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The Impact of Rainfall on the First Out-Migration: A Multi-level Event-History Analysis in Burkina Faso

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Using event history analyses, we investigate the impact of rainfall conditions — a crucial environmental factor in the livelihood of Sahelian households — on the risk of the first village departure in Burkina Faso. The distinction of migrations by destination and duration proves critical in studying this relationship. Findings suggest that people from the drier regions are more likely than those from wetter areas to engage in both temporary and permanent migrations to other rural areas. Also, short-term rainfall deficits tend to increase the risk of long-term migration to rural areas and decrease the risk of short-term moves to distant destinations.

KEY WORDS: migration, Burkina Faso, rainfall, drought, environmental refugees.

INTRODUCTION

The impact of environmental factors on spatial mobility is a recurrent theme in the literature on migration in Burkina Faso and in other Sahelian countries. Repeated droughts and low soil productivity have often been cited as major factors pushing people to leave their villages (Boutillier, Quesnel, & Vaugelade, 1977; Cordell, Gregory, & Piché, 1996; Marchal,

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1975; Mathieu, 1994). The concept of environmental refugees is another illustration of the widespread belief that migration is strongly influenced by environmental conditions (Lonergan, 1998). Since rain-fed agriculture is the main source of livelihood in rural Burkina Faso, intuitively it makes sense that environmental factors (e.g. rainfall and land degradation) will influence socio-economic conditions and may lead people to emigrate. For example, in Sahelian and Sudanian regions, crop yields are mostly controlled by the amount and distribution of rainfall during the growing season and we may expect that poor harvests tend to drive some households to migrate further south (Grouzis & Albergel, 1989; Sicot, 1989). A link between environmental conditions and migration was indeed measured in several settings in rural Africa (Ethiopia, see Ezra, 2001; Mali, see Findley, 1994). Yet, despite repeated statements on the effects of environmental factors on migration in Burkina Faso, there is little empirical evidence on this topic. Lack of appropriate data is an important factor in explaining this situation. Compared to data on mortality and fertility, data on migration are scarce in most African countries. The most detailed study of burkinabe migration relies on the 1974–1975 National Migration Survey (Cordell et al., 1996), almost 30 years old. A national survey on migration and urbanisation was also conducted in 1992 (République du Burkina Faso and CERPOD, 1997), but the data are considered unreliable and have hardly been used. Finally, censuses also offer some information on spatial mobility in Burkina Faso, but they are highly aggregated and only give information at the time of the census. Environmental data are also in very short supply, and rainfall time-series are in fact the only reliable data on environmental conditions covering a long period for the entire country.

The aim of this study is to explore the impact of rainfall conditions on the first departure from the village in Burkina Faso. This study combines recent longitudinal multilevel data from a national retrospective migration survey, a large-scale retrospective community survey and a long time-series of rainfall data. This study more specifically focuses on the influence of agro-climatic factors on the risk of ''leaving the village'', among both men and women. Individual-level variables and community-level factors are combined with rainfall data in discrete-time event-history analyses to model the determinants of first migration from rural areas over the last 30 years. Competing risk analyses are performed to explore the differential effects of rainfall conditions depending on the destination and the duration of migrations.

The first part of the study summarises the background. Methodology, data sources and explanatory variables are presented in the second part. In the third part we present the descriptive and multivariate results. The paper ends with the discussion of the results and the conclusion.

BACKGROUND

General Background

Burkina Faso is one of the poorest countries in the world: it ranked 159th of 162 countries in the UNDP's human development index (UNDP, 2001), and its GDP per capita was approximately 230 US$ at the end of the 1990s (IMF, 2000). The country's population was estimated at 10.3 million in the last census (1996), growing at a rate of about 2.7% per year. With an urbanisation rate close to 20%, it is one of the least urbanised countries in the world (PRB, 2001). The country's economy depends heavily on agriculture and cattle-raising: together they account for one-third of the country's GDP and 90% of the population is engaged in these activities (INSD, 2000). Agriculture in Burkina Faso is to a large extent a rain-fed subsistence agriculture, and its productivity is mainly determined by environmental factors (Niemeijer & Mazzucato, 2002). As a consequence, the agro-climatic conditions are critical to rural households, for which agriculture represents the main source of livelihood.

Environmental Conditions in Burkina Faso

Burkina Faso is a Sahelian country characterised by a strong south–north decreasing gradient of average annual rainfall (Figure 1). In the northern part of Burkina Faso, the rainfall is scarce and irregular, with an average annual precipitation below 500 mm. The agro-climatic conditions are thus very constraining for agriculture and the main economic activities are extensive pastoralism and rain-fed agriculture of pearl millet and sorghum (Hampshire & Randall, 1999). The conditions are more suitable for agriculture in the southern part (average rainfall above 900 mm), where the main crops include maize and cotton in addition to millet and sorghum (Ingram, Roncoli, & Kirshen, 2002).

