifer recharge and soil fertility. No longer able to feed themselves, people become environmental refugees, heading for the nearest city or food relief center (1994: 28).

High population growth rates create a unique, self-perpetuating set of problems by overtaxing natural resources and inhibiting a political system's capacity to concentrate on adequate food production. These conditions result in the inability at the household level to get out of poverty and cause families to rely on children to provide labor and security. Families deplete the environment through having many children in order to support a system of future economic security, and as more families occupy the earth and conduct the same practices, the stress on the environment is greater, ultimately surpassing the long-term carrying capacity of the earth.

Brown does argue elsewhere (Brown 1978) that resources are overexploited in developing countries because of economic and political priorities biased toward developed countries and national urban sectors. He acknowledges the need to change consumption patterns in developed countries, to promote a more equitable distribution of the world's wealth, and to draft rules that

govern the international economic system, as well as to focus on labor-intensive, capital-saving investment in developing countries in order to limit demands on the environment. However, although Brown recognizes the consequences of the imbalances between rich and poor countries and urban and rural areas, he contends that the drain on resources by a growing population is the most direct and immediate source of environmental degradation. Political and economic choices might exacerbate the tendency to overuse resources, but population growth creates its own set of problems with environmental consequences over and beyond the dynamics of the dominant economic regime. The inverse relationship between population growth and environmental security is direct, and is paramount to the relationship between social systems and the environment.

#### The I=PAT Perspective

Paul Ehrlich and Anne Ehrlich (1990) also contend that there are too many people on the planet to ensure long-term environmental sustainability without some universally effective change in resource use. Overpopulation is not a matter of high density in a given area; as Brown has also indicated, some densely concentrated urban areas are thriving because residents can rely on resources imported from less densely populated areas. Rather, the issue of overpopulation for Ehrlich and Ehrlich involves the number of people in an area relative to its resources and the capacity of the environment to sustain human activities (referred to as the carrying capacity of the land). Overpopulation occurs when a population cannot be maintained without rapidly depleting nonrenewable resources and without degrading the capacity of the environment to support the population (Ehrlich and Ehrlich 1990, 38). In this sense, the world is already overpopulated, with

some regions drawing on an environmental credit system in which the residents have no way to pay off their debt.

Ehrlich and Ehrlich (1990) echo Brown's policy recommendation of population control, encouraging policymakers to focus on "the needs of societies," which require slower population growth in the aggregate, as well as those of couples and families, who might desire more children than society can support in the future. The objective of population control takes priority over other efforts to reduce human impact on the environment because of the time lag involved in slowing the momentum of population growth (p. 190).

Although Ehrlich and Ehrlich make population control the first priority in limiting human impact, they do not support Brown's argument that overpopulation creates social and environmental problems independent of those created by the global economic system and the imbalances between and within developed and developing nations. Instead, they argue that the volume of population amplifies the consequences of per capita impact on the earth through a multiplicative function. They present the I=PAT model to estimate the measure of human impact on the environment, where:

$$\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology}^2$$

In this model, even rich nations where population growth is slow contribute to the problem of overpopulation because the average level of consumption is relatively high. In the long run, population control is the most effective means to reduce the environmental impact of human

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<sup>2</sup>Human impact is a product, rather than a sum, of the three factors. Population is measured as the number of people residing in an observed area. Affluence is a measure of the average person's consumption of resources in that area. Technology is an index of the environmental disruptiveness of the technologies that provide the goods consumed. These technologies include modes of extraction (for example, logging), production (carbon dioxide emissions at factories), and operation (CFCs) (Ehrlich and Ehrlich 1990, 58).

activity. If the other factors were reduced in the absence of declining population rates, aggregate levels of consumption would eventually rise again, with lower per capita consumption practiced by a larger number of people.

This model is useful for showing that the choices people make about how to use available resources temper the relationship between population growth and the environment. However, the formula is flawed in at least four ways. First, the authors make the naive assumption that per capita consumption will not increase when population declines, noting that “the total impact of a society can be lowered by decreasing any of these three factors, as long as the others are not increased so as to offset the reduced factor (p. 58).” If there are more resources to go around in a society whose members aspire to achieve a certain consumption level, it is unlikely that they will not take what they can when there is more available. In some situations, a drop in population growth rates might result in a reduced capacity to produce goods for the same level of consumption, but in a wealthy society that can import goods from areas with higher population, this scenario could be delayed for some time.

Second, population growth rates or absolute population size might affect the magnitude of the affluence and technology variables in the equation. For example, changes in population density can affect the development or spread of technology (Boserup 1981). Therefore, affluence and technology cannot be assumed to be constant as population size increases or shrinks. The effect of halving a society’s population does not necessarily mean that the environmental impact of that population will also be halved; it may be reduced more or less depending on the accompanying shifts in affluence and technology.

Third, using a measure of the “average person’s consumption habits” as an indicator of affluence in a society reveals nothing about the dynamics that create or support different consumption levels within or between sectors, countries, or regions. In Brazil, for example, much of the land has been deforested and taken out of agricultural production by cattle ranching enterprises since the 1970's. Cattle-ranching is a capital-intensive, low-labor industry that causes erosion and further environmental degradation. Few people are employed by cattle ranchers, and profits are concentrated among large landowners and foreign investors. Because ranching takes arable land out of production, landlessness is increased, thus reducing consumption levels for a large share of the rural population. Those displaced by cattle ranching are forced to find other means of local wage labor, to relocate to another rural site, or to become attached to the urban wage sector to some degree. The concept of an “average person” with a constant level of consumption is difficult to locate in this process.

The fourth criticism is tied to this point. The I=PAT formula includes nothing explicit about the differential impact of social systems. Social systems in this context include the institutions and agencies that govern and regulate human social and economic behavior. The number of people trying to draw from a limited pool might affect relative access to resources, but different systems of resource management will determine who has greater access and how those resources are used. Only the people in one society drawing from a common resource supply (as defined by legally or commonly recognized borders) may shape the structure imposed, or the structure may include external actors trying to obtain some share of the resources at the expense of the local population.

In a more general sense, economic priorities established at the macro-level will influence what individuals determine to be the most expedient use of resources at the micro-level. The value of each of the three independent variables in the I=PAT equation is caused by the social system in which these factors interact. Therefore, paying attention to the structural determinants of human impact can strengthen this model by specifying the value of these variables in a given country as a function of the complementary relationship between two or more institutional actors.

### Population as Proximate Cause

Jolly (1991) identifies a wing of the population/environment debate that addresses this shortcoming in Ehrlich and Ehrlich's model. "Population as proximate cause" theorists argue that population growth is a proximate cause of environmental degradation, with other variables working through population growth to affect the environment (Jolly 1991, 17). The environmental impact of ultimate causes like poverty, polluting technologies, distortionary policies, and demand from developed countries are more severe when they are mediated by high rates of population growth. Without high rates of growth, the problems created by the ultimate causes would not be so great. On the other hand, if the ultimate causes did not exist, population growth would not be such a problem. These theorists advocate fixing the ultimate causes in the long run but also support family planning in the short term to buy time while solving the problems that cause land degradation.

### *The Breakdown of Traditional Systems*

Supporting the "proximate cause" position, Repetto and Holmes (1983) identify three nondemographic factors that contribute to environmental deterioration. First, unequal access to

land pushes poor people to the margins of arable land, and inefficient use of large landholdings produces less food for local consumption, putting more pressure on remaining available land. Second, the process of commercialization has made the subsistence value of commodities insignificant compared to the price they obtain on the open market, meaning forests and land cleared for pasture are exploited at a much faster rate than they would be by population growth alone. Finally, the authors identify the breakdown of traditional resource management systems in developing countries under external commercial and political pressure. These traditional systems controlled access to resources in a way that dealt with technology limits and fragile environments. At the same time, a stable population was maintained by socially regulated patterns of fertility, mortality, migration, and marriage. Colonial and national governments disrupted both systems, creating virtually open-access resource systems that have been exploited by large companies rushing for concessions in the area (p. 615).

Repetto and Holmes run several simulation models to compare the effects of population growth alone on resource use to the effects of population growth when combined with commercialization and the conversion of community-managed land to an open-access resource. They find that environmental degradation is greatest when population is increasing rapidly and land is treated as an open-access resource. The authors suggest that this outcome may be the result of incomplete property rights, shortsighted official policies, or severe immediate economic need which causes people to sacrifice their future livelihood on the land to meet present needs (p. 625). They conclude that

[t]he analysis and examples employed...question the idea that population growth per se is the main cause of resource pressures in the Third World. We wish to call attention to the effects of breakdowns in traditional systems of resource management and the creation of virtual open-access situations; to the terms and conditions under which natural resources are being

commercially exploited; to the importance of export demands arising in the international economy; to changes in technological methods of resource extraction and harvest; and to inequality of access to natural resources in many Third World countries. These factors, operating in conjunction with population growth, are leading to considerably more rapid deterioration than would demographic increase alone (p. 624).

### *The Local Context*

Bilsborrow (1992) also finds that population increase, in conjunction with land use systems like land concentration and subdivision of family plots through inheritance, can create resource scarcity at the local level. He argues that the ability to absorb population growth depends on the quantity and quality of land immediately available as well as a number of “contextual factors” like the availability of untapped land resources in the nearby area, water, technology, agricultural prices, and the availability of off-farm employment (1992, 6).

Bilsborrow’s position is distinct from the work presented up to this point because it includes *migration* as a factor in individual-level responses to immediate economic and environmental problems resulting from population growth. Local interest in slowing population growth, according to Bilsborrow, depends on whether there is the perception that the potential for arable land, resources, and income exists elsewhere. Under this conceptualization, the availability of untapped land is a particularly critical factor because migration resulting from the expectation that land extensification is still possible in rural areas is “the key link between population pressure in one area of a country and the opening up of new areas for agriculture in another (Bilsborrow and Stupp 1995, 3).”

However, expectations about migration do not necessarily relieve local population pressure, according to Bilsborrow. In Guatemala, for example, new lands in the north have been opened for settlement since 1964, creating the perceived availability of more arable land.

However, much of this land is in large landholdings, and the number of sub-subsistence farms in older established areas has increased as a result of inheritance patterns (Bilsborrow 1992). The rate of population growth has remained high. These conditions have led to intensification of land use in all regions. Intensification is indicated by increases in labor per land area, use of fertilizers, insecticides and other chemicals, and irrigation. Meanwhile, many households have migrated permanently to the Peten, where land is largely unsuitable for agriculture.

