



# **Environmental Change and Out-Migration: Evidence from Nepal**

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**ABSTRACT**

The concept of “environmental refugees” has been put forth to hypothesize a connection between environmental deterioration and out-migration. In this paper we test this hypothesis using data from Nepal. We operationalize environmental degradation in terms of declining land cover, rising times required to gather organic inputs, increasing population density, and perceived declines in agricultural productivity. Holding constant the effects of other social and economic variables, we find that population density is unrelated either to short- or long-distance mobility, but that moves within the immediate vicinity are predicted by perceived declines in productivity and land cover and increased time required to gather firewood. Long-distance moves are predicted by perceived declines in productivity, but the effect is weaker than in the model of short-distance mobility and even this effect is confined only to lower and non-Hindu castes. No other environmental characteristics affect the odds of making a distant move, thus casting doubt on the utility of the concept of environmental refugees in explaining interregional or international migration. Environmental deterioration mostly leads to short-distance moves within the immediate vicinity, affecting males and females in a manner consistent with Nepal’s gendered division of labor.

## INTRODUCTION

Among social scientists seeking to model human migration theoretically and study it empirically, attention has generally focused on economic, social, and to a lesser extent, cultural factors.

Neoclassical economists specify geographic discontinuities in wage rates as the driving force behind migration, whereas those subscribing to the new economics of labor migration attribute it to failures in local markets for capital, credit, and insurance (cf. Todaro and Maruszko 1987; Stark 1991).

Institutional theorists view migration as a response to structural transformations experienced by societies as they shift towards markets and integrate within global regimes of trade and investment (cf. North 1981; Sassen 1988) or as a response to labor demand originating in segmented labor markets (Piore 1979; Portes and Bach 1985). Sociologists have emphasized the embeddedness of decision-makers within social organizations (Portes and Sensenbrenner 1993), notably migrant networks that yield social capital to facilitate movement (Massey 1990). Anthropologists, as well as sociologists, have sought to incorporate culture into the analysis (Kearney 1986), the former by considering the subjective meanings of migration to individuals and groups (Rouse 1991, 1992) and the latter by hypothesizing a “culture of migration” that contributes to the cumulative causation of migration over time (Kandel and Massey 2002).

In none of these disciplinary accounts do environmental conditions figure as salient determinants of migrant decision-making. To the extent that environmental conditions are mentioned, they are either assumed to be a consequence of market expansion (e.g., the consolidation of landholding and the mechanization of production—see Massey et al. 1998) or they are addressed under the rubric of “population pressure” (whereby demographic growth increases demands on natural resources to cause environmental deterioration—see Massey and Taylor 2004).

Though it is now well-established that out-migration stems from economic development rather its absence, studies have not assessed whether or how environmental conditions mediate structural economic changes to influence migratory decisions. Moreover, despite historical evidence indicating a lagged correlation between population growth and emigration (see Thomas 1973; Hatton and Williamson 1998), contemporary social scientists generally downplay “population pressure” as a fundamental cause of migration (Massey et al 1998), noting that rates of natural increase are uncorrelated with rates of international out-migration around the world (Zlotnick 2004)

Despite the lack of credence given to environmental factors among social scientists, many environmentalists take as an article of faith that population growth, environmental deterioration, and out-migration are fundamentally interrelated (see Hermsmeyer 2005). The term “environmental refugees” was introduced by El-Hinnawi (1985) to describe people who have been displaced through natural disaster and environmental degradation. Based on his review of global conditions, Jacobson (1988) estimated the number of environmental refugees to be 10 million in the mid-1980s,

a figure that Myers (1997) put at 25 million by the mid-1990s. Although this concept has been criticized for its vagueness and lack of specificity and such numbers derided as inflated (see Black 1998, 2001), the notion of environmental refugees remains popular among environmentalists, ecologists, development activists, and some scholars (Suhrke 1994).

One reason for the lack of consensus about environmental effects on migration is the scarcity of good data on the subject. In his review of the evidence, Castles (2001) points out that whereas Myers and Kent (1995) list millions of people *at risk* of environmental displacement, they never offer counts of people who *actually moved* for environmental reasons. However, specific case studies do appear to link population growth, environmental deterioration, and political violence to migration (see Homer-Dixon 1991, 1994), an interplay of forces that Lee (2001) calls the “environment-security nexus.” But these studies also show that environmental conditions are but one factor in a complex of causally interconnected variables whose mutual influence cannot be sorted out in qualitative accounts (see Castles 2001; Wood 2001).

In this analysis we seek to assess the causal importance of environmental deterioration on human migration by taking advantage of prospective longitudinal data gathered in Nepal’s Chitwan Valley during the late 1990s. These data allow us to assess environmental conditions—actual and perceived—at the beginning an observation period and to measure their influence on the subsequent odds of out-migration over the ensuing 36 months while controlling for the social and economic effects currently favored by social scientists to account for population mobility. This analysis not only permits us to assess the significance of environmental conditions in determining human migration; it also allows us to measure the relative importance of environmental versus other factors in migrant decision-making.

## **SETTING: NEPAL’S CHITWAN VALLEY**

Nepal is one of the world’s most diverse ecological settings (Chaudhary 1998; Majupuria 1999; Shrestha 1993) but also one on the brink of serious environmental degradation (Blaike, Cameron, and Seddon 1980; Blaike and Brookfield 1987; Eckholm 1976; Ives and Messerli 1989). The fragile Himalayan environment presently suffers from rapid deforestation and soil erosion, which threaten native flora and fauna and undermine local bio-diversity. In combination with rapid population growth, accelerating social change, and ongoing economic development, Nepal offers an ideal setting to test the relative influence of environmental conditions on migration.

Our study area is the Western Chitwan Valley of South-Central Nepal, a wide, flat valley nestled in the Himalayan foothills approximately 450 feet above sea level. Until the early 1950s, Chitwan was covered by virgin forests, infested with malaria-carrying mosquitoes, and home to many dangerous fauna, ranging from poisonous snakes to Bengal Tigers. Beginning in the mid-

1950s the Nepalese government began a program to clear the forest, eradicate malaria, and distribute the cleared land to settlers from the highlands. Approximately one-third of the original forest was preserved as Chitwan National Park, which remains home to several endangered species today.

Rich soils, flat terrain, and the promise of new opportunities drew highland farmers into the valley, but it remained a remote and isolated frontier until 1979, when the first all-weather road was completed (see Shrestha et al. 1993). This road linked Chitwan's largest town, Narayanghat, to the eastern portion of Nepal's East-West highway and, therefore, to cities throughout Eastern Nepal and India. Two other important roads quickly followed: one to the west that linked Narayanghat to the western portion of Nepal's East-West highway and the other to the north that connected Narayanghat to Kathmandu, Nepal's capital.

Because of Narayanghat's central location, by the mid-1980s this once isolated town had become a major transportation hub for the entire country. This change was accompanied by a proliferation of government services, business expansion, and growing employment (Pokharel and Shivakoti 1986; Axinn and Yabiku 2001). The government invested heavily in agriculture, with large outlays for irrigation, mechanization, improved seeds, pesticides, fertilizer, and new methods of production and marketing (Shivakoti and Pokharel 1989). Bus service made Narayanga's jobs and business opportunities accessible throughout the valley and commercial enterprises—grain mills and retail outlets, as well as government services such as schools, health clinics, post offices, and police stations—sprang up everywhere. The valley's population grew rapidly through both immigration and natural increase (His Majesty's Government of Nepal 1987; Shrestha et al. 1993; Tuladhar 1989).

Within the lifetimes of most residents, therefore, Chitwan's social and economic structure was radically transformed, and these shifts brought about rapid change in the natural environment. Whereas in the 1970s Chitwan was relatively homogeneous in terms of access to natural resources, by the late 1990s the proliferation of non-family organizations had shifted land use away from forestry and agriculture toward buildings and physical infrastructure (Axinn and Ghimire 2002; Shivakoti et al 1999). These changes greatly increased variation in access to firewood and fodder, which most families use on a daily basis (Axinn and Axinn 1983; Biddlecom et al. 2005). The macro-level proliferation of non-family organizations was accompanied by significant micro-level changes in environmental quality, such that many farmers came to see natural resources as deteriorating (Barber et al. 2003). Taken together, real declines in access to firewood and fodder, a growing scarcity of agricultural land, increases in population density, and the spreading perception that farmland was declining in productivity would seem likely to motivate out-migration from Chitwan, independently of whatever social and economic mechanisms are also in play.