The country's rainfall is also characterised by a high degree of seasonal and annual variability (Roncoli, Ingram, & Kirshen, 2001). Rain falls during a single wet season lasting three to five months (approximately from May to September). Large year-to-year variations in total precipitation and in the timing of rainfalls translate into extremely variable crop outcome and uncertainty at the household level (Reardon, Matlon, & Delgado, 1988;

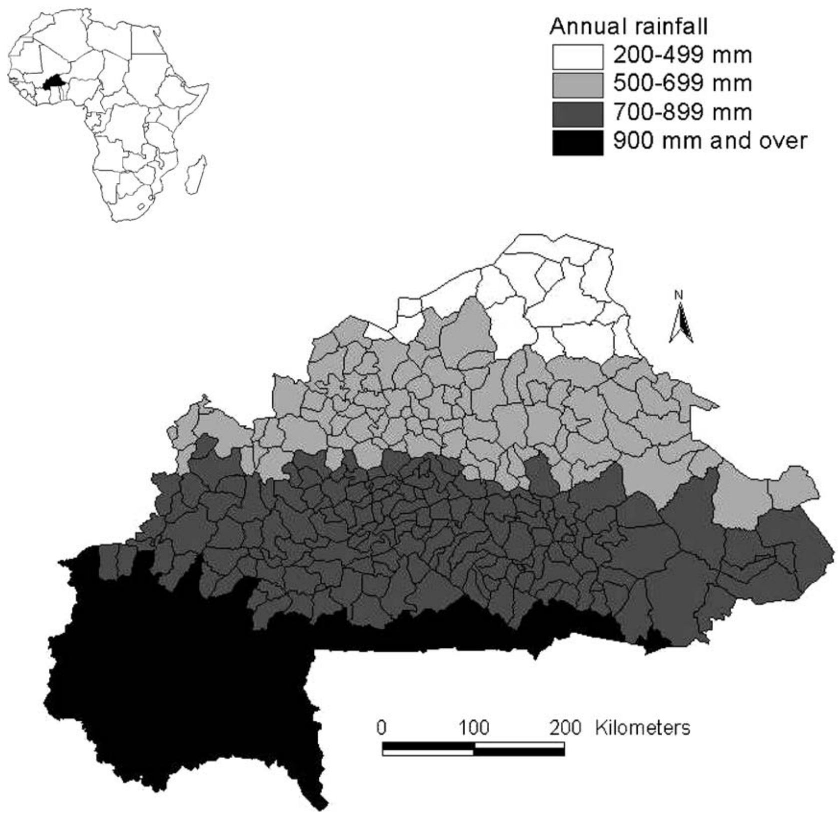

FIGURE 1. Map of Burkina Faso showing mean annual rainfall at the department level, 1960–98.

Roncoli et al., 2001). Following the general pattern of Sahelian West Africa, Burkina Faso has experienced a long-term downward trend of rainfall over the last 50 years (Nicholson, 2001; Niemeijer & Mazzucato, 2002). The long period of aridity that began in the late 1960s was accompanied by several droughts, most notably those in the early 1970s and in the mid-1980s (Hampshire and Randall, 1999; Nicholson, 2001; Roncoli et al., 2001).

Burkina Faso is also characterised by poor soil fertility and, according to various authors, land degradation is a serious problem in this part of Africa (Lindqvist & Tengberg, 1993). The issue of land degradation in Burkina Faso is controversial, however. On the basis of an assessment by regional experts (GLASOD map in Oldeman, Hakkeling & Sombroeck, 1990), a large part of the country (mostly the Mossi Plateau) is considered degraded. Empirical data on land degradation are sparse however, and a recent study suggested that neither the agricultural soil productivity nor the soil chemical fertility had significantly declined over the last few decades in Burkina Faso (Niemeijer & Mazzucato, 2002). So, while soils are poor in most parts of the country, there is no convincing evidence of a widespread degradation trend. Other factors seriously constrain agricultural productivity however. The lack of fertilisers, the low degree of mechanisation of agriculture, the lack of irrigation, and the spread of parasitic plants all act as constraints on agriculture (Berner et al., 1997; Ingram et al., 2002).

Migration in Burkina Faso

Burkina Faso has long been characterised by intense mobility, both within the country and to other countries such as Côte d'Ivoire and Ghana (Cordell et al., 1996; Hampshire & Randall, 1999). Migrations to neighbouring countries represent a large proportion of all migrations from rural areas (the majority of migrations among men), and Côte d'Ivoire has long been the principal destination for international migrants, attracting approximately 80% of these in the 1990s.[1] Labour migration to Côte d'Ivoire can be traced to historical factors such as forced labour policies and colonial taxation under French colonial rule (Cordell et al., 1996). Côte d'Ivoire has continued until recently to attract a large number of Burkinabe migrants, mainly composed of young men moving for economic reasons (Cordell et al., 1996; Roncoli et al., 2001), although the situation is likely to change with the recent conflict in Côte d'Ivoire. Migrations from rural areas have also been directed towards urban centres and have contributed significantly to the process of urbanisation since the post-war years (Cordell et al., 1996). Ouagadougou and Bobo Dioulasso, Burkina Faso's two largest urban centres, have attracted the largest share of rural-urban movers over the last decades, although smaller towns have also received important numbers of migrants (INSD, 2000).