Ecuador has experienced similar patterns. Farms have undergone fragmentation, and land productivity has not increased in line with population growth in the last 25 years. Most landless peasants who have migrated in that period have relocated to cities, but 10 percent have moved to the Amazon, causing deforestation of 80,000 to 150,000 ha per year since 1972 (World Bank 1989, cited in Bilsborrow 1992, 19). The national government anticipates that the Amazon will absorb an increasing proportion of future population growth, but has done little to make agriculture in the region sustainable.

Bilsborrow concludes that the most effective way to limit deforestation in fragile areas is to address population growth, land distribution, poverty, and agricultural technology *elsewhere* in the country while developing appropriate agricultural technologies for those already settled. Out-migration does not appear to relieve demographic pressure on land resources in origin areas; population growth remains positive or near zero in rural areas. In addition, people who migrate are landless to begin with, meaning that benefits in the area of origin are limited to reduced pressure on *common* property resources. Therefore, rather than reducing population pressure on land, migration encourages the persistence of inefficient land use systems, a pattern exacerbated

by population growth in origin areas, while expanding the impact of human agriculture into fragile areas.

### Regional Political Economy Perspective

Schmink and Wood (1992) are also concerned with the interaction between population growth and land use. The regional political economy approach they employ goes beyond investigating the impact of socially determined land use systems to look at the constraints imposed by the local physical environment itself. This includes looking at the geographic and socioeconomic processes that influence the intensity of population pressure and the carrying capacity of the land. Within this highly variable context, the authors do not identify population growth as the cause of environmental degradation, but rather locate the cause in the capacity of institutions to effectively marginalize increasing segments of the population, which in turn creates inefficient or harmful land use practices by a greater number of people.<sup>3</sup>

The authors' underlying assumption is that resource use is determined to a large extent by a society's dominant form of economic production and class structure and the way in which economic groups are positioned in the state apparatus (Schmink and Wood 1992, 39). In research on the Brazilian Amazon, Schmink and Wood find two scales of production in conflict as small farmers compete for land under systems of land concentration and expanded production by

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<sup>3</sup>Blaikie and Brookfield (1987) have developed a definition of "the margin" that is useful for understanding the regional political ecology system. The authors contend that the classical hypothesis about rates of population growth and density (population pressure on resources, or PPR) does not go far enough to explain land degradation. They incorporate the concept of "the margin" from economics, ecology, and political-economics to show how the three spheres are related. Blaikie and Brookfield stress the role of regional economies, state action regarding land use, and the adaptability of the environment in producing degradation, political and economic marginalization, inadequate production, outmigration and poverty. Combinations of these three factors vary according to the economic history, geography, and social organization of a region, and the individuals negatively affected by the outcome respond with unique survival

large landholders. In the common arena of regional and national markets, small producers are constrained by access to land title, stipulations on credit, exploitation in the market, and unequal exchange. If farmers do not receive enough support to make their land commercially profitable for more than a few years, they increase production either through participation in seasonal wage labor migration and investment of their earnings in the land, use of extensive agriculture practices, or relocation to a forested area with fertile soil. These alternatives result in different rates and patterns of deforestation.

In terms of the environment in the Amazon, any of these three options is a feasible short-term household response to marginalization. Most households clear less than half of their landholding in the first five years, so extensification on the same plot is an option for several years after. Migration to an area incorporated more recently is also possible. Over the last three decades, the agricultural frontier has expanded into the western half of the Amazon, opening up access to more arable land and transportation networks. Wood (1983) argues, however, that seasonal migration is the first line of defense when households are no longer able to produce a commercial surplus on their land. This occurs because the Brazilian state encourages the existence of a dual economy in the Amazon on the assumption that capitalist surplus is maximized when the peasant economy can supplement workers' low wages. To that end, the state will act in the interest of small farmers to perpetuate the peasant economy by fostering the creation of wage labor positions to sustain households on their current landholding. Because the seasonal migrant to a large landholding (often the household head) does not earn enough to cover the total cost of the maintenance and reproduction of his labor, the household absorbs the rest of the cost by

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strategies.

continuing subsistence agriculture. Seasonal migration becomes a sustenance strategy formulated by households in the noncapitalist mode of production. Repeat migration of the entire household to a more distant point on the agricultural frontier then becomes less feasible in economic terms, as the household is required to have one foot in the capitalist economy and one in the peasant economy in order to survive.

### Summary

This section has highlighted the central arguments that characterize the population and environment debate. As they have been presented, these arguments are increasingly concerned with the ways in which institutions that govern social and economic systems constrain the options available to poor farmers in making decisions about land use. However, the debate ignores differences in land use across households and within one household over time depending on the internal labor supply and consumption needs. Therefore, to the extent that differences in household composition and stages in the life cycle effect differences in land use, these arguments fall short in explaining a component of variability in resource use and environmental change.

I do not reject this set of arguments without qualification, however. One way households maximize the internal labor supply and satisfy consumption needs is to engage in selective temporary migration to other rural or urban areas or in permanent household migration to an agricultural frontier. To emphasize the relationship this behavior has to the environment, I draw on Bilsborrow and Wood and Schminck to demonstrate that migration can be both the cause and the outcome of environmental change. Within a given political-economic-social-physical environment, these authors identify migration as an important process that affects household

decisions about family size, land use, and survival strategies. Spread over a community, those decisions inform notions of what levels of population growth and environmental damage are acceptable, given that migration exists as a safety valve to relieve local pressure.

Bilsborrow addresses the negative impact permanent migration has on the relationship between population and the environment because the process encourages frontier expansion and unsustainable practices in origin areas. Wood and Schmink, on the other hand, suggest that permanent migration, while potentially a source of environmental degradation, is a more desperate and less frequently used strategy than temporary migration, which reduces some of the environmental impact of human activity by reducing the labor supply in a household that would otherwise practice extensification in order to increase income. Of course, if a household is not adequately endowed to continue practicing subsistence agriculture when one member or more migrates temporarily, those members remaining may practice less efficient or less conservation-based techniques because of the shortage of labor, and permanent migration can be the end result of consequent environmental damage. Thus, these authors beg the questions that I address in the next section of this paper: 1.) What determines the migration strategy a rural household chooses? and, 2.) what can we observe about the effect of migration on the environment, depending on how those strategies are realized?

## **II. Introducing a Life Course Perspective on Migration**

Before developing a household-centered approach to explain the linkages between population and the environment, it is worth explaining why characteristics of the household are important determinants of land use practices by small farmers.

Rural households respond to a number of incentives and constraints at the personal, local, state, and national levels in making decisions about land use and planning strategies to maximize the household economy. In past research, resources like financial capital, human capital, assets, credit, titling, markets, equal terms of exchange, transportation, local networks, and a wage labor flow have been shown to contribute to a household's decision to stay on a landholding and make it productive rather than to abandon the land (Garland 1987; Moran 1983, 1989; Wood 1983). In many cases, the ability to resist coercion to leave the land is paramount even to these factors. *Internal factors* are important as well; the output of the household labor supply is a crucial part of the rural household economy in developing countries. Dependence on that labor supply to produce a successful harvest and provide supplemental income increases in poor households that do not have access to the external resources listed here. The age and composition of the household thus become critical in determining the household's survival. Almeida (1992) supports this argument, stating that in Brazil's Amazon frontier,

Given the level of other resources, only those families who have already reached a certain degree of maturity in the cycle of family formation have the size and age composition adequate for success on the frontier. This factor operates most strongly within the poorest strata of the population, who lack access to financial intermediation or to any additional resources (p. 136).

As the landholding becomes less productive, household members must choose one of several options to optimize the internal labor supply: to clear more land on the current landholding; to return to the area of origin; to migrate permanently to an urban area as potential wage laborers; to move on to land that has not been cleared or that has been cleared more recently; or to participate selectively in temporary migration flows. I focus here on the last two alternatives to evaluate the environmental impact of migration strategies that keep households centered in rural areas.

When the role of the household labor supply is ignored, it is logical to assume that two households in the same area lacking access to the resources listed at the beginning of this section will make the same choice about migration. This does not always happen, however. Therefore, I propose a re-ordering of these variables to first consider a household's *capacity* to respond to migration opportunities at any given time, depending on its gender composition, the age of its members, and the social and familial roles they carry out. This approach is based on the life-course perspective and expands on the concept of "household stages" presented by migration theorists who advocate using the life cycle as an analytical tool. This variation in household structure is important, because if a household is well-positioned to move, then its members will be less likely to make sacrifices to maximize the potential of their landholding. "Well-positioned" in this context means that based on the household labor supply, the cost to the household to move is no greater than the cost of trying new farming methods, extending the existing landholding, sending some members to work elsewhere with hope of remittances, or establishing a relationship with creditors and buyers to make the landholding more profitable. Alternatively, if a household can sacrifice the labor of one member, temporary migration becomes an option for increasing savings and diversifying income sources.

I suggest that the ability to participate in migration systems varies throughout the course of a household's development, and this ability frames the way household members perceive the opportunities and constraints presented by external forces. I do not dispute that the policies and patterns that accompany the encroachment of large-scale capitalist enterprises into rural parts of developing countries are enough to drive people from their land to cities or to marginal areas.

However, I contend that incorporating the life cycle of rural households into models of temporary and permanent migration may better explain the timing and frequency of migration as well as the destination of individuals and households. By predicting different trends in migration, fluctuations in deforestation due to small farmers' behavior can also be better understood. In this section, I explain why I use the household as my unit of analysis and then provide a brief overview of life cycle theory, describe some of its relevant weaknesses, and show how life course analysis overcomes some of these flaws. I then review three studies of migration in Latin America that have paid attention to the significance of the life cycle of households in shaping migration patterns and the consequent environmental impact of those patterns. In the last part of this section, I suggest how a similar life course model focused on the relationship between households and the changing environment could make the dynamic more explicit.

I treat the household as the unit of analysis in this paper because it provides a valuable intermediate analytical step, mediating the interactions between individual behavior and macro-level social, cultural, and economic patterns. According to Schmink (1984),

In response to the opportunities and constraints defined by broad historical and structural processes, the domestic unit is conceived of as mediating a varied set of behaviors...that are themselves conditioned by the particular makeup of this most basic economic entity. The focus on domestic unit mediation of individual decisions and behaviors permits the study of differential responses to general structural conditions as well as the analysis of changes specific to subgroups of the population (p. 87).