## **DIMENSIONS OF ENVIRONMENTAL VARIATION AND MIGRATION**

A key issue in all research on the effect of environmental trends on demographic behavior is how to define the specific aspects of environmental change that are most relevant. Previous research has considered an extremely broad set of environmental conditions, including population density; access to natural resources; air, water and soil pollution; land use and land cover; the use of fertilizers, pesticides, and irrigation; and perceptions of change with respect to pollution, land productivity, and access to natural resources (Bhandari 2004; Bilsborrow 1992; Bilsborrow and DeLargy 1991; Blaike and Brookfield 1987; Bongaarts 1996; Boserup 1965 1981; Cohen 1995; Ehrlich, Ehrlich and Daily 1993; Foster and Rosenzweig 2003, 2004; Heilig 1997; Hill 1990; Hamilton, Seyfrit, and Bellinger 1997; Moran, Brondizio and VanWey 2005; Moran and Brondizio 1998; Perz 1997).

From these alternatives we chose five to represent the leading dimensions of environmental change within the Chitwan Valley. This ecosystem is characterized by significant internal variation with respect to population density, perceptions of agricultural productivity, access to locally important natural resources, and land use patterns. For several reasons we hypothesize that shifts in these conditions will significantly affect migratory behavior within and outside the valley.

First, scholars have long argued that out-migration follows from rising population density, dating back to Davis' theory of multiphasic demographic change (Bilsborrow 1992; Davis 1963). Given any particular social and economic infrastructure, rising density affects the environment by producing greater pollution and degrading natural resources, which, in turn, motivate residents to leave (Bhandari 2004; Conway and Shrestha 1981; Dignan 1989; Thomas 1973; Gurung 1999; Hatton and Williamson 1998; Shrestha 1990; Thacker 1991). We thus hypothesize higher levels of population density to be associated with higher rates of out-migration among residents of the Chitwan Valley.

Second, because this setting is almost entirely agricultural, perceptions of land productivity are likely to be particularly powerful in motivating behavior (Ghimire and Mohai 2005, Thacker 1991). Local farmers who believe that land resources in their area have become less productive over time are more likely to move in search of more productive land elsewhere. Farmers in this part of Nepal practice an intensive rotation of three crops per year, with rice being the most important. Land productivity is essential for both subsistence and income generation among local families. We therefore predict that a perceived decline in agricultural productivity will be associated with a greater likelihood of out-migration among farm households.

Third, the direction of land use change in this setting is away from open farmland towards a more developed, built environment, with potentially serious consequences for farmers (Axinn and Ghimire 2002; Shivakoti et al. 1999). As agricultural land becomes scarcer, families either move to

find additional land or leave the agricultural sector entirely to pursue other economic activities. The search for new land clearly promotes migration; but the migration literature also indicates that moves out of agriculture into other sectors likewise entail geographic mobility. We thus predict that local areas with less open farmland will have higher rates of out-migration than those where agriculture is more abundant.

Fourth, in this agrarian setting access to fodder for animals is a critical resource. Husbandry of large and small animals comprises a key component of food production in the valley, and virtually every family cares for at least some animals; and among larger farms livestock cultivation is extensive (Axinn and Axinn 1983; Fox 1987; Ghimire and Mohai 2005). In addition to grazing land, herds require fodder to be collected from local forests which has steadily been reduced owing to deforestation since the 1960s. Because declining access to fodder implies more labor, farm families facing a local scarcity of fodder are motivated to relocate to areas closer to forests and vegetation. We thus predict that families facing less access to fodder will evince higher rates of out-migration.

Fifth, even more than fodder, nearly all households rely on firewood for heating and cooking, and it also must be collected from local forests that are steadily declining (Biddlecom, Axinn and Barber 2005; Filmer and Pritchett 1997; Kumar and Hotchkiss 1988; Schmidt-Vogt 1994; Seddon 1989; Shrestha 1999). As with fodder, therefore, less access to firewood is hypothesized to motivate migration to areas with more abundant forests. In this part of Nepal, however, the collection of fodder and firewood are highly gendered activities, with women primarily responsible for gathering fodder and men more likely to collect firewood (Bhandari 2004; Kumar and Hotchkiss 1988). Because of this important gender differentiation, variations in access to fodder and firewood are expected to have different effects on the migratory behavior of men and women.

Finally, we differentiate among moves by distance because we expect environmental change to have stronger effects on local than long-distance mobility. Given that the Chitwan Valley continues to exhibit a great deal of environmental variation, we expect local environmental changes to have a stronger influence on local moves within the valley than on long-distance moves out of the valley. To the extent that residents are motivated to move by environmental changes, they can usually find improved conditions without leaving the valley. This distinction is important because it underscores a salient reason for why the migration literature has overlooked environmental influences. Whereas most theoretical models and research investigations have focused on long-distance moves, environmental change may primarily influence local geographic mobility, rendering environmental influences invisible in most studies.

## DATA COLLECTION AND MEASUREMENT

Our analysis draws on data derived from the Chitwan Valley Family Study (CVFS), which offers a unique resource for studying the effect of environmental change on migration. Not only does the CVFS database offer objective and subjective assessments of environmental conditions, it also allows us to distinguish between local and long-distance moves while controlling for the confounding effects of social and economic variables typically used by social scientists to predict migration.

### The Chitwan Valley Family Study

This Chitwan Valley Family Study gathered four basic kinds of information: household survey data, individual interviews that included detailed life histories, land use data, and data from a monthly registry of demographic events. For purposes of sample design, the valley was divided into mutually exclusive “neighborhoods”—geographic clusters of 5-15 households—and these were selected on an equal probability basis using a multi-stage cluster design (Barber, Shivakoti, Axinn, and Gajurel 1997). Once a neighborhood was selected, researchers surveyed every household within it, yielding a total of 1583 households with a 100% response rate at the household level. The baseline survey was completed in 1996 and contained basic measures of household consumption, resources, agricultural practices, and environmental perceptions.

After completing the baseline survey, all individuals aged 15-59 residing in the household were interviewed separately using a standardized questionnaire that included a life history calendar. Also interviewed in this manner were spouses of respondents who lived elsewhere or who were outside the age range. A total of 5,271 individuals were interviewed during this stage with a 97% response rate. The standardized interviews yielded information on family background, personal characteristics, daily experiences, community context, and social attitudes. The life history calendar provided retrospective data on residence, marital status, children, contraceptive use, living arrangements, schooling, and work experience (Axinn, Pearce, and Ghimire 1999; Belli 1998; Freedman et al. 1988). Common identifiers allow events from the life history calendar to be linked to data from the baseline questionnaire.

After these surveys were completed, in early 1997, the study undertook a detailed set of land use measurements for each neighborhood and launched a monthly registry of demographic events, including migration, living arrangements, marriage, birth, death, and contraceptive use. The registry tracked all households in the original sample for three years and followed each household member even if they left the study area. We draw on the resulting 36 person-months of data to define a hazard of out-migration, which we predict from each person’s individual, family, and neighborhood circumstances in 1996. Specifically, we consider all those interviewed at the baseline to be at risk of

out-migration in the subsequent period and follow them month-by-month, coding the outcome variable as 0 if they did not migrate in that month and 1 if they did. All person-months subsequent to the departure were excluded from consideration.

## Measures of Migration

Measures used in the study are defined in Table 1 along with their means and standard deviations. We employ two complimentary definitions of migration. The first defines a move as any departure *from the neighborhood* lasting one month or more that did *not* involve a move out of the Chitwan Valley. The second defines migration as a departure *from the Chitwan Valley* lasting at least a month. The latter obviously captures long-distance mobility, whereas the former measures only short distance mobility. As shown in the table, around 12% of reported moving within the valley during the observation period whereas 29% left the valley. For simplicity, we refer to the former as local moves and the latter as distant moves. These definitions allow us to operationalize monthly hazards of short and long distance mobility, treating the two kinds of moves as competing, mutually exclusive risks.

## Environmental Measures

We assess local environmental conditions and perceptions using five basic measures: neighborhood population density, the respondent's perception of changing agricultural productivity, the time required to collect firewood, the time required to gather animal fodder, and the share of neighborhood land covered with flora rather than buildings or infrastructure. We defined population density as the number of households per 100,000 square feet<sup>1</sup>. The average density was around 19 households per 100,000 square feet, but the standard deviation of 64.9 indicates there was substantial variation across neighborhoods in the sample.