The household, as defined separately from the family, is an economic unit whose members draw on a common pool of resources, including labor, to support their own consumption and material reproduction (Schmink 1984, 89). Individuals who possess income or some other resources usually deposit those resources in his/her household of origin or procreation. The

decision to migrate, made either collectively or by the household head, is influenced by how much those individual members can contribute in different settings. The household is the context in which most decisions about migration are made, and without the household as a reference point, individual behavior loses much of its meaning.

In demographic studies where the household is the unit of analysis, the life cycle model is often used to identify changes in the timing of a household's development through historical time. Development is marked by stages, as in Glick's (1977) model, which indicates the woman's age at marriage, first and last childbirth, children's departure from the household, a post-children phase, and the death of the first spouse. At each stage, according to Elder (1978, 1996), members play a new role in the household development, amounting to a role sequence for each person that plays out over the life cycle. The life cycle model uses the median age of one adult in the household, usually the woman, at the inception of each stage, and records changes in that age over historical time to identify shifts in age of marriage, household size, length of time household members co-reside, and age differences between parents and children. The data are used to make inferences about changes in behavior regarding timing of marriage, birth spacing, dependency ratios, and parent/child relationships over the life span of the household through historical time.

In life cycle studies, the household is viewed "as a collective unit, engaged in activities and decisions which change in relation to the roles and social characteristics of its members, and in response to external conditions (Hareven 1978)." This perspective makes the life cycle relevant for analyzing the dynamic household economy. In terms of migration studies, the life cycle model identifies the periods when the household is mostly likely to be under demographic stress,

requiring additional sources of income, and when the household will be most stable, maximizing the available labor supply. In turn, the relative stability of the household structure influences household responses to changes in the stability of land resources.

The usefulness of life cycle theory for this paper lies in the value of recognizing the mutability of the household decisionmaking environment over the life of the household. However, the theory is limited in at least three respects. Most significant for the work cited here, the life cycle model deals with events occurring at the median age for one household member and ignores variation. Differences in birth spacing is an example of a potential problem resulting from this approach. The model provides information about the age of the mother at first and last birth, so we know the age spread of the youngest and oldest children, but we do not know anything about the years between births, or about childhood deaths in the household. How does a household that depends on migrant wage labor compensate if there is a period when one child has left the household and the next oldest is not ready to begin seasonal migration?

Following from this criticism is a second point: variation around the average age of parents at different stages in the life-cycle indicates very different household structures. Marriage for a woman at age 35 will be different than at age 20. There may be more economic resources available, but her own parents may become dependent on her family of procreation earlier in the household's development. The roles household members play, while in the same sequence across households, will be qualitatively different given variations in parents' age and timing of childbirth.

Third, the life cycle model only focuses on the roles individuals play within the household. This excludes the meaning of the roles played by the same people in work and community

settings. This focus also excludes consideration of the effect of other households and social networks on the nature of the household in question. Elder (1978) describes this problem as “an interior bias in which the stages become the source of variation in family patterns (p. 48).” This flaw is especially problematic in migration studies because first-time migrants in a household often find work through a social network (Massey et al. 1987), and the same support systems contribute to the survival strategies of those who remain in the sending community.

Life course analysis responds to the flaws in life cycle theory by incorporating variation in the timing of stage transitions and recognizing the social context in which those transitions occur. The basic premise of life course analysis is that an individual’s development is shaped by social pathways represented by school, work, and government as well as by the household. Thus, the individual is simultaneously a private being and a social being, carrying out several evolving roles. The timing of entry onto these pathways (whether early, on-time, or late in relation to structured expectations or averages) and the amount of time spent in certain role identities affect future life course development. Human development is a cumulative process, so that each experience informs an individual’s perspective and decisions at the next transition point. The historical moment in which transitions occur also determines timing and duration. Life course analysis is thus concerned with explaining the variation that the life cycle neglects. This approach demands a much more multi-layered, interactive, synchronized view of individual experience and the development of the household than does the life cycle model. This view is useful for exploring the relationship between migration and the environment because it involves households in the labor market, in social networks, and in the process of environmental change, and anticipates that this

involvement will vary over time based on features of the household and the external world.

### Empirical Studies of Household Development and Migration Patterns

To different degrees, work on migration and the household has used life cycle theory or life course analysis to explain variations in migration timing and strategies. In the review that follows, I discuss several works that show how temporary migration becomes a regularized strategy in rural communities where households have access to few resources other than labor. In each of these studies, changes in land use patterns either spark migration or follow from the migration process after several years. These case studies suggest that migration needs to be considered among the key demographic factors affecting the environment.

#### *Central Mexico*

In her comparison of two sending communities in central Mexico, Arizpe (1982) argues that “structural processes provide the necessary conditions for migration to occur...but that the patterns of age, sex, recurrence, and occupational specialization can only be understood with reference to the labor and social conditions of the peasant household (p. 20).” In both villages, the peasant economy has broken down over the last century as a result of the agrarian reform period that unseated domestic production and drew producers into the national and international market. Despite the decline of a local economy, the households of San Francisco Dotejiare, 300 kilometers northwest of the capital, have remained wealthier than the households of Santiago Toxi, 50 kilometers closer to Mexico City. Arizpe attributes this to a lower population density in Dotejiare at the time of the agrarian reform, meaning that each household received a larger plot than did households in Toxi. In addition, Dotejiare has continued the cultivation of the zacaton

plant, and as the only village in the region to do so, makes a considerable profit from its sale. Arizpe argues that Toxi, with its high level of unemployment due to land fragmentation, erosion, and loss of traditional occupations, as well as the centralization of the economy in Mexico City and the unequal terms of exchange through prices for agricultural products, simply represents a different moment than does Dotejiare in the breakdown of the traditional peasant economy (p. 42).

As opportunities become constrained in these villages, seasonal migration provides an additional cash income to the household. However, households in the two communities use remittances for different purposes, and therefore develop different sending patterns. In Dotejiare, wealthier households are organized as extended families. The household sends teenaged children to Mexico City as temporary migrants in the third and fourth stages of the domestic life cycle, identified as the period when the mother is between 31 and 44 years old. At this time, the household labor supply is fairly stable, as dependents in the household are able to contribute to the workload that supports their own consumption. The migrants may send remittances to the household in order to finance agricultural investments, but migration also provides an alternative for children who would not be able to support themselves in the next generation when the family landholding was fragmented again into smaller holdings. Poorer families in the area follow the same trajectory, as the process of temporary migration diversifies the household's contact with different sectors of the economy and allows some members to migrate permanently rather than to rely on agriculture in the future (p. 44).

In Dotejiare, it is possible to delay migration until the household's labor supply is fairly

stable because the community is still able to achieve subsistence through agriculture. Migration is a strategy for the household's future survival. In Toxi, on the other hand, where household members cannot support themselves through agriculture alone, migration is a continuous process that begins soon after the first child is born to a young couple. Because the mother's labor is most often focused on child-care and domestic responsibilities, she cannot provide as much income to the household as she did prior to childbirth. Consequently, the father's work intensifies during the first two stages of the household life cycle (identified as the time when the mother is between 18 and 30 years old) when he is involved in agriculture and migratory labor. In the third stage (mother aged 31-38), children begin to migrate with the father and then replace him in a pattern called "relay migration (p. 37)." As older children marry and leave the household, younger children take over the migration process. The mother only remains engaged in local wage labor occasionally because she continues to provide most of the domestic labor as daughters migrate seasonally. Arizpe assumes that through seasonal migration, sons send remittances to the household for an average of seven years, and daughters for five years. From this, she determines that poor households in Toxi will want to have three sons or some combination of four sons and daughters to maintain the household over the course of 20 years. The additional income from a fifth or sixth child would provide a surplus for the household in later stages.

The environmental factors that spurred seasonal migration flows also affect how households invest their earnings from migration. Over time, rural households have lost cash income from the land because of the subdivision of plots, the loss of soil fertility due to intensive cultivation, deforestation for fuelwood, and consequent erosion. As a result, households

participating in seasonal migration flows invest their earnings not in production, but in biological reproduction, according to Arizpe. Households invest in raising and educating as many children as possible in order to increase eventual surplus income (Arizpe 1982: 40). With a smaller proportion of income coming from the land, households can relax land use practices, perhaps leaving the land to fallow for a period and then returning to more productive crop rotation methods in the future to satisfy household needs. The surplus income due to the increased labor supply might also reduce deforestation for fuelwood by making electricity more affordable.

The shift in agricultural practices that results from seasonal migration, and from increased migration due to increased fertility, does not necessarily imply that the process reduces the rate of environmental degradation. Increased dependence on transportation or a rise in consumerism can also have environmental impact. However, it is important to recognize that decisions about land use, migration, future fertility, and investment are made against a backdrop of institutional, economic, and environmental constraints that shape survival strategies to include increased temporary migration and less dependence on agricultural production.

#### *The Highlands of Southern Peru*

In her study of communities in the highlands of southern Peru, Collins (1985) also investigates migration and the life cycle of rural households that depend in part on off-farm labor for their survival. Like Arizpe, Collins notes that households participate in seasonal migration for different reasons, varying from a short-term strategy to obtain cash for immediate needs to a build-up of cash reserves for investment (p. 281). Poorer households that use temporary migration as a response to a temporary economic crisis “exercise less choice over the type and the

production at times when their labor is needed (p. 282).”

been discouraged from producing food for sale because of government pricing policies, subsidies of food imports, inflation, drought, and declining terms of trade. Therefore, they have turned to and the production of cash crops (coffee) in the lowlands. Involvement in trade and transport requires more initial capital than most poor families have, so households employ the second and years old and there are 2 to 6 children under the age of 15, migrate seasonally for wage labor or coffee production as a way to make ends meet. Migration occurs at a time of “demographic happening if it were not essential to survival. The accumulation of savings comes later, when the mother is over 40 years old and some children can participate fully in agriculture or migrate

According to Collins, the tendency to migrate when there is a high dependency ratio in the young household changes the division of labor and alters the household’s role in the community.

woman) has a greater burden in maintaining the household. Children are also expected to become more productive, and the household has less time and fewer resources to participate in kin and

pattern in the household, there is a potential incentive to increase fertility in order to accumulate greater savings by involving more children in seasonal migration.