To assess agricultural productivity, the baseline questionnaire asked: "Compared to three years ago, do you think crop production has increased, decreased or stayed about the same?" Preliminary analyses showed that perceptions of decline had the greatest predictive power so we coded our measure of agricultural productivity as 1 if crop production was perceived to have decreased and 0 otherwise. The growing pressure on Chitwan's land base is indicated by the fact that 57% of respondents perceived that agricultural productivity was declining.

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<sup>1</sup> Land area comes from the 1996 land use survey, in which a team of field workers mapped the area of each neighborhood using compasses and tape measures. These measurements were digitized and used to calculate the exact area of each neighborhood broken down by category of land use. Neighborhoods ranged in size from 46,762 square feet to 3,223,438 square feet, with a mean of 837,850.

**Table 1.** Definitions, means, and standard deviations of variables used in the analysis of migration and environment in Nepal's Chitwan Valley.

Variable	Definition	Mean	SD
<b>MIGRATION (1997-1999)</b>			
Local	Left <i>Neighborhood</i> on Trip >1 Month	0.12	0.32
Distant	Left <i>Valley</i> on Trip >1 Month	0.29	0.45
<b>ENVIRONMENTAL CONDITIONS (1996)</b>			
Productivity	1 if Perceived as Declining, 0 Otherwise	0.57	0.49
Share Green	% Neighborhood Covered in Flora	72.80	25.33
Time for Firewood	Minutes Required to Gather Firewood (00s)	3.36	2.23
Time for Fodder	Minutes Required to Collect Fodder (00s)	1.07	0.77
Density	Persons per 100,000 Square Feet	19.16	64.93
<b>THEORETICAL CONTROLS (1996)</b>			
<b>Human Capital</b>			
Enrolled in School	1 if Currently Enrolled, 0 Otherwise	0.15	0.36
Years of Schooling	Years Enrolled Prior to 1996	5.78	5.85
Has Wage Job in 1996	1 if Now Has Wage Job, 0 Otherwise	0.34	0.47
Has Salaried Job in 1996	1 if Now Has Salaried Job, 0 Otherwise	0.09	0.29
<b>Social Capital</b>			
Local Network	1 if HH Has Local Migrant, 0 Otherwise	0.19	0.39
Distant Network	1 if HH Has Distant Migrant, 0 Otherwise	0.53	0.50
Local Prevalence	Prop. Local Migrants in Neighborhood	0.08	0.07
Distant Prevalence	Prop. Distant Migrants in Neighborhood	0.25	0.12
<b>Physical Capital</b>			
Farmland	1 if Household Owns Land, 0 Otherwise	0.75	0.44
Equipment	Number of Pieces Owned	1.53	1.33
Livestock	Number of Standardized Units	2.02	2.04
House Plot Owned	1 if House Plot Owned, 0 Otherwise	0.80	0.40
Home Quality	Index Ranging from 4-18	9.26	3.57
Market Access	Minutes Walk to Nearest Market (logged)	1.87	1.21
<b>DEMOGRAPHIC CONTROLS (1996)</b>			
<b>Gender</b>			
Female	1 if Female, 0 if Male	0.53	0.50
<b>Age (Birth Cohort)</b>			
15-24 (1972-1981)	1 if Yes, 0 Otherwise	0.36	0.48
25-34 (1962-1971)	1 if Yes, 0 Otherwise	0.24	0.43
25-44 (1952-1961)	1 if Yes, 0 Otherwise	0.19	0.39
45-59 (1936-1951)	1 if Yes, 0 Otherwise	0.20	0.40
<b>Ethnicity</b>			
High Caste Hindu	1 if Yes, 0 Otherwise	0.47	0.50
Low Caste Hindu	1 if Yes, 0 Otherwise	0.10	0.30
Hill Tibeto-Burmese	1 if Yes, 0 Otherwise	0.15	0.36
Newar	1 if Yes, 0 Otherwise	0.07	0.25
Terai Tibeto-Burmese	1 if Yes, 0 Otherwise	0.20	0.40

The survey also asked respondents how long it took them to travel to where fodder or firewood was located, collect it, and then bring it home. We coded the responses in minutes and for convenience in presenting coefficients divided the total by 100. On average respondents reported spending 336 minutes per trip (5.6 hours) collecting firewood and 107 minutes per trip (1.8 hours) to gather fodder.

We also physically determined the share of each neighborhood that was covered with flora. Although most studies of land use and land cover rely on data derived from remote sensing devices (Liverman et al. 1998; Fox et al. 2003), our detailed on-the-ground measures yield highly accurate and reliable information. Because flora coverage is readily observed remotely, however, our measures are roughly comparable to those that would be obtained using satellite imagery. On average, around 73% of neighborhood ground area was covered with flora, although again there was substantial variability throughout the valley (see the standard deviation of 25.3).

## Control Variables

Our interest here is in measuring the *independent* effects of environmental changes on out-migration while holding constant the effects of social and economic variables that are more typically included in migration models. Prior research and theory suggest that the critical determinants of migration fall into three basic categories: human capital, social capital, and physical capital (see Massey et al. 1998). Given that the likelihood of migration also varies in characteristic ways by age and gender, controls for these variables are also included, along with indicators of ethnicity.

*Human capital* refers to skills, experiences, and abilities that raise an individual's productivity in the labor force, making it more valuable for him or her to migrate (Sjaastad 1962). Measures of human capital were derived from responses to a series of questions on the life history calendar. To measure education, respondents were asked: "Did you ever go to school to study even for one day?" If the answer was "yes" the interviewer then asked: "In which year did you first go to school?" Every year the respondent was in school was recorded on the life history calendar. These questions yield a dichotomous indicator of enrollment in 1996 and the total number of years of schooling prior to that date. Around 15% of respondents were enrolled in school and average education stood at 5.8 years.

Respondents were also asked a series of questions about their work history. This history included measures of both salaried employment and daily wage work and ascertained both the history of work experience and current work status. In rural Nepal, a salaried job implies stable employment, high earnings, social benefits, and certain protections whereas daily wage labor lacks these benefits. We thus developed two different measures of labor force experience: (1) working a salaried job in 1996; (2) working as a day laborer in 1996. Each of these is a dichotomous measure,

coded 1 if the respondent experienced the condition and 0 otherwise, thus roughly indicating the quality of work experience. As can be seen, 34% of respondents held a wage job at the time of the baseline survey and 9% had a salaried job.

*Social capital* refers to the instrumental value that people derive from their social connections to others. In the case of migration, being related to others with prior migratory experience greatly increases the odds of out-migration by reducing the costs and risks of undertaking a trip. We measure social capital in two ways: by the presence of others with migratory experience in the household, and by the relative number of persons within the neighborhood who have migrated in the past, which following Massey et al (1994) we call the migration prevalence ratio.

Our measure of household members' migration experiences comes from the individual interviews of those aged 15-59 in 1996, which provided a complete record of all moves. To measure social capital at the household level, we coded a household network tie as 1 if any member of the household had ever moved out of the current neighborhood before 1996 and 0 otherwise. To measure social capital at the neighborhood level, we used the same data to determine the relative number of residents with prior migratory experience in 1996. From the individual life history calendar, we coded migration experience as 1 if an individual had ever moved out from the sample neighborhood before 1996 and 0 otherwise and then computed the proportion of individuals for each neighborhood who ever migrated before 1996.

Because our models analyze both local and distant moves, we constructed the social capital measures to match the specific kind of migration being predicted. In models predicting local moves we measured household and neighborhood experience with respect to local moves, whereas in models predicting distant moves we measured household and neighborhood experience with respect to moves outside the valley. Among respondents in Chitwan Valley, 19% had a tie to someone who had migrated locally and the average person lived in a neighborhood where 8% of the residents had local migration experience. Likewise, 53% had a tie to someone who had migrated outside the valley and the average person lived in a neighborhood where 25% of residents had undertaken a distant move.

*Physical capital* refers to the presence or absence of tangible assets within the household or neighborhood. On the one hand, ownership of an asset may encourage migration either by providing collateral for borrowing to finance a trip or by providing a particular motivation for migration, or both. For example, land ownership, may motivate a household member to migrate in order to self-finance productive agricultural investments in the absence of viable capital markets, while simultaneously providing the collateral to act on this motivation. On the other hand, the lack of an asset, may also signal an important motivation for migration (though not, of course, providing any collateral to finance it, which is where social capital comes in). Throughout the world, one of the

most powerful motivations for migration is self-financing the construction or improvement of a home in the absence of effective mortgage and consumer credit markets (see Taylor et al. 1996). Thus the lack of an owned home, or the possession of a home of marginal quality, generally increases the odds of out-migration.

Our measures of physical capital come from the baseline interview, which asked a series of question about different types of property ownership, including whether the household owned any agricultural land, whether it owned the house plot, the number of farm animals it owned, and the number of pieces of farm and household equipment it possessed. For the first two variables we developed dichotomous indicators, coded 1 if the household owned farmland or the house plot and 0 otherwise. These two pieces of property are rather widely owned. Some 80% of respondents reported owning the plot upon which their house stood and 75% said they owned farmland.

Our count of livestock owned takes into account the numbers of buffalo, cattle, sheep, goats, and pigs owned by the household. The number of each kind of livestock was converted into a standard “livestock unit” using a conversion factor and these standard units were then summed to create a comparable count of total livestock owned. The average household owned around two units of standardized livestock. The number of pieces of equipment was determined from questions that asked whether the household owned a radio, television, bicycle, motorbike, tractor, cart, pumpset, or gober gas plant. For each item present in the household, the index of household goods increased by 1, yielding an index that ranged from 0 to 8. The average on this indicator was 1.52 pieces of equipment.

We measured housing quality from interviewer observations concerning four attributes of the dwelling: number of stories, material used to make the walls, material used to make the roof, and material used to make the floor. Number of stories is coded from 1 to 5 corresponding to the number of floors in the house. Material used to make the walls is coded from 1 to 6 (concrete = 6, brick = 5, stone = 4, wood = 3, mud = 2, and cane with mud = 1). Material used to make the roof is coded from 1 to 4 (concrete = 4, tin = 3, slate = 2, and thatch = 1). Material used to make the floor is coded from 1 to 4 (concrete = 4, brick = 3, wood = 2, and mud = 1). Overall, the housing quality scale is constructed by summing these four measures, yielding a measure that ranged from 4 to 18 with an average of around 9.3.

Finally, we included an indicator of access to markets as an indicator of the stock of capital accessible to each household. This variable was measured as the number of minutes required to reach the nearest market on foot, where a market is defined by the presence of two or more shops. This variable was highly skewed and in order to improve fit, we took the natural log of the number of minutes, yielding a mean value of 1.87 (around 6.5 minutes).

Demographic controls were measured in straightforward fashion by specifying dummy variables for gender, age category, and ethnic group. Previous research in Chitwan has found that

ethnicity exerts a strong effects on fertility intentions (Pearce 2000) and family formation (Axinn & Barber 2001; Ghimire et al. 2006; Thapa 1989, 1997; Yabiku 2006) and for this reason we include controls to capture any effects of ethnicity on migratory behavior. Nepalese society includes more than 60 linguistic subgroups (Bista 1972; Caplan 2000; Dahal 1993; Gurung 1980, 1998; Niraula 1994) that may be grouped into five categories for analytical purposes: high caste Hindus, low caste Hindus, Newar, Hill Tibeto-Burmese, and Terai Tibeto-Burmese (Axinn & Yabiku 2001; Blaikie et al. 1980). We indicate these categories using dummy variables and take high caste Hindus as the reference category.

## ENVIRONMENT AND OUT-MIGRATION

The Chitwan Valley Family Study thus offers a promising opportunity to measure the effects of environmental conditions on out-migration while simultaneously controlling for other social and economic factors known to influence mobility. We use discrete time event history methods to model the monthly hazard of out-migration, with person months serving as the unit of analysis (Allison 1982, 1984; Petersen 1986, 1991). We follow individual sample members month-by-month for 36 months beginning on February 1997 and each month regress the 0-1 migration outcome on independent variables defined as of the 1996 baseline. All person-months subsequent to the one in which a trip was taken are excluded. As already noted, local moves within the Chitwan Valley and long-distance moves out of the valley are each treated as competing risks. As a result, in the analyses of local moves individuals are treated as censored if they make a long-distance move before moving locally and in the analyses of long-distance moves individuals are treated as censored if they make a local move before leaving the valley. We control for duration by counting the number of months transpired since February 1997, along with a squared term, and then estimate the model using the GLIMMIX macro of SAS, following an estimation strategy advocated by Barber et al. (2000). This strategy produces a multilevel hazard model that accounts for the clustering of individuals in our sample by community (see Barber et al. 2000; Yabiku 2004).

### Local versus Distant Moves

Table 2 presents the results of two separately estimated models, which are functionally equivalent to results achieved using a single multinomial logit model. The left-hand columns show odds ratios and t-tests for a model estimating the effect of independent variables on the relative likelihood of *leaving the neighborhood* for a period of at least one month (“local moves”), and the right-hand columns show odds ratios and t-tests for the same set of independent variables, but predicting the odds of *leaving the Chitwan Valley* for one month or more (“distant moves”). In both cases, the top panel shows the estimated effects for the five environmental indicators, the middle

panels contain various theoretical controls defined according to the kind of capital they represent, and the bottom panels hold constant the effects of demographic factors such as gender, age, ethnicity, and duration.

The estimates reveal that environmental conditions are much more closely tied to local than to long-distance mobility. Of the five indicators, three are significant in predicting moves within the Chitwan Valley but only one is significant in predicting the odds of making a distant move. A perceived decline in agricultural productivity, a lower share of the neighborhood covered in green, and a greater time to gather firewood are all associated with greater odds of moving locally; but only perceived decline in productivity is significant in predicting the odds moving over a long distance, and the effect is considerably less powerful.

In neither equation does time required to gather fodder or neighborhood population density influence the odds of geographic mobility. It is not the sheer number of people per unit of land that appears to be important, but the degree to which a neighborhood has been denuded of vegetation and the effects of such degradation on the time required to collect firewood. Each percentage point increase in the share of the neighborhood that is covered in flora decreases the odds of local mobility by 2%, and every hundred minutes of additional travel time required to gather firewood raises the odds of movement within the valley by 6%. Holding these variables constant, declining agricultural productivity is associated with both local and long-distance moves, but whereas declining productivity raises the odds of moving within the Chitwan Valley by 30%, it only increases the likelihood of leaving the valley by 18%.

The strong connection between local migration and agricultural productivity, relative vegetation, and access to firewood, and the lack of association between the latter two measures and long distance migration along with the much weaker effect of agricultural productivity, suggest that to the extent the term “environmental refugees” applies in Nepal, it refers mainly to localized displacements. As environmental conditions deteriorate, people indeed leave their immediate confines in search of opportunity, but mostly they stay within the region.

This pattern of results stands in marked contrast to the effects of the social and economic factors we consider, which generally display strong effects on distant moves but weaker effects on local moves. Whereas school enrollment naturally tends to root people to their current location, the effect is only significant in the equation predicting departure from Chitwan; and whereas each additional year of schooling raises the odds of long-distance migration by a highly significant 5%, the effect on local moves is only 2% and is not statistically significant. Holding a salaried job with privileges and benefits, however, has a stronger effect in promoting local mobility than long-distance migration, although both effects are significant statistically. Holding a wage job has no effect on the likelihood of either kind of move.