The use of migration strategies extends the productive life of a household's landholding by allowing sustainable agricultural practices, although at the price of increased labor output from each household member. In the aggregate, these shifts in household and community organization can lead to different uses of the land and local affiliations. For instance, families with some savings can pool their resources to become involved in trade and transport, or they can expand coffee production. In this way, repeat migration can alter the opportunities available to a community over time and also change the relationship of the local community to receiving areas. In the case of wage labor migration, sending communities can build ties to employers or become subject to greater dependency, depending on how much autonomy the sending area can maintain from the receiving area. These potential outcomes stress the importance of longitudinal studies to understand how the use of migration transforms the sending area and changes the perception of household members about the opportunities and constraints that have shaped their circumstances.

#### *International Migration from Western Mexico*

Arizpe and Collins discuss how the economic needs and the labor supply of a household determine the timing of migration in the life cycle. Although their insights explain variation in migration patterns due to internal household structure, the life cycle approach neglects the effect on migration practices of relationships outside of the household, including extended kin networks and community networks. In their work on temporary migration from western Mexico to the United States, Massey et al. (1987) show that investigating the significance of these relationships

as they relate to household level decisions about migration explains more about the destination, capital, the authors show that external relationships help to determine not only the timing but the quality of migration.

created an extremely volatile political economy, and household strategies represent the primary mechanism through which individuals adapt to economic flux and change (1987:175).” In rural

farming, as well as the small landholdings for independent farmers that are the legacy of the agrarian reform plan imperfectly executed in the 1930's. Temporary migration of one or more

because of historical ties between the countries like the bracero program that provide inroads for finding work.

sending and receiving areas. Massey et al. (1987) provide the most succinct definition:

Migrant networks consist of social ties that link sending communities to specific points of complex web of complementary social roles and interpersonal relationships that are

The most important social ties are based on kinship, friendship, and . Kinship and

*paisanaje*

receiving area, where people from the same community might meet each other for the first time

*Paisanaje*

migrants return to their home area for a festival or holiday and share in a ritual or traditional event.

Social ties affect processes in both the sending and receiving areas. An individual might find work with someone through a social connection, and the relationship forged during the migration experience will affect how the two people interact in the home community. The strongest bond between male migrants based on *kinship* is between fathers and sons. When the migration experience strengthens their relationship, the men are more likely to provide information or assistance to one another at home. Other important relationships exist between brothers, and between a man and his brothers' sons (Massey et al., 1987: 140-141). Bonds based on *friendship* are strongest between individuals who grew up together and whose relationship was fortified by shared participation in an institution like school, church, or a sports club. As the number of migrants in a group increases, circles of friends are more likely to overlap, thus diversifying work opportunities. *Paisanaje* is an important integrative force in receiving and sending areas, providing a way for migrants to identify and develop social outlets abroad and to stay informed about future migration opportunities at home.

Although there is variation in how households employ migration, Massey et al. do find a dominant pattern based on the life cycle stages of the household. Young men become involved in migration cycles before marriage. The rate of migration declines right after marriage, but increases again when children are born. Fathers in households with young children make short trips to meet the increased consumption needs and to compensate for the income lost when the mother leaves the labor force or farm work in order to focus on child care. Because the father has

responsibilities in the household, he cannot stay away for extended periods. As the children grow older, he is again able to participate in more extended recurrent migration flows because as children's labor contributions increase, the father's presence is less critical. Children also begin to join the migrant labor force in their teens. By the time children leave home permanently, fathers no longer need to migrate to support the household.

There are many variations to this pattern, with some young husbands participating in recurrent migration cycles soon after marriage, and some young couples settling in the United States. However, in general, Massey et al. find that there is an inverse relationship between the ratios of workers per household member and migrants per household worker, noting that, "As the relative number of workers falls over the early stages of family development, the relative number of migrants rises. Then as the relative number of workers begins to grow once again in the later stages, the relative number of migrants falls (1987: 207)." This strategy is different from that posited by Arizpe and Collins, who suggested that households will send out as many wage labor migrants as possible to accumulate savings. In this case, it appears that households either select a few members to be migrants, or they stagger participation so that each person goes for only a few years. The feasibility of the latter option probably increases as social capital increases, so that inactive migrants can pass on their contacts and knowledge to new migrants.

Migration affects land use in the sending communities observed in at least three ways. First, migrants who purchase land in their home community tend to purchase the best land available. Therefore, ownership of irrigated land and dryland is concentrated in migrant households, leaving nonmigrant households with less productive landholdings (p. 237-239).

Because of the additional effort required to raise crops on poor land, those households may constantly require the labor of all members, so that temporary migration is never an option. Second, although migrants purchase more land, they do not always put it into production. Households might lease the land to nonmigrant households or leave it in fallow (p. 240). Finally, migration tends to lead to a decline in cultivation because migrant households are less dependent on earnings from agricultural production. Among those households that continue to farm, however, the mode of production changes, with increased use of hired labor, machinery, and agricultural inputs. These households also become more oriented toward commercial agriculture (p. 249).

### Summary

The work discussed in this section supports two important arguments: first, the nature of migration flows depends on the age and composition of households in a community; second, migration is a demographic process with environmental implications. In addition, these works are useful for conceptualizing a model of migration patterns and environmental change because they show that historical events have transformed the ways households can use natural resources, leading to a need for migration as an economic survival strategy. This strategy, timed according to the household life-cycle, has in turn affected household roles, optimal family size, and the intensity of small-farmer agriculture. Massey's work has shown that these changes result not only from a transformation of how a household's internal labor supply is used, but also from the household's involvement in social networks in order to initiate and perpetuate migration flows.

Research on migration and the life-cycle recognizes the externally imposed constraints on

rural households that make migration a necessary survival strategy, and focuses on the capacity of a given household to exercise that strategy. Implicitly, this research also points to a need for a way to measure the interdependence between household events and environmental change. We know quite a bit about how historical events affect households differentially in the way they use their land, depending on the availability of economic, social, and human capital. We know less about how these historical events contribute to environmental change, and how environmental change affects households differentially. Therefore, it is necessary to make this interdependence explicit.

One way to model this relationship draws on the concept of temporal interdependence from life course analysis, described briefly at the beginning of this section. Temporal interdependence refers to relationships between individuals and society that develop over time and are influenced by the particular historical moment in which they occur. Three general modes of temporal interdependence identified by Elder are the intersections between family (household) history and social history, between the life course of the household and that of its individual members, and between the course of events in the household and other institutional sectors operating in the economy and polity (Elder 1978, 55). By also including a measure of the outcomes of the interdependence between household events and environmental change, we can better understand the constraints and opportunities imposed on rural households that rely directly on land and natural resources. In the cases examined here, rural households in Latin American countries rely on permanent crops for market production and annual crops for subsistence. At the micro-level, if a landholding is fragmented or overused and rates of production are expected to

decline, household members are forced to make a decision about their alternatives based on the household labor supply as well as their savings and the immediate availability of other income. At the macro-level, those alternatives are constrained by environmental factors like population density, availability of arable or forested land, in addition to social and economic factors. The environment thus shapes the way households work and live; conversely, variation in household structure and development shapes the way individuals use the resources the environment provides.

### **III. Household Development and the Environment on the Agricultural Frontier**

The case studies described above focus on migration alternatives in rural communities that have been transformed by industrialization, capitalism, and a national bias toward the urban sector. In these cases, temporary migration provides a way to maintain the household in an established rural area. Permanent rural-rural migration by an entire household in Mexico and Peru is less frequent because new land is not widely available, or the government does not encourage the occupation of new lands.

In contrast, in Brazil, Bolivia, and other countries in which the Amazon forest lies, national governments have encouraged families to migrate to the region to farm on the agricultural frontier. In the 1970's and 1980's, the state financed directed colonization programs and subsidized the purchase of 100 ha plots of land, homes, and agricultural inputs to expand agricultural production and relieve population pressure in other regions. Private colonization schemes also provided land and infrastructure to migrants who paid a higher price for landholdings. At the same time, spontaneous settlers who did not qualify for government programs moved to the Amazon without financial support to clear land and begin farming. Two

studies have followed migrants in directed colonization projects, both public and private, to evaluate the environmental impact of small-farmer occupation of the region relative to the large-scale commercial enterprises in the region. These enterprises include the timber industry, capital-intensive agriculture, cattle ranching, and mining. The studies provide some insight into the way the migration process transforms household dynamics and land use, particularly in a region where permanent relocation to new land remains feasible and even attractive, given the ever-present threat of coercion from large landowners to leave one's current holding.

#### The Household Life-Cycle on a Productive Frontier

In previous work, Moran has found several household determinants of success on the Amazonian frontier, including previous experience in agriculture and land management, kin networks, and possession of capital on arrival (Moran 1989, 23-29). He finds that over time, the household's ability to experiment with crops, expand production, and diversify strategies to increase income and capital productivity largely determine survival on the same plot. Variation in the timing of permanent household migration to another landholding is explained by variation in the number of failed harvests in one place.

More recently, Moran (1996) has proposed a study that would measure the contribution of the household life course to patterns of land use and deforestation in the Amazon. It is important for purposes of this paper to note that this study focuses on households that do *not* permanently migrate within the Amazon after initial settlement. Observed deforestation is the result of extensification on a single landholding. Information about permanent migrants has to be inferred from what was known about the household at the time of the last survey in the region, as

the study does not propose to follow them.

The investigation would test the hypothesis that in the migration process, frontier households experience specific patterns of formation, transformation, and aging that affect land-use strategies and influence environmental change. These factors, in addition to land tenure and economic and environmental uncertainty, mediate the relationship between population growth and the environment. Specifically, the authors suggest that as households age, land use shifts from high labor to low labor activities, and rates of deforestation decrease. This suggestion is based on an observed pattern of land use in which settlers initially focus on annual crop production, and later shift to perennial crop production and then to cattle grazing. The longest term residents observed are involved in perennial crop production again. Although there might be cohort effects reflecting credit incentives at particular times in the past, the authors suggest these transitions are marked by changes in the composition of household labor as young households grow (p. 34) as well as by changes in activities as a new community develops. Stressing the potential environmental importance of these shifts, Moran posits that,

Understanding what rates of forest clearing might be consistently predicted from knowledge of the structure and changes in the composition of households would be helpful in knowing whether observable rates of forest removal represent a stage in the developmental cycle of households or represents the simple and direct impact of increasing population in these environments (Moran 1996, 27).