**Table 2.** Multilevel hazard model predicting monthly rate of out-migration in Nepal's Chitwan Valley 1997-1999.

Independent Variables	Local Moves		Distant Moves	
	Odds Ratio	t-test	Odds Ratio	t-test
<b>ENVIRONMENTAL CONDITIONS</b>				
Perceived Productivity Decline	1.30*	2.23	1.18*	2.05
Share of Neighborhood Green	0.98**	-2.34	1.01	1.25
Time to Gather Firewood	1.06*	2.08	1.03	1.53
Time to Collect Fodder	1.03	0.40	1.08	1.41
Population Density	0.97	-1.40	1.00	0.18
<b>THEORETICAL CONTROLS</b>				
<b>Human Capital</b>				
Enrolled in School	0.93	-0.49	0.79*	-2.27
Years of Schooling	1.02	1.51	1.05***	5.46
Currently Has Wage Job	0.87	-1.19	0.96	-0.43
Currently Has Salaried Job	2.44***	4.37	1.39*	2.31
<b>Social Capital</b>				
Household Has Network Tie	1.02	0.16	1.53***	5.15
Neighborhood Prevalence	9.28	1.64	4.59***	3.32
<b>Physical Capital</b>				
Market Access	1.07	0.76	1.03	0.65
Farmland	1.31	0.95	0.70*	-1.68
Equipment	1.05	1.02	1.02	0.65
Livestock	0.94*	-2.07	0.99	-0.43
House Plot Owned	0.50*	-3.03	1.01	0.07
Home Quality	0.96	-1.41	1.02	0.97
<b>DEMOGRAPHIC CONTROLS</b>				
<b>Gender</b>				
Female	1.04	0.33	0.71***	-4.20
<b>Age (Birth Cohort)</b>				
15-24 (1972-1981)	6.63***	8.22	3.00***	7.97
25-34 (1962-1971)	3.10***	5.05	1.43**	2.56
25-44 (1952-1961)	1.75**	2.33	0.81	-1.35
45-59 (1936-1951)	----	----	----	----
<b>Ethnicity</b>				
High Caste Hindu	----	----	----	----
Low Caste Hindu	1.00	-0.02	1.21	1.28
Hill Tibeto-Burmese	0.89	-0.56	1.27*	1.91
Newar	0.98	-0.07	0.96	-0.18
Terai Tibeto-Burmese	1.09	0.42	0.89	-0.85
<b>Duration</b>				
Month	0.95***	-2.74	0.97**	-2.02
Month Squared	1.00	1.80	1.00	0.64
ICC	0.52		0.08	
Deviance	3,241		7,697	
Person Years	70,688			

As other studies have found, social capital is a very powerful predictor of long-distance migration. Households that contain other members with migratory experience are 53% more likely to leave the valley and the probability of making such a move increases by a factor of 4.6 for each point increase in the proportion of migrants living in the surrounding community. In short, people who are related to others with migrant experience outside the Chitwan Valley— either members of their own household or simply neighbors in the surrounding community—are much more likely to become long-distance migrants themselves. Having a tie to another local migrant has no detectable effect on the odds of moving within the valley, however, and although the coefficient for the relative number of such migrants in the neighborhood is large, it is imprecisely estimated owing to the low mean and limited standard deviation on this variable, and is therefore not significant statistically.

The foregoing effects of human and social capital are, in relative terms, generally much stronger and more powerful in predicting long-distance moves than the environmental conditions considered here. In contrast to the rather strong effects of human and social capital, physical capital had fewer significant influences on the likelihood of long-distance mobility. Only land ownership influences the likelihood of leaving the valley, lowering the odds by around 30%. With respect to local mobility, moreover, only livestock ownership and house plot ownership influence the odds of movement, with the former lowering them by 6% for each standardized unit and the latter cutting the odds of departure by half.

As usual in studies of migration, age was highly significant in both equations. The odds of local and long-distance mobility both decline with rising age; but the extent of selectivity is more pronounced for the former than the latter. The effects of gender also differ by distance of the move. Whereas males and females display about the same likelihood of making a move within the Chitwan Valley, females are significantly less likely than males (nearly 30%) to leave the valley. Thus local mobility is highly selective with respect to age but unselective with respect to gender, whereas long-distance mobility is highly selective with respect to gender but less selective with respect to age. We observe few differences in the propensity to take either a short or long move by ethnicity. Although the Hill Tibeto Burmese displayed 27% greater odds of moving out of the valley compared to high caste Hindus this was the only significant effect in the model and it was on the margins of statistical significance. For both kinds of moves, the odds of migration generally decline with each passing month during the three year period and this duration effect is roughly linear.

## Gender, Environment, and Mobility

The foregoing results suggest that environmental conditions are strongly linked to local mobility but weakly connected to long-distance moves. It may be, however, that the influence of environmental variables varies by gender given the gender-specific nature of the tasks of gathering firewood versus fodder. As firewood is heavier than fodder, and given the fact that men display greater upper-body strength than women, collecting the former is generally considered a “male” task whereas gathering the latter is culturally defined as “female.” Given this gendered division of labor, we might expect the time spent to gather firewood to affect the mobility of men but not women, and the time to gather fodder to influence women but not men, and this is generally what our analyses reveal.

Table 3 contrasts the effect of environmental variables on the odds that men and women undertake local and distant moves. For the sake of brevity t-tests are not reported and statistical significance is simply indicated by asterisks. As can be seen, every extra hundred minutes required to gather firewood increases the odds of male migration by 12% but has no effect on the likelihood of female migration. Likewise, every 100 additional minutes required to collect fodder increases the odds of female migration out of the valley by 14% but has no effect on the odds of long-distance mobility by males. In addition, although local mobility is promoted by perceived declines in agricultural productivity among both men and women, only among females is the effect statistically significant and only for short-distance moves, which is consistent with the fact that Nepali women bear a disproportionate share of the burden of agrarian cultivation (Acharya and Bennett 1983; Kumar and Hotchkiss 1988). The lack of a significant effect of agricultural productivity on moves outside the valley once the data are broken down by gender underscores the relative weakness of the connection between environmental conditions and long-distance migration.

## Effects of Ethnicity

Although there are some differences in the strength of effects by gender, the coefficients in Table 3 generally suggest that human capital, social capital, and demographic factors influence migration in similar ways for men and women. In terms of ethnicity, however, we often observe rather large differences in the coefficients of men and women, at least with respect to local moves. Relative to high caste Hindu males and females, for example, males in other castes are generally much less likely to migrate locally than women. For example, whereas low-caste males are 50% less likely to move locally females are 40% more likely to do so, a large and significant difference. Likewise, Terai Tibeto-Burmese are 46% less likely to move within the valley but coethnic females are 46% more likely, another large and significant difference.

**Table 3.** Multilevel hazard model predicting monthly rate of out-migration separately for males and females in Nepal's Chitwan Valley 1997-1999.

Independent Variables	Local Moves		Distant Moves	
	Males	Females	Males	Females
<b>ENVIRONMENTAL CONDITIONS</b>				
Perceived Productivity Decline	1.24	1.41*	1.19	1.18
Share of Neighborhood Green	0.98	0.97**	1.02	1.00
Time to Gather Firewood	1.12**	1.00	1.03	1.03
Time to Collect Fodder	1.13	1.08	1.03	1.14*
Population Density	0.98	0.97	1.02	0.99
<b>THEORETICAL CONTROLS</b>				
<b>Human Capital</b>				
Enrolled in School	0.74	0.90	0.90	0.58***
Years of Schooling	0.95	1.08***	1.04***	1.08**
Currently Has Wage Job	0.68*	1.00	0.99	0.92
Currently Has Salaried Job	1.65**	6.40***	1.53***	1.57
<b>Social Capital</b>				
Household Network Tie	1.20	0.94	1.53**	1.58***
Neighborhood Prevalence	7.20	15.39*	7.28***	3.34*
<b>Physical Capital</b>				
Access to Markets	0.92	1.15	1.07	0.99
Farmland	1.27	1.29	0.64*	0.69
Equipment	1.10	1.01	1.09	0.97
Livestock	0.88**	0.98	0.96	1.03
House Plot Owned	0.41**	0.51*	0.68	1.71
Home Quality	0.89**	0.97	0.99	1.04
<b>DEMOGRAPHIC CONTROLS</b>				
<b>Age (Birth Cohort)</b>				
15-24 (1972-1981)	9.27***	6.53***	4.27***	1.88***
25-34 (1962-1971)	5.84***	2.71**	2.13***	0.80
25-44 (1952-1961)	1.78*	2.53**	0.83	0.68
45-59 (1936-1951)	----	----	----	----
<b>Ethnicity</b>				
High Caste Hindu	----	----	----	----
Low Caste Hindu	0.50**	1.40	1.24	1.09
Hill Tibeto-Burmese	0.62	1.28	1.27	1.18
Newar	0.46	1.52	0.85	1.08
Terai Tibeto-Burmese	0.56*	1.46	0.87	0.90
<b>Duration</b>				
Month	0.95*	0.95*	0.96**	1.00
Month Squared	1.00	1.00	1.00	1.00
ICC	0.58	0.37	0.17	0.10
Deviance	1,310	1,887	3,825	3,758
Person Years	30,261	40,427	30,261	40,427

In order to explore the influence of ethnicity further, in Table 4 we estimated models separately for high caste Hindus and all others, seeking to learn whether environmental conditions have differential effects on local mobility by ethnicity. As can be seen, environmental factors do not appear to affect significantly the migratory behavior of high caste Hindus, the privileged group in the local ethnic hierarchy. Their mobility is determined entirely by human capital, social capital, and demographic factors.