To investigate their hypothesis, the authors propose to collect land use histories, demographic histories and schedules of economic and labor activities from migrants to Para. With this data, they intend to analyze the demographic characteristics of households at the time of settlement over the course of frontier occupation; how the age and gender composition of labor of

households changes over the domestic life cycle; how labor composition interacts with external variables to affect farming and forest clearing strategies; and what implications these farming strategies carry for forest growth (p. 27).

The conceptual framework for modeling the frontier household is based on the life cycle method of analysis. The authors describe five stages that are expected to have distinct implications for land use and environmental outcomes. Roughly, these stages are typified as: 1.) young households with a small number of very young children, deforesting heavily for several years and planting annual crops; 2.) an increase in parity, and the early contribution of children to the household labor supply, allowing adults to diversify activities and to initiate long-term agricultural activities; with enough additional labor, more land may be cleared to allow part of the initial clearing to be left in fallow; 3.) the contribution of labor by teenagers in more skilled farm activities; the further expansion of a diversified economic strategy, including the cultivation of more permanent crops (fruit trees, sugar cane, rubber) and fewer annual (subsistence) crops; 4.) household dismemberment through migration and marriage; children may work on secondary plots or migrate to local urban areas as part of an income diversification strategy; household continues consolidation of long-term farming activities; 5.) multiple-generation and second-generation households on consolidated farms involved in long-term agricultural activities; households stop deforesting; some areas in various stages of secondary succession.

Arguably, this model is oversimplified. It assumes that the household occupies a 100 ha plot of land with fertile soil, which is not common in the region. There is no mention of coercion to leave the land, or intention to sell cleared land to speculators. Seasonal migration comes late in

the development of the household, as a strategy for surplus income generation. Finally, the household is assumed to be autonomous, although Moran has shown in earlier work that rural households draw on local social networks for labor and material resources, especially early in the settlement process. However, the model is useful for showing how a household's options are transformed over the life course. Under stable political, economic, and environmental conditions, the household is able to maximize the labor supply through income diversification strategies; under less stable circumstances, the labor supply contributes to household survival strategies. In either case, the age spread and composition of the household determines in part how opportunities and constraints will be met.

#### The Amazon as a Speculative Frontier

Almeida and Campari (1995) present an economic model of deforestation in the Amazon. They compare settlers in government-sponsored colonization projects in Para to settlers in private colonization projects in Mato Grosso. Across the Amazon, they find that speculative behavior in the 1980's encouraged deforestation, as successful farmers bought up and deforested surrounding land to increase the value of their holdings, and poor farmers sold their cleared land for capital gain before moving onto a new plot.

Almeida/Campari and Moran perceive different trends in the Amazon. On the speculative frontier they observe, Almeida and Campari (1995) find that household members continue to deforest to increase land value, even if they diversify their economic strategy so that the land is not productive and agricultural income contributes less to the household (p. 70). Moran's model assumes the existence of a productive frontier in the Amazon, where the commodities produced

on the land are more valuable than the land itself. Moran et al. do not deny the significance of speculative activity, but predict that the capacity to accumulate capital through production rather than land speculation increases as households grow and age. A stable household that has made greater investments in its land in terms of labor and assets is less likely to sell the landholding than is an old household that has turned land to pasture because of a lack of labor to maintain productivity. More longitudinal data is required to measure the relative long-term environmental impact of land speculation from the 1980's against the impact of aging communities experiencing peripheral inclusion as producers for the capitalist economy.

#### Utility of the Life Cycle-Environment Model

The work discussed in this section emphasizes the limitations of the frontier household to respond to environmental change or to act on decisions about land use, based on the position of the household in the life course. Moran's work is especially useful because it makes explicit the dynamic relationship between the household and the environment and demonstrates that the rate of deforestation does not necessarily increase monotonically over a generation as the number of households on the frontier increases. In addition, the process of migration is expected to influence household formation and therefore to affect land use through the number of producers and consumers on the landholding across the life cycle. This is an important consideration in determining how migration influences future behavior and environmental outcomes.

However, as I mentioned earlier, Moran's model is oversimplified in several ways. Most significant for the purposes of this paper, he assumes that every household and every landholding is fully productive over the life cycle, from marriage to the time children leave the home

permanently. In many cases, this is not true. Soil quality varies substantially within microregions of the Amazon, so that without prior knowledge of the area, household members cannot predict the productivity of the landholding they have selected or that has been assigned. In addition, households face pressure to move off the land from large-scale commercial farmers, especially when the household does not hold a title to the landholding.

Almeida and Campari argue that one response to reduced productivity and increased coercion is to sell a household's landholding and move farther into the frontier, thus increasing the rate of deforestation and environmental degradation by both the migrant who forges ahead and by the new owner of the land, who may expand the landholding or increase the use of chemical and technological inputs in order to raise productivity again. Another response is to incorporate temporary migration into the household economy, depending on the stage of the household life cycle. This can result in less dependence on crops from the land as the proportion of income from migration increases, or it can lead to acquisition of more land or the use of advanced technologies on the current landholding, depending on how equipped the household labor supply is to adapt. Although Moran hypothesizes that the latter two conditions might occur late in the household's life cycle, he does not describe the possible mechanisms like migration which can provide the capital for the transition to those stages.

The next section of this paper proposes a research design which merges the model of the life cycle and the environment with models of the life cycle and migration patterns discussed in section II. The result is a model that highlights the ways in which the age structure and gender composition of a household mediates the way in which environmental change is both the cause

and the consequence of migration patterns.

#### **IV. An Alternative Research Design**

So far, this paper has addressed two concerns. First, the existing literature on population and the environment is inadequate because it has not looked at stages of household development to explain variation in resource use in rural areas. Specifically, although the literature has recognized the potential environmental impact of migration, it has ignored the changing capacity of a household's members to migrate, either permanently or temporarily, over the course of the household's development. Including information about migration strategies at different household stages may explain more variation in estimates of the rate of environmental degradation because there is evidence that these strategies transform land use patterns in local areas. This is supported by the literature addressing migration and the life cycle, which has shown that the migration patterns set up around the household life course change the way households and communities use their land over time. Second, studies that look specifically at how frontier settlers use their landholding in an area where arable or forested land is abundant have not explored the role migration continues to play in the household's development, although temporary or permanent migration may be an important part of the household economy and an important factor in determining land use. The model described below combines these concerns in order to measure changes in resource use and migration as households pass through the life cycle.

##### Purpose

The purpose of this design is to develop a longitudinal data set that looks at the role of migration over the household life course, and the changes in resource use that result from differences in

migration strategies. I recognize the importance of the economic, political, and institutional context in which household development occurs and do not attempt to discount the significance of that context. Instead, I control for those factors in order to highlight the variation in environmental change explained by the household life cycle.

### Hypotheses

#### *Determinants of migration*

- \* Households with the least capital and least access to resources will be most dependent on the internal labor supply.
- \* Temporary migration will be a survival strategy for rural households where land is not productive, where there is no market, or where the market price for crops is inadequate to support a household.
- \* Temporary migration will be a strategy for accumulating capital and resources in households with stable access to inputs other than labor.
- \* In a given community, temporary migration will be a more common response to diminished productivity of the land than will permanent migration.

#### *Migration patterns within a household*

- \* Migration by the male head of household will begin shortly after the first child is born in poorer households where the strain of an increased dependency ratio will be greatest.
- \* There will be more migrants per worker in the household when there are only a few workers in the household relative to the number of consumers; as the number of workers per consumer rises, the number of migrants per worker will fall. (Migrant workers will be a relatively large part of the household labor supply when there are more producers than consumers in the household.)
- \* Migration will occur later in the life cycle for a household that is accumulating capital for investment, because the household can afford to divert its labor supply.
- \* Households in communities with migrant networks will consider temporary migration as normative behavior and migration will become routinized in the culture.

- \* Within a community with a migrant network, household members who have family members or friends with migration experience will be more likely to migrate themselves, and to find work.
- \* Social connections will vary over the life course. Early in the household life cycle members may have the most contact with other family members, and later in the life cycle most contact may be with neighbors, other parents, or *paisanos*.
- \* Within a community, land use relations will be transformed by migration. Some households may purchase more land as status and leave it alone or sublease plots; others may invest in agricultural technology which will change production methods. This will change work patterns in the community.

#### *Migration-environment linkages*

- \* Land use practices will change in the absence of a principal worker early in the household life cycle. Most importantly, the quality of land management may be reduced.
- \* Households will involve children in agriculture until they are old enough for labor migration. Then the adults in the household will decide where the child's labor will make the greatest contribution in agriculture or in migration. If the household has the resources to diversify crops and can use the labor there, that decision may win out over migration; if the family wants money for further inputs, or doubts the viability of a future on the current landholding, they will choose migration.
- \* Birth spacing will affect the use of children's labor on the land and the timing of migration by young family members. If lower-parity births are close together, this will increase the dependency ratio early, but the household can split children's labor between farming and labor migration. If births are farther apart, the household may have to stagger their participation in labor migration in order to maintain the household.
- \* Substituting wage labor migration for total production from the land may allow some part of the land to be left in fallow, thus slowing the pace of erosion and other soil damage.

#### Modeling the 3-way linkage between the life cycle, migration patterns, and the environment

I provide three figures to represent graphically the models discussed in previous sections and the model proposed here.