In contrast, environmental conditions do affect the mobility within other ethnic groups. Thus the odds of undertaking a local move are 31% greater for lower-caste Hindu and non-Hindu groups when they perceive agricultural productivity to be declining, and the odds of moving locally rise by 10% for these groups with each additional 100 minutes required to gather firewood. On the other hand, each percentage point increase the share of the neighborhood covered in vegetation decreases the likelihood of local mobility by 3%. The coefficients in the right-hand column show that the effect of agricultural productivity on long-distance moves is confined to the lower caste Hindu and non-Hindu ethnic groups. Within the Chitwan Valley, in other words, environmental effects on mobility appear to be confined to the less privileged categories of Nepal's ethnic hierarchy.

## CONCLUSION

In this study we employed a unique data set available from the Chitwan Valley Family Study to measure the effects of environmental conditions of migration while holding constant the effects of human, social, and physical capital and controlling for demographic factors such as age, gender, ethnicity, and duration. We estimated discrete time hazard models to predict the odds of out-migration during the 36 person-months following February 1997 given individual, household, and environmental characteristics observed in 1996 and using two different definitions of migration: within and outside the Chitwan Valley.

We found no evidence that migration—either local or distant—was related to demographic pressure as measured by population density. Neighborhood density had no significant influence on the likelihood either of moving away from the neighborhood or out of the valley. Perceived agrarian productivity, the share of the neighborhood covered in flora, and the time required to collect firewood did influence mobility, but mainly promoted local rather than distant moves. As agricultural productivity declines and the share of the neighborhood covered in flora falls, and as the time required to gather firewood correspondingly increases, individuals are more likely to leave their home neighborhood to look for opportunities elsewhere in the vicinity.

**Table 4.** Multilevel hazard model predicting monthly rate of out-migration separately for high caste Hindus and other ethnic groups in Nepal's Chitwan Valley 1997-1999.

Independent Variables	<u>Local Moves</u>		<u>Distant Moves</u>	
	High Caste	Other	High Caste	Other
<b>ENVIRONMENTAL CONDITIONS</b>				
Perceived Productivity Decline	1.30	1.31*	1.07	1.30*
Share of Neighborhood Green	0.99	0.97**	1.00	1.01
Time to Gather Firewood	1.02	1.10**	1.05	1.01
Time to Collect Fodder	0.94	1.17	1.13	1.10
Population Density	0.96	0.98	1.01	1.00
<b>THEORETICAL CONTROLS</b>				
<b>Human Capital</b>				
Enrolled in School	1.33	0.52**	1.07	0.58***
Years of Schooling	1.06**	1.00	1.07***	1.05***
Currently Has Wage Job	0.77	1.00	0.82	1.16
Currently Has Salaried Job	1.97**	2.45**	0.88	1.92***
<b>Social Capital</b>				
Household Network Tie	1.40*	0.67	1.62***	1.54***
Neighborhood Prevalence	0.99	62.15*	3.14*	9.64***
<b>Physical Capital</b>				
Access to Markets	0.92	1.11	1.05	1.02
Farmland	3.98*	1.20	0.51	0.73
Equipment	0.95	1.18**	1.01	1.01
Livestock	0.95	0.92*	1.01	0.98
House Plot Owned	0.27***	0.56*	1.62	0.80
Home Quality	0.91**	0.98	1.01	1.04
<b>DEMOGRAPHIC CONTROLS</b>				
<b>Gender</b>				
Female	1.27	0.83	0.81*	0.62***
<b>Age (Birth Cohort)</b>				
15-24 (1972-1981)	3.60***	9.60***	1.98***	3.63***
25-34 (1962-1971)	2.11*	4.53***	1.29	1.36
25-44 (1952-1961)	1.06	2.45**	0.75	0.83
45-59 (1936-1951)	----	----	----	----
<b>Duration</b>				
Month	0.97*	0.94**	0.98	0.97
Month Squared	1.00	1.00	1.00	1.00
ICC	0.54	0.58	0.13	0.10
Deviance	1,516	1,663	3,973	3,662
Person Years	34,677	36,011	34,677	36,011

Although the odds of leaving the Chitwan Valley are significantly increased by perceived decline in agricultural productivity, the effect was much smaller than that observed for local moves and it was only significant among lower and non-Hindu castes. This single environmental effect, meanwhile occurred in the context of much more powerful social and economic influences on migratory behavior. The environment, therefore, is just one of a set of factors that influence long-distance mobility and it is by no means the most important. Both social capital and human capital have much stronger and more consistent effects on migration out of Chitwan.

The environmental effects on local population mobility that we detected appeared to vary between men and women in a way that is consistent with the gendered division of labor in Nepal. The time required to collect firewood—a stereotypically male task in Chitwan—affects the odds of male but not female mobility within the valley; and the time required to gather fodder, which is generally considered a female task, affects the odds of female but not male migration outside of the valley. Female migration within Chitwan was also related to perceived decline in agricultural productivity, but the effect of falling agricultural productivity on local and distant moves was confined to lower-caste Hindu and non-Hindu groups. The influence on local mobility of land cover and time to gather firewood was likewise confined to these groups, suggesting that caste privilege may insulate people from the negative economic effects of environmental deterioration.

In general, these results cast doubt on the broader validity of the concept of “environmental refugees,” at least with respect to long distance migration. We find no evidence that rising population density, declining vegetation, or a growing scarcity of organic inputs play any role in promoting departures from the Chitwan Valley, and the long-distance mobility provoked by declining agricultural productivity is relatively weak and confined to the low caste Hindu and non-Hindu ethnic groups. As formulated by El-Hinnawi (1985), Jacobson (1988), Myers (1997), and others, the concept of “environmental refugees” was introduced to frame environmental change as a major driver of migration worldwide, but our findings suggest that environmental deterioration does not produce mass migration to distant locales.

Although large numbers of people may often be displaced by natural and human-caused disasters in Africa and Asia, these moves are generally to adjacent regions and end up being classified as international owing more to the legacy of colonialism than anything else. Although more work clearly needs to be done using representative data from other regions, the present analysis suggests that demographers should evince considerable caution in viewing “environmental refugees” as a major component of migratory streams around the world. For the most part, environmental deterioration appears to promote local searches for organic inputs or alternative employment opportunities, not a desperate search for relief in distant lands.

## REFERENCES

- Acharya, Meena, and Lynn. Bennett. 1981. *The Status of Women in Nepal, Volume II*. Kathmandu: Centre for Economic Development and Administration, Tribhuvan University.
- Allison, Paul D. 1982. "Discrete-Time Methods for the Analysis of Event Histories." *Sociological Methodology* 13:61-98.
- \_\_\_\_\_. 1984. *Event History Analysis: Regression for Longitudinal Event Data*. Beverly Hills: Sage Publications.
- Axinn, Nancy W. and George H. Axinn. H. 1983. *Small Farms in Nepal: A Farming Systems Approach to Description*. Kathmandu, Nepal: Rural Life Associates.
- Axinn, William G. and Jennifer S. Barber. 2001. "Mass Education and Fertility Transition." *American Sociological Review* 66:481-505.
- Axinn, William G. and Dirgha J. Ghimire. 2002. "Population and Environment: The Impact of Fertility on Land Use in an Agricultural Society." Paper presented at the Annual Meeting of the Population Association of America, May 9–11, Atlanta, GA.
- Axinn, William G., Lisa D. Pearce, and Dirgha J. Ghimire. 1999. "Innovations in Life History Calendar Applications." *Social Science Research* 28:243-264.
- Axinn, William G. and Scott T. Yabiku. 2001. "Social Change, the Social Organization of Families, and Fertility Limitation." *American Journal of Sociology* 106:1219-1261.
- Barber, Jennifer S., Ann E. Biddlecom, and William G. Axinn. 2003. "Neighborhood Social Change and Perceptions of Environmental Degradation." *Population and Environment* 25:77-108.
- Barber, Jennifer Susan Murphy, William G. Axinn, and Jerry Maples. 2000. "Discrete-time Multilevel Hazard Analysis." *Sociological Methodology* 30:201-35.
- Barber, Jennifer S., Ganesh P. Shivakoti, William G. Axinn, and Kishor Gajurel. 1997. "Sampling Strategies for Rural Settings: A Detailed Example from Chitwan Valley Family Study, Nepal." *Nepal Population Journal* 6(5):193-203.
- Belli, Robert F. 1998. "The Structure of Autobiographical Memory and the Event History Calendar: Potential Improvements in the Quality of Retrospective Reports in Surveys." *Memory* 6:383-406.
- Bhandari, Prem. 2004. "Relative Deprivation and Migration in an Agricultural Setting of Nepal." *Population and Environment* 25:475-99.
- Biddlecom, Ann E., William G. Axinn, and Jennifer S. Barber. 2005. "Environmental Effects on Family Size Preferences and Subsequent Reproductive Behavior in Nepal." *Population and Environment* 26:183-206.
- Bilsborrow, Richard E. 1992. "Population growth, Internal Migration and Environmental Degradation in Rural Areas of Developing Countries." *European Journal of Population* 8: 125-48.
- Bilsborrow, Richard E. and Pamela F. DeLargy. 1991. "Population Growth, Natural Resource Use and Migration in the Third World: The Cases of Guatemala and Sudan." *Population and Development Review* 16: S125-S147.
- Bista, D.B. 1972. *People of Nepal*. Kathmandu: Ratna Pustak Bhandar. Black, Richard. 1998. *Refugees, Environment, and Development*. London: Longman.