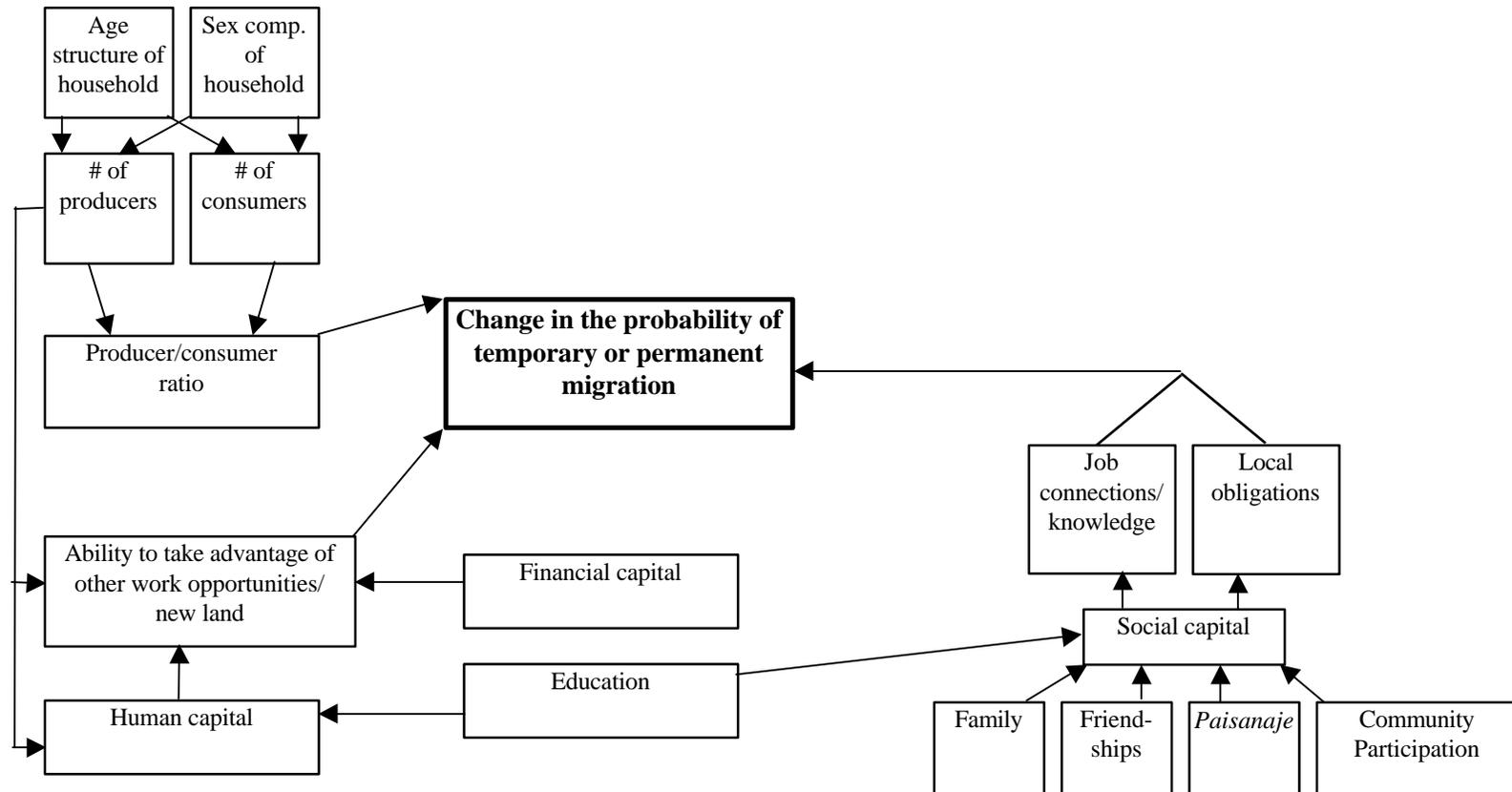
Figure 1 demonstrates the relationship between the rural household life cycle and migration patterns as presented by Arizpe (1982), Collins (1985), and Massey et al. (1987). A change in the probability of temporary or permanent migration is influenced by *the producer/consumer ratio in the household, the ability to take advantage of other work opportunities or obtain new land*, and by the job connections and local obligations associated with a household's *social capital*. The producer/consumer ratio is determined by the age structure and gender composition of the household, and is hypothesized to increase the probability of migration the most when the number of consumers relative to producers is high, usually early in the life cycle (Massey et al. 1987, 206-207).

Figure 2 demonstrates the relationship between the rural household life cycle and environmental change, as presented by Moran (1983), Collins (1985), and Moran (1996). Again, the *producer/consumer ratio* and *social capital* influence the dependent variable, which in this case is decisions about land use. However, the relevant factors that build social capital are different. Where in Figure 1 migration patterns were influenced by relationships that increase job connections and local obligations, in Figure 2 the decisions about land use are influenced by labor contributions and resources provided by community members.

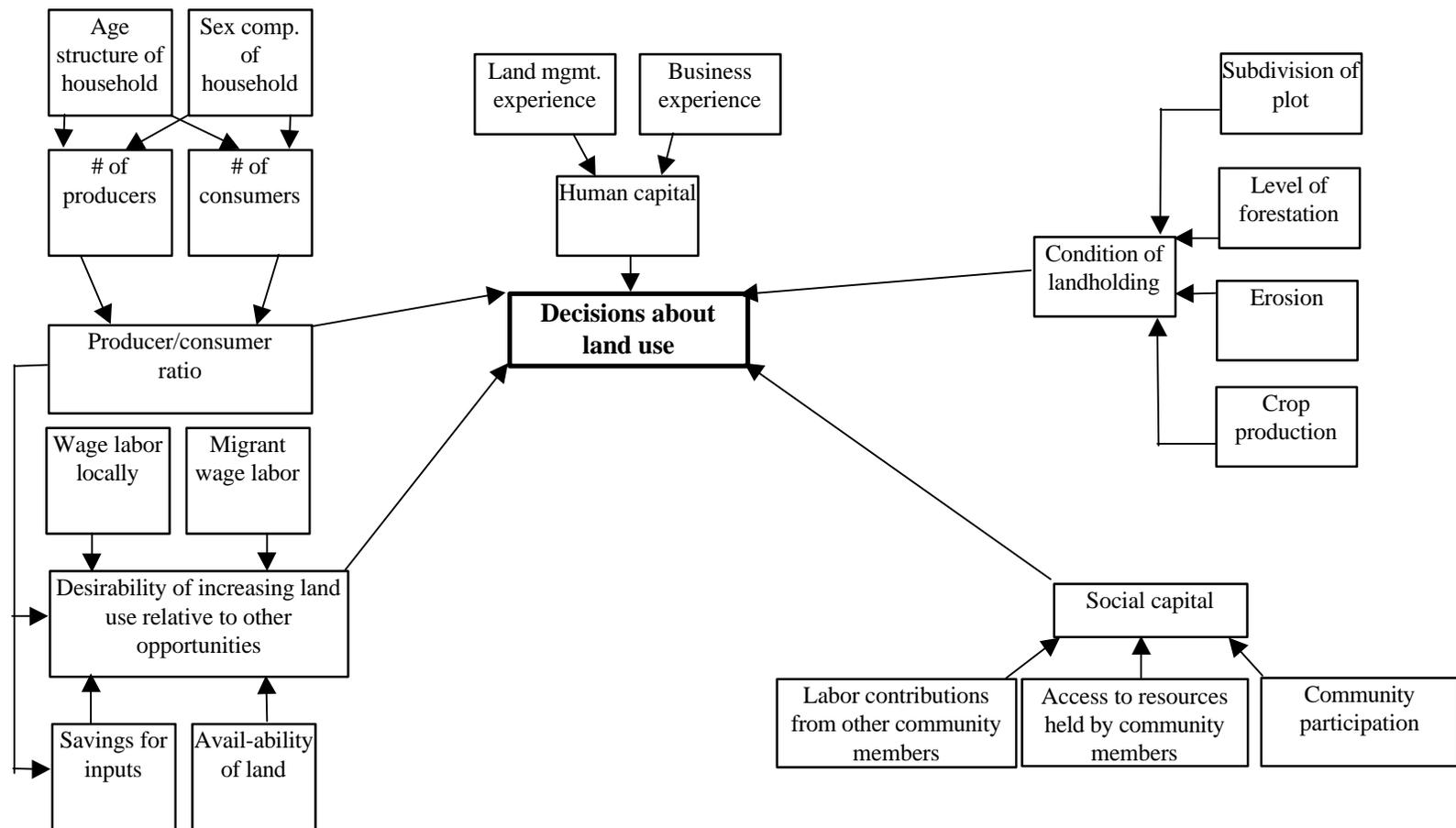
Decisions about land use are also influenced directly by *human capital*. The most important aspects of human capital for this model are land management experience and business experience, which determines the household's prior knowledge about maximizing productivity and market access.

Figure 1: The Rural Household Life Cycle and Migration Patterns

(Arizpe 1982; Collins 1985; Massey et al. 1987)



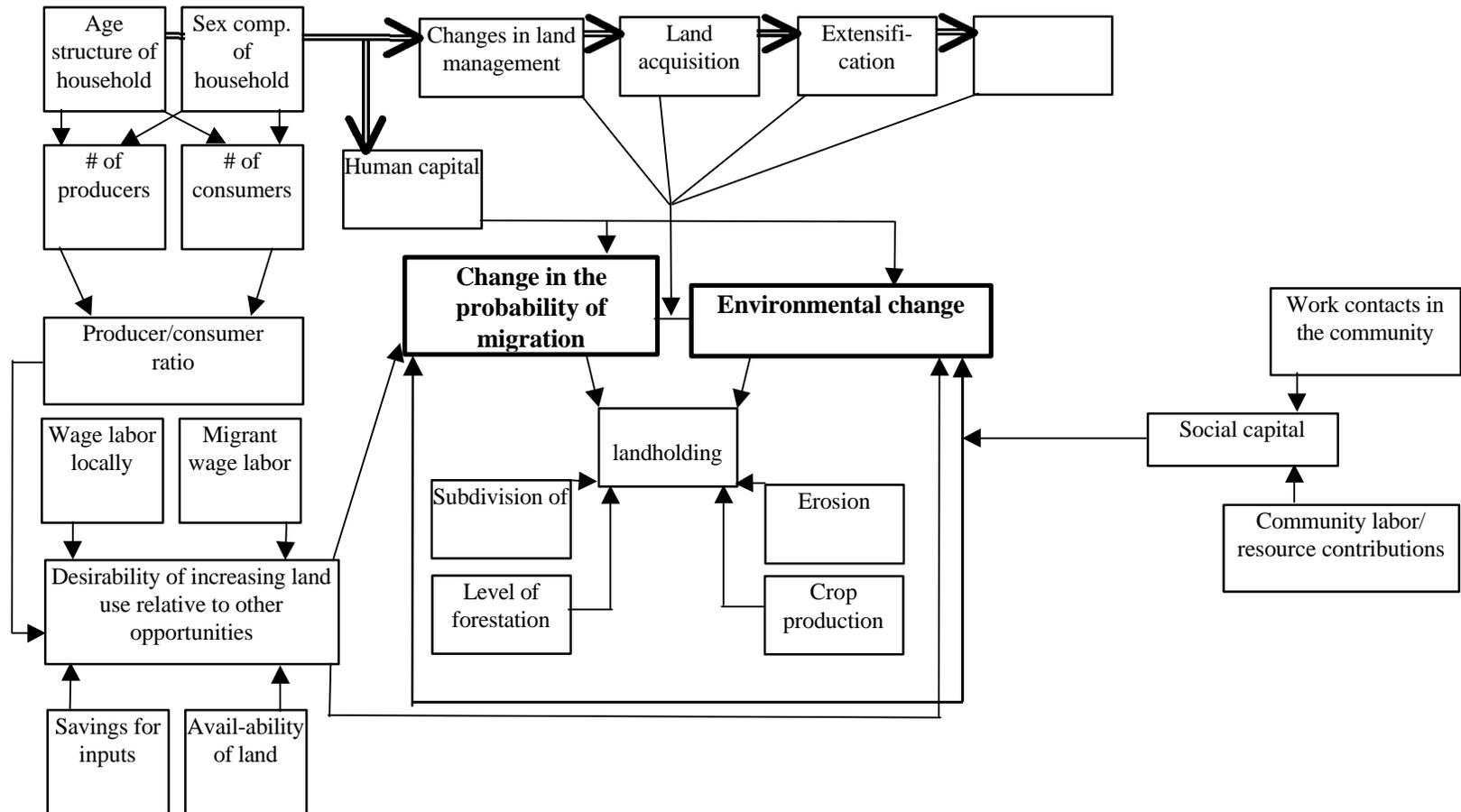
**Figure 2: The Rural Household Life Cycle and the Environment**  
(Moran et al. 1996)



This model identifies important contextual variables as well. The *desirability of increasing land use relative to other opportunities* is influenced by the availability of wage labor opportunities compared to the availability of land, as well as the achieved or potential accumulation of savings for inputs, which is largely affected by the number of producers in the household. Finally, the *condition of the landholding* sets an upper limit on what the household can achieve. This is affected by socially determined causes like the subdivision of a plot due to inheritance patterns; economically determined causes like the nature of crop production (whether annual or perennial, the level of chemical and technological inputs, and the extent of monocropping, for example); and ecologically determined causes, like the level of forestation and the level of erosion.

Figure 3 shows the ways in which environmental change results from migration patterns over the rural household life cycle. The factors which appeared in Figures 1 and 2 appear here as well, being shown to influence both the change in the probability of migration and change in the environment. These factors include *the producer/consumer ratio*, *human capital*, *social capital*, and *the desirability of increasing land use relative to other opportunities*. The *condition of the landholding*, which first appeared in Figure 2, is also shown to influence the probability of migration by creating the circumstances that make it difficult for a household to support itself on the land, given the composition of that household. Although the literature on migration and the life cycle that I review in section II recognizes that the condition of the landholding is often the biggest contributor to the decision to use, this model enhances that argument by showing that the effect of the condition of the landholding is greatest early in the life cycle, when the household has

**Figure 3: Environmental Change Resulting from Migration Over the Rural Household Life Cycle**



the fewest resources to take advantage of other labor opportunities.

The most significant addition to this model is the change in household activities that occurs between the decision to migrate and the observation of environmental change. These activities include *changes in land management, land acquisition, extensification, and use of chemical and technological inputs*. The decision to choose one activity over another is influenced at least in part by the *age structure* and *sex composition* of the household. For example, if the household will break up in the near future as children leave, household members might be less likely to purchase or clear new land, unless wage laborers can be hired to carry out production. The number of migrants and the timing of their migration will also determine wage earnings and the extent to which labor migration becomes the principal means of income, perhaps reducing the need for agriculture.

The model presented in Figure 3 enhances earlier models by showing the ways in which migration patterns and environmental change are caused by similar factors. The model also makes explicit the role of the household life cycle in influencing these two processes directly and in shaping household activities that arise from different migration strategies. These enhancements are important for understanding the ways in which households are constrained by structure and life cycle stages in making their decisions about migration and about how to employ earnings from wage labor migration.

### Data collection

I recommend a national panel study that surveys rural migrant households in personal interviews. Interviews with non-migrant households would also be collected to obtain a control

group. Households in the sampling frame should include those that have either 1.) sent one or more members to work as seasonal laborers in other towns/regions at least once over the life of the household, 2.) recently (<5 years) resettled in new agricultural areas, or 3.) not used temporary or permanent migration. The sampling frame would be drawn from the community of origin. This is necessary because to some extent having a common area of origin will control for the condition of the land, population density, infrastructure, and state and local policies that promote certain crops or methods of farming. It is problematic to use the area of origin to identify people who have since migrated, however, because it is difficult to get a representative sample. Residents in the community may only know the destination of migrants who went to a very particular area, and if migrants have made a second move from that area, they will probably be lost from the sampling frame. In addition, it is necessary to locate origin areas where a migration network attracted a group of households to a single destination. This would allow the researcher to compare current behavior in the destination area to reported behavior in the area of origin for several households.

Ideally, the study would identify several rural areas where local households have used both temporary and permanent migration strategies. The study would compare households that have sent some members to work as migrant laborers to those households that have not used any kind of temporary migration strategy. The study would also identify households that have left the area to resettle in a new rural area, and would follow those households to their area of destination, recognizing the limitations described above. This would allow for a three-way comparison between nonmigrant, temporary migrant, and permanent migrant households to study the

determinants of migration. Finally, the study would also collect information about other households in the destination area of permanent migrants to make local comparisons about current temporary migration and land use strategies.

The study would focus on obtaining historical and current information about household composition, social capital, migration, and land quality. A multi-level analysis would also include variables to control for community and national level effects.

Information about the internal structure of the household would include household size, as well as the age, sex, education, and work experience of the members. Information to create variables that capture relevant life-cycle stages would also be collected. This includes time when the dependency ratio was highest, when children began to contribute labor, and when children were eligible for migration. Drawing on the work on life cycles by Massey et al. (1987), I would expect to define 5 life-cycle stages: married with no children, married with young children, married with some teens and some young children; married with all teens in the household; and married with no children in the home. These stages would be modified in areas where most households were composed of extended families, stem families, or another non-nuclear unit. Other household variables that are important for discussing land use include assets, income, and migration experience.

The ability to determine the timing of one event relevant to other events would be enhanced by the use of event history calendars. At least three calendars would be required to understand the timing of behaviors considered here. Each of these calendars, however, poses some limitations to in-depth analysis of household dynamics.

1.) life history of household calendar: includes information on age at marriage, timing of births and deaths in the household, education, work experience, stage in household life cycle at time of interview, sources of income (proportion from farming/cattle raising/agricultural production compared to other sources), timing of productive household investments and changes in consumption.

The proposed design of this calendar makes at least two assumptions that are not necessarily valid among all households: first, the head of household is assumed to be male; and second, decisionmaking patterns appear to be homogenous among household members. By asking only about the sources of income, investments, and changes in consumption that were actually realized in the household, this calendar neglects alternative strategies and the reasons these strategies were not selected. This neglect conceals the fact that there may be competing interests in the household, and that the outcome of that competition may be conditioned by power dynamics. These assumptions are especially limiting in discussions of gender. Access to land titles, resources, and investment funds may be very different for men and women in married-couple households, and women may be more restricted than men in pursuing their self-interest or the collective interest of the household relative to men's ability to satisfy their priorities. Furthermore, female-headed households may have very different patterns of income accumulation and allocation, particularly if they have fewer opportunities for capital investments. Therefore, randomly selected households may be interviewed in more depth to understand the constraints imposed by gender on available options.

2.) migration history calendar: includes information on each migration experience in the

household--the date migration was initiated by each household member, occupation, how work was obtained, length of stay, income earned/remitted to household, change in contribution to immediate household labor supply due to migration.

Admittedly, collecting relevant person-year information on all household members will result in an unwieldy data set. One alternative is to consider only the migration history of the household head, or only the initial migration experience of each household member, in early analyses of changes in land use patterns.

3.) land use calendar: amount of farmland owned by household, when title obtained, soil type, timing of sale or purchase of land parcels, amount of rented farmland, irrigation, number and gender of family members working on land, number of hired workers, person-hours worked on land each week at different seasons, crops grown, changes in crops, crop rotation strategies, length of fallow periods (if any), land used for grazing, area deforested, timing of deforestation, crop yield in areas according to quality of land and number of years land in agricultural use.

Household-centered explanations of changes in land use must deal with gender explicitly as well as with age and household size. Gender is important not only because of differential access to resources, as described above, but because men and women may have different styles of land management. First, women may have different ties to forms of community support than do men, so the ways in which they collectively manage land may vary (Hondagneu-Sotelo 1994, Collins 1985). Second, women are not able necessarily to perform the same heavy labor as men. Therefore, they must either find in-kind assistance or wage labor in the community, train their children to perform those tasks, or neglect some aspects of land management. Third, in the

absence of the household head, there are fewer people working the land, so there are fewer person-hours in which to accomplish land maintenance tasks, including terracing, maintenance of irrigation canals, and selective weeding to prevent erosion. Again, these responsibilities may be neglected in the interest of satisfying day-to-day demands, or the household may begin to substitute less labor-intensive, more high-tech methods.

Information about the community which would affect all households is also required. This includes data about droughts, heavy rains, or other natural conditions that would have reduced ecological security; population density; traditional line of inheritance of family landholdings; local employment opportunities and wage levels; availability of schools; health clinics; roads; communication systems; and local environmental conditions (INSTRAW 1994, 52). This provides information about local parameters that put an upper limit on the ability to access markets, expand a landholding, or find other work in the absence of productive soil or reliable market conditions.

I hypothesize that poor households that rely on the internal labor supply rather than technological inputs to the land to increase household income are more likely to be involved in migration flows and to practice less conservative use of the immediate natural resource supply. To test this would require tying information about the household income level to the availability of inputs, government loans, and incentive programs. Therefore, national-level data regarding the terms of guaranteed market prices, titling, and subsidized loans for specific purposes such as inputs and commercial crops are required.

#### Method of analysis

I propose using continuous-time event history models to estimate the hazard rate of migration at different stages in the household life cycle and the hazard rate of changes in land use that result from incorporating migration into the household economy. I describe two sets of models to obtain these rates.