- \_\_\_\_\_. 2001. "Environmental Refugees: Myth or Reality." *United Nations High Commissioner for Refugees Working Papers* 34:1-19.
- Blaikie, Piers, and Harry Brookfield, eds. 1987. *Land Degradation and Society*. New York:Routledge Kegan & Paul.
- Blaikie, Piers, John Cameron, and David Seddon. 1980. *Nepal in Crisis: Growth and Stagnation at the Periphery*. Bombay: Oxford University Press Delhi.
- Bongaarts, Jon. 1996. "Population Pressure and Food Supply System in the Developing World." *Population and Development Review* 22: 483-503.
- Boserup, Esther. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure*. Chicago: Aldine Press.
- \_\_\_\_\_. 1981. *Population and Technological Change: A Study of Long-Term Trends*. Chicago: University of Chicago Press.
- Caplan, Lionel. 2000. *Land and Social Change in East Nepal: A Study of Hindu-Tribal Relations*, 2nd Edition. Kathmandu: Himal Books.
- Castles, Stephen. 2001. "Environmental Change and Forced Migration." Presented at the Westmorland General Meeting of the Preparing for Peace Initiative, Green College, Oxford University, December 6.
- Chaudhary, Ram P. 1998. *Biodiversity in Nepal: Status and Conservation*. Saharanpur and Bangkok: S. Devi & Teepress Books
- Cohen, Joel. 1995. *How Many People can the Earth Support?* New York: Norton.
- Conway, Dennis, and Nanda R. Shrestha. 1981. *Causes and Consequences of Rural-to-Rural Migration in Nepal*. Bloomington: Indiana University.
- Dahal, D. R. 1993. "Rethinking Fertility Transitions: Some Observations from Nepal." *Population Dynamics in Nepal* 2:49-58.
- Davis, Kingsley. 1963. "The Theory of Change and Response in Modern Demographic History." *Population Index* 29:345-366.
- Dignan, T. 1989. "Land and Landlessness Among Rural to Rural Migrants in Nepal's Terai Region." *International Regional Science Review* 12: 189-209.
- Eckholm, Erik P. 1976. *Losing Ground: Environmental Stress and World Food Prospects*. New York: Norton.
- El-Hinnawi, Essam. 1985. *Environmental Refugees*. Nairobi: United Nations Environment Programme.
- Ehrlich, Paul, Ann Ehrlich, and Gretchen Daily. 1993. "Food Security, Population, and Environment." *Population and Development Review* 19:1-32.
- Filmer, Deon, and Lant Pritchett. 1997. "Environment Degradation and Demand for Children: Searching for the Vicious Circle." World Bank Policy Research Paper Number 1623. Washington, D.C.: World Bank
- Foster Andrew D. and Mark R. Rosenzweig. 2003. "Economic Growth and the Rise of Forest." *The Quarterly Journal of Economics* 118):601-37.
- \_\_\_\_\_. 2004. "Agricultural Productivity Growth, Rural Economic Diversity, and Economic Reforms: India, 1970- 2000." *Economic Development and Cultural Change* 52:509-42.

- Fox, Jefferson M. 1987. "Livestock Ownership Patterns in a Nepali Village." *Mountain Research and Development* 7:169-72.
- Fox, Jefferson, Ronald R. Rindfuss, Stephen J. Walsh, Vinod Mishra, eds. 2003. *People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS*. Berlin: Kluwer Academic Publishers.
- Freedman, Deborah, Arland Thornton, Donald Camburn, Duane Alwin, and Linda Young-DeMarco, L. 1988. "The Life History Calendar: A Technique for Collecting Retrospective Data." *Sociological Methodology* 18:37-68.
- Ghimire, Dirgha J. and Paul Mohai. 2005. "Environmentalism and Contraceptive Use: How People in Less Developed Settings Approach Environmental Issues." *Population and Environment*, 27(1): 29-61.
- Ghimire, Dirgha J. William G. Axinn, Scott T. Yabiku, and Arland Thornton. 2006. "Social Change, Premarital Non-family Experiences and Spouse Choice in an Arranged Marriage Society." *American Journal of Sociology*, 111(4): 1181-1218.
- Gurung, Ganesh Man. 1999. "Migration, politics and deforestation in lowland Nepal." Pp. 85-95 in Harald Olav Skar ed., *Nepal: Tharu and Tarai Neighbours*. Kathmandu: Educational Enterprises, Mandala Book Point, Ratna Pustak Bhandar.
- Gurung, H.B. 1980. *Vignettes of Nepal*. Kathmandu: Sajha Prakashan.
- Gurung, S.B. 1998. "The Land and the People." Pp. 1-13 in P. Shumshere, J. B. Rana, and D. N. Dhungel, eds., *Contemporary Nepal*. New Delhi: Vikas Publishing House.
- Hamilton, Lawrence, Carole Seyfrit, and Christina Bellingier. 1997. "Environment and Sex Ratios among Alaskan Natives: An Historical Perspective." *Population and Environment* 18:283-299
- Hatton, Timothy G., and Jeffrey G. Williamson. 1998. *The Age of Mass Migration: Causes and Economic Impact*. Oxford: Oxford University Press.
- Heilig, Gerhard K. 1997. "Anthropogenic Factors in Land-Use Change in China." *Population and Development Review* 23:139-68
- Hermesmeier, Heidi A. 2005. "Environmental Refugees: A Denial of Rights." *Contemporary Topics in Forced Migration Working Papers* 2:2-19. Forced Migration Laboratory, Center for Comparative Immigration Studies, University of California, San Diego.
- Hill, Allan. 1990. "Demographic Responses to Food Shortages in the Sahel." In Geoffrey McNicoll and Mead Cain, eds., *Rural Development and Population: Institutions and Policy*. New York: Oxford University Press.
- His Majesty's Government of Nepal. 1987. *Population Monograph of Nepal*. Kathmandu: National Planning Commission Secretariat.
- Homer-Dixon, Thomas F. 1991. "On the Threshold: Environmental Changes as Causes of Acute Conflict." *International Security* 16:76-116.
- \_\_\_\_\_. 1994. "Across the Threshold: Empirical Evidence on Environmental Scarcities as Causes of Violent Conflict." *International Security* 19:5-40.
- Ives, Jack D. and Bruno Messerli. 1989. *The Himalayan Dilemma: Reconciling Development and Conservation*. New York: Routledge.
- Jacobson, Jodi. 1988. "Environmental Refugees: A Yardstick of Habitability." *World Watch Paper* 86, World Watch Institute, Washington, D.C.