*Hazard rate of migration*

The first set of models estimates the probability of initiating temporary or permanent migration. The first subset I will discuss estimates the probability of initiating a *temporary* migration flow in the household at each stage of the life cycle after marriage (stage  $x_1$ ), given that the household is still at risk. The household is the unit of analysis in this model. Initiation of temporary migration is considered to be the first time at least one household member is sent to another rural area or to an urban area to work as a wage laborer. Observations are measured in household-years. I would expect that for poor households the hazard rate is highest shortly after the first children are born (defined as the second stage,  $x_2$ ) and then drops off in the later life cycle stages. For wealthier households, the rate would be highest when there are some teenagers and some young children in the household (defined as stage 3,  $x_3$ ) and then drop off. That is, households that do not initiate migration flows by the time there are some teenagers present are less likely to initiate them at all. The model for this is derived from Allison's (1984) discussion of event history analysis:

$$\log (P(t)/(1-P(t))) = a(t) + \beta_1 x_1(t) + \beta_2 x_2(t) + \beta_3 x_3(t) + \beta_4 x_4(t) + \beta_5 x_5(t) + \beta_6 x(t) + \beta X_j$$

$P(t)$  is obtained by coding the initiation of migration 1 if it occurred, 0 if it did not. The intercept  $a(t)$  varies for each year. This allows the hazard to vary autonomously with time, so that not all of the change in the hazard appears to result from the time-varying explanatory variables. This is important, because a household may decide to migrate after three years of bad harvests regardless of the position in the household life cycle, and the intercept would capture the meaningfulness of that independent event.  $\beta_1x_1(t) - \beta_5x_5(t)$  represent dummy variables for five life-cycle stages whose values vary over time (married with no children, married with some teens and some young children, married with all teens, married with no children in the household).  $\beta_6x_6(t)$  is the number of children in the household, which is also time-varying; and  $\beta_jX_j$  is a vector of coefficients that represent social capital, condition of the landholding, and local and national contextual factors. Coefficients are estimated by the maximum likelihood method. The results from this equation can be interpreted as deviations from a baseline hazard rate (defined as the constant in the model) that is always present and does not change over time. A negative intercept means that in a given year, the hazard rate of initiating migration for all households is below the baseline; a positive intercept means that the hazard rate is above. For the dummy variables representing life-cycle stages, the hazard rate decreases when the coefficient is negative and  $x = 1$ ; it increases when the coefficient is positive and  $x = 1$ . For variable  $x_6$ , the hazard rate increases or decreases relative to the baseline (depending on the direction of the coefficient) as the number of children in the household increases.

The second subset is similar, but the dependent variable is the hazard rate of initiating permanent migration. The variables of interest are the same, namely the time-varying dummy

variables for the life-cycle stages and the number of children in the household. I would expect to see a lower hazard rate overall compared to the rate for temporary migration, but I would expect the significant deviation from the baseline hazard to occur only at stage 3 (household with some teenagers and some young children) because all household members would be able to contribute labor on a new landholding.

*Hazard rate of changes in land use*

The second set of hazard models would estimate the rate of several different potential changes in land use resulting from migration patterns (discussed as part of Figure 3 earlier in this section). These four categories are composed of changes in land management, use of chemical/technological inputs, extensification, or land acquisition. A fifth possibility proposed by Moran et al. (1996) is *reforestation*. Consideration of changes in land use is important because at the aggregate level, the rate of environmental change could be predicted by the rate at which these events were occurring.

Clearly, the occurrence of any of these events will affect the hazard rate of the others. For example, extensification on a single holding may be delayed if new technological inputs are used, or if the household acquires a second plot of land. In all cases, change in land management underlies the probability of each of the other events. Land management includes a diverse set of practices relating to the maintenance of a private landholding as well as of public goods like water and grazing lands, and may lead to more or less environmental degradation depending on household composition and community participation in land conservation. Therefore, for purposes of analysis, land management may best be conceived as an index, including the presence

or absence of relevant land maintenance practices over several seasons.

The complexity of potential land use scenarios requires the specification of a model that can account for the potential effect of prior land use decisions on the hazard rate of a particular activity at a later stage in the household life cycle. To obtain the hazard rate of any one change in land use, this model would have to account for several factors pertaining to the household economy, including: a.) the number of years the household has participated in temporary migration flows; b.) an index for land management practices; and c.) prior changes in land use.

A brief explanation of the decision to use hazard models is useful. I chose this method because hazard models are specifically designed to handle right-censored data like that which I might expect to find in the proposed data set. The sampled households that have not initiated migration (or that have not employed one of the four land use strategies) are still at risk at the end of the observation period. If they are excluded from the sample, or if the maximum length of time observed is assigned as the value of the dependent variable for those cases, there is a risk of creating large biases (Allison 1984, 11). The hazard model avoids this problem by allowing those cases to contribute exactly what is known about them to the dependent variable. If the data is collected for ten years, then households in which there has been no migration (or change in land use) will contribute 10 zeroes to the dependent variable.

I chose discrete-time hazard models over continuous-time models because the methods generally yield similar results, and because when there are time-varying covariates in the equation, the costs and convenience of the two methods are comparable (Allison 1984, 22). I chose this method as a first pass, however, and would expect to do sensitivity testing to find out if a model

predicting a continuous-time hazard rate, which allows events to occur over an interval, produces significantly different coefficients.

Another alternative for the first set of models is to use a repeated events model, which would account for multiple migrations in a household during the observed period. This would yield useful estimates of the rate at which migration is employed in a household at particular life-cycle stages and would give some indication of how much the labor supply is used in migration compared to in agriculture. However, as a preliminary step, investigating the rate of initial migration is theoretically important because it provides information about the time at which alternative economic strategies become desirable or crucial for the household.

## **V. Discussion**

The information obtained in this project will enable researchers to understand the timing of migration and related changes in land use. It will also shed light on the question posed by Moran (1996) as to whether changing rates of environmental degradation and resource use are due primarily to population growth or to fluctuations in the household life cycle. Clearly, population growth will create more households that will pass through the stages of the life cycle where migration and deforestation are most likely. However, the ability to estimate potential land use cycles and to identify peaks in deforestation rates will be aided by having some criteria to identify those poor households that are most likely to resettle or to begin seasonal migration in order to save their current landholding. With this information, household economic strategies that allocate labor resources in response to the availability and security of natural resources can be used in addition to the macro-level variables currently used to predict deforestation, including national

policy and population growth rates. This addition to estimating procedures may yield more accurate estimates.

The proposed research design and analysis have some limitations. First, I focus on the household as an economic and decisionmaking unit because that is the context in which changes in income and changes in land use are made. This restricts the amount of information that is conveyed about the characteristics of the individuals who are migrating or remaining on the land.

Second, the analytical model discussed does not include all of the factors included in the graphical model in Figure 3. This includes variables measuring the condition of the landholding and local infrastructure, factors which I have argued often function as push factors in the decision to choose temporary or permanent migration. In addition, it lacks an explicit discussion of social capital variables, which need to be separated out from variables measuring life cycle stages. I chose to emphasize only the variables measuring the life cycle stages, because these would be observable in any setting. A case study proposal would have highlighted the environmental and social capital variables that would be expected to influence decisions about migration and land use in a given setting. Instead, by choosing the most generalizable model to discuss, I have neglected important explanatory variables for particular cases.

## **VI. Conclusion**

In this paper, I set out to enhance the theoretical literature on population and the environment by developing a model that takes into account the age structure and gender composition of rural households to explain variation in the timing of migration and decisions about land use. I argue that this model is important because migration patterns transform land

use. In differently structured households, these patterns may reduce or delay environmental degradation by limiting dependence on the productivity of the land, or these patterns may increase degradation by contributing to the decision to practice extensification with slash and burn methods or intensification with inappropriate inputs.

The literature review in this paper has shown that the arguments that characterize the population and environment debate capture the importance of migration only marginally. Where migration is considered, researchers ignore the changing capacity of a household's members to migrate, either permanently or temporarily, over the course of the household's development. The significance of these patterns is demonstrated elsewhere; literature on the life cycle and migration shows that migration patterns set up around the household life cycle change the way household and communities use land over time.

A third relevant area of literature addressed in this paper focuses on the life cycle and the environment. This work is useful for conceptualizing the way in which the migration process has changed frontier household formation and land use. However, the idealized context for this relationship assumes an indefinitely productive frontier and ignores the possibility that local conditions may pressure households into using temporary migration as a survival strategy, or as a means to obtain more advanced inputs. By ignoring the potential for migration patterns to continue after initial resettlement on the frontier, researchers miss the ways in which these patterns influence land use.

I combine the strengths from each of these areas to arrive at a model that considers the ways in which environmental change drives rural households to modify their income strategies,

and the ways in which these strategies are conditioned on the household life cycle. The response to change then influences future activities which perpetuate environmental change, although at different rates, depending on what resources are available to the household in a given life cycle stage. This model emphasizes the producer/consumer ratio and human capital in a household, the household's social capital, the condition of the landholding, and the desirability of increasing land use relative to other strategies at a given time as factors that contribute to both the probability of migration and decisions about land use. In addition, changes in household activities that result from migration patterns at different life cycle stages are considered. These include changes in land management, use of inputs, extensification, or land acquisition.

To operationalize this model, I propose a data set which includes event history calendars providing information on the life history of the household, its migration history, and its land use history. I then suggest using discrete-time event history analysis to determine the hazard rate of the initiation of migration and changes in land use. Together, these models can provide information about the way in which farmers are changing their income-generating strategies and the ways in which they are using land. By including the household life cycle, these models can also explain part of the variation in rates of deforestation due to small farmers and make predictions about future rates of deforestation based on the household structures and migration patterns in a region.

This paper is intended to suggest a method for bringing the household into the population and environment debate by shifting the focus from aggregate growth rates to household behaviors observed on a smaller scale. This change in scale allows us to consider the variation in an

individual's behavior depending on his/her immediate context. Across households, the number of people in the home will determine the way in which money is earned and spent, and the way in which land use is maximized; within households, the need for new resources to support everyone present will change, as more people are able to contribute to the labor and social capital.

In the big picture, the addition of one more person to the planet does not indicate a constant, uniform pressure on resources. Instead, individuals drain resources more or less at different times depending on a number of household-level factors. Recognizing this can reduce some of the fear about a "population explosion" by contributing to an informed understanding of the cycles of environmental degradation. If we can predict cycles of degradation, rather than interpreting a contemporary decline or increase as indefinite, policies and attitudes about land use and about population growth, while cautious, need not be extreme.

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