- Kandel, William, and Douglas S. Massey. 2002. "The Culture of Mexican Migration: A Theoretical and Empirical Analysis." *Social Forces* 80:981-1004.
- Kearney, Michael. 1986. "From the Invisible Hand to Visible Feet: Anthropological Studies of Migration and Development." *Annual Review of Anthropology* 15: 331-61.
- Kumar, Subh K. and David Hotchkiss. 1988. "Consequences of Deforestation for Women's Time Allocation, Agricultural Production, and Nutrition in Hill Areas of Nepal." *International Food Policy Institute Research Report* 69. Washington, D.C.
- Lee, Shin-Wha. 2001. *Environment Matters: Conflict, Refugees, and International Relations*. Seoul and Tokyo: World Human Development Institute Press.
- Liverman, Diana, Emilio F. Moran, Ronald R. Rindfuss, and Paul C. Stern. 1998. *People and Pixels: Linking Remote Sensing and Social Science*. Washington, D.C.: National Academy Press.
- Majupuria, Trilok Chandra. 1999. *Nepal, Nature's Paradise: Insight into Diverse Facets of Topography, Flora, and Ecology*. Gwalior, Nepal: Devi.
- Massey, Douglas S. 1990. "Social Structure, Household Strategies, and the Cumulative Causation of Migration." *Population Index* 56:3-26
- Massey, Douglas S., Joaquín Arango, Graeme Hugo, Ali Kouaouci, Adela Pellegrino, and J. Edward Taylor. 1998. *Worlds in Motion: International Migration at the End of the Millennium*. Oxford: Oxford University Press.
- Massey, Douglas S., Luin P. Goldring, and Jorge Durand. 1994. "Continuities in Transnational Migration: An Analysis of 19 Mexican Communities." *American Journal of Sociology* 99:1492-1533.
- Massey, Douglas S., and J. Edward Taylor. 2004. "Back to the Future: Immigration Research, Immigration Policy, and Globalization in the 21<sup>st</sup> Century." Pp. 373-88 in Douglas S. Massey and J. Edward Taylor, eds., *International Migration: Prospects and Policies in a Global Market*. Oxford: Oxford University Press.
- Moran, Emilio F. and Eduardo Brondizio. 1998. "Land Use Change after Deforestation in Amazonia." Pp. 94-120 in Diana Liverman, Emilio F. Moran, Ronald R. Rindfuss, and Paul C. Stern, eds., *People and Pixels: Linking Remote Sensing and Social Science*. Washington D.C.: National Academies Press.
- Moran, Emilio F., Eduardo Brondizio and Leah K. Van Wey. 2005. "Population and Environment in Amazonian: Landscape and Household Dynamics." Pp. 106-34 in Barbara Entwisle and Paul C. Stern, eds., *Population, Land Use and Environment*. Washington, D.C.: National Academies Press.
- Myers, Norman. 1997. "Environmental Refugees." *Population and Environment* 19:167-82.
- Myers, Norman, and Jennifer Kent. 1995. *Environmental Exodus: An Emergent Crisis in the Global Arena*. Washington, DC: Climate Institute.
- Niraula, Bahnu B. 1994. "Marriage Changes in the Central Nepali Hills." *Journal of Asian and African Studies* 29:91-109.
- North, Douglass C. 1981. *Structure and Change in Economic History*. New York: Norton.
- Pearce, Lisa D. 2000. "The Multidimensional Impact of Religion on Childbearing Preference and Behavior in Nepal." Unpublished Ph. D. dissertation, The Pennsylvania State University, University Park, PA.
- Perz, Stephen. 1997. "The Environment as a Determinant to Child Mortality among Migrants in Frontier Areas of Para' and Rondonia, Brazil, 1980." *Population and Environment* 18:301-24

- Petersen, Trond. 1986. "Estimating Fully Parametric Hazard Rate Models with Time-Dependent Covariates: Use of Maximum Likelihood." *Sociological Methods and Research* 14:219-246.
- \_\_\_\_\_. 1991. "The Statistical Analysis of Event Histories." *Sociological Methods and Research* 19:270-323.
- Piore, Michael J. 1979. *Birds of Passage: Migrant Labor in Industrial Societies*. New York: Cambridge University Press.
- Pokharel, Bola N., and Ganesh P. Shivakoti. 1986. "Impact of Development Efforts on Agricultural Wage Labor." Winrock Rural Poverty Research Paper Series, No. 1.
- Portes, Alejandro, and Robert S. Bach. 1985. *Latin Journey: Cuban and Mexican Immigrants in the United States*. Berkeley: University of California Press.
- Portes, Alejandro, and Julia Sensenbrenner. 1993. "Embeddedness and Immigration: Notes on the Social Determinants of Economic Action." *American Journal of Sociology* 98:1320-51.
- Rouse, Roger C. 1991. "Mexican Migration and the Social Space of Postmodernism." *Diaspora* 1:8-23.
- \_\_\_\_\_. 1992. "Making Sense of Settlement: Class Transformation, Cultural Struggle, and Transnationalism Among Mexican Migrants in the United States." *Annals of the New York Academy of Sciences* 645: 25-52.
- Sassen, Saskia. 1988. *The Mobility of Labor and Capital: A Study in International Investment and Labor Flow*. Cambridge: Cambridge University Press
- Schmidt-Vogt, Dietrich. 1994. "Deforestation in the Nepal Himalaya: Causes, Scope, Consequencies." *European Bulletin of Himalayan Research* 7: 18-24.
- Seddon, David. 1989. "Population and Poverty in Nepal." Pp. xx-xx in Gerry Rodgers, ed., *Population Growth and Poverty in Rural South Asia*. New Delhi: Sage.
- Shivakoti, Ganesh P., William G. Axinn, Prem Bhandari, and Netra B. Chhetri. 1999. "The Impact of Community Context on Land Use in an Agricultural Society." *Population and Environment* 20:191-213.
- Shivakoti, Ganesh P. and Bola N. Pokharel. 1989. "Marketing of Major Crops in Chitwan: A Case Study of Six Village Panchayats." Winrock Research Paper Series, No. 8.
- Sjaastad, Larry A. 1962. "The Costs and Returns of Human Migration." *Journal of Political Economy* 70S:80-93.
- Shrestha, Nanda R. 1990. *Landlessness and Migration in Nepal*. Boulder: Westview Press
- \_\_\_\_\_. 1993. "Nepal: The Society and its Environment." Pp. 53-103 in Andrea Matles Savada, ed., *Nepal and Bhutan: Country Studies*. Washington, D.C.: Federal Research Division, Library of Congress.
- Shrestha, Nanda R., Raja R. Velu, and Dennis Conway. 1993. "Frontier Migration and Upward Mobility: The Case of Nepal." *Economic Development and Cultural Change* 41:787-816.
- Shrestha, Vinod P. 1999. "Forest resources of Nepal: Destruction and Environmental Implications." *Contributions to Nepalese Studies* 26:295-307.
- Stark, Oded. 1991. *The Migration of Labor*. Cambridge: Basil Blackwell.
- Suhrke, Astri. 1994. "Environmental Degradation and Population Flows." *Journal of International Affairs* 47:473-96.

- Taylor, J. Edward, Joaquín Arango, Graeme Hugo, Ali Kouaouci, Douglas S. Massey, and Adela Pellegrino. 1996. "International Migration and Community Development." *Population Index* 63:397-418.
- Thacker, Prabha. 1991. "Migration: A Strategy for Survival in the Mountains." *Appropriate Technology* 17:26-8
- Thapa, S. 1989. "The Ethnic Factor in the Timing of Family Formation in Nepal." *Asia-Pacific Population Journal* 4(1):3-34.
- Thapa, G. 1997. "Indigenous Management of Nepal's Natural Resources: Some Policy Issues." Pp. 290-98 in Ganesh Shivakoti, George Varughese, Elinor Ostrom, A. Shukla, and G. Thapa, eds., *People and Participation in Sustainable Development: Understanding the Dynamics of Natural Resource Systems*. Bloomington: Indiana University Press.
- Thomas, Brinley. 1973. *Migration and Economic Growth: A Study of Great Britain and the Atlantic Economy*. Cambridge: Cambridge University Press.
- Todaro, Michael P. and L. Maruszko. 1987. "Illegal Migration and U.S. Immigration Reform: A Conceptual Framework." *Population and Development Review* 13:101-14.
- Tuladhar, J.M. 1989. *The Persistence of High Fertility in Nepal*. New Delhi: Inter-India Publications.
- Wood, William B. 2001. "Ecomigration: Linkages Between Environmental Change and Migration." Pp. 42-61 in Aristide R. Zolberg and Peter Benda, eds., *Global Migrants, Global Refugees*. New York and Oxford: Berghahn.
- Yabiku, Scott T. 2004. "Marriage Timing in Nepal: Organizational Effects and Individual Mechanisms." *Social Forces* 83:559-586.
- \_\_\_\_\_. 2006. "Neighbors and Neighborhoods: Effects on Marriage Timing." *Population Research and Policy Review*, 25(4): 305-327.
- Zlotnick, Hania. 2004. "Population Growth and International Migration." Pp. 15-34 in Douglas S. Massey and J. Edward Taylor, eds., *International Migration: Prospects and Policies in a Global Market*. Oxford: Oxford University Press



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