Migrations within rural areas are still the dominant type of internal migration flow and involve both short-distance and long-distance moves. The former disproportionately concern women migrating for family reasons, such as marriage and separation, while long-distance moves mainly consist of migrations for economic reasons, such as agricultural expansion. One specific type of long-distance move in rural Burkina Faso developed from the late 1960s and involves migrations from densely populated areas in the Mossi Plateau to the less populated areas of Burkina Faso's southwest

(Cordell et al., 1996; Goldberg & Frongillo, 2001). Migrations between rural areas were also encouraged by resettlement programmes, such as the AVV (*Aménagement des Vallées des Voltas*) programme launched in the early 1970s to develop regions freed from onchorcercosis, also called river blindness disease (Cordell, et al., 1996; Ouédraogo, 1986). Spontaneous population movements also swelled in the villages adjacent to the official migration areas (Quesnel, 1999).

As in other developing countries, circulation is also a prominent feature of burkinabe migration (Blion, 1995; Cordell et al., 1996). In other words, people continue to maintain strong links with their place of origin, and a large fraction of migrants tend to return to their village at some point. In Burkina Faso, the probability of returning to the village is especially high among men: 60% of those leaving their village after age 15 return within 10 years, while the corresponding figure for women is around 15% (Schoumaker et al., 2002). Those leaving the country also have the highest probability of returning to their village,[2] but a significant percentage of those leaving to urban and (to a lesser extent) rural destinations also go back to their village (Schoumaker et al., 2002). The fact that a considerable proportion of those leaving their village tend to return home at some point suggests that one should also look at the factors that influence the risk of returning to the village. That question will be addressed in further research. However, by distinguishing short-term and long-term migrations, this study will partly take into account the fact that a significant fraction of those leaving actually return to their village of origin.

Environmental Conditions and Migration

The role of environmental factors in explaining migration is a persistent theme in the literature (Boutillier et al., 1977; Cordell et al., 1996; Marchal, 1975; Mathieu, 1994). As far as climatic conditions are concerned, the common view is that ''migration rises both immediately and as a long-term response to the threat of recurrent droughts'' (Findley, 1994, p. 539). Quite illustrative in this respect is the anecdote reported in the preface of *Hoe and Wage*, a detailed study of migration in Burkina Faso.

> In October 1974, in the village of Nanou in Southwestern Burkina Faso, Siaka Coulibaly, the chief, extended the traditional welcome. [...] Introductions made and visitors welcomed, he spoke: ''You want to know why people migrate? Well, make it pour money and bring rain in abundance. Then you will know why people leave.'' (Cordell et al., 1996, p. xii).

Because rain-fed agriculture is the main source of livelihood in rural Burkina Faso, it is natural to expect some impact of rainfall on migration. Migratory responses to climatic constraints can take several forms however: some people will move for a short duration and return to their village within a few months (temporary migration). Others will leave their region permanently to cultivate in better endowed rural areas or to work in urban areas or abroad.

Temporary migration is an important aspect of spatial mobility in the drought-affected Sahel and is often interpreted as part of a household survival strategy for coping with drought and high levels of production uncertainty (Guilmoto, 1998; Hampshire & Randall, 1999; Hill, 1990; Reardon et al., 1988; Roncoli et al., 2001). Such temporary moves usually involve only a few members of the household (mainly young men) and represent a way to diversify incomes. While temporary migration may be adopted as a strategy even in non-drought years (Ezra, 2001; Hampshire & Randall, 1999; Reardon et al., 1988), it is likely to vary with fluctuations in rainfall and harvests (Findley, 1994). Young men may be more likely to move in periods of economic hardship to earn additional incomes, whether in rural areas, in urban areas or abroad (Coulibaly & Vaugelade, 1981; Lallemand, 1975; Roncoli et al., 2001). Migration can also be used to reduce the number of consumers by sending children and women to stay with relatives in a period of drought (Findley, 1994; Roncoli et al., 2001). Finally, fluctuations in rainfall may also influence the destination of migration. Since moving abroad or to urban areas usually entails higher costs than moving to rural areas, such moves may be postponed in periods of economic stress (Findley, 1994; Nelson, 1983).

Some people may also leave their village permanently in response to the risk of repeated droughts (Findley, 1994). Cordell et al. (1996) suggest, for example, that migrations from the northwestern part of the Mossi Plateau in the late 1960s–early 1970s were induced by irregular rainfall, and that migrants departed for areas with more rainfall (see also Boutillier et al., 1977). Permanent migrations may also be influenced by rainfall-driven fluctuations in harvests. For example, migrants may decide to move after several consecutive years of bad harvests. Female migration could also increase after poor harvests, as women might be permitted or encouraged to marry earlier in order to reduce the family's food demands (Findley, 1994). On the other hand, long-term migrations to urban areas and to foreign countries might be deterred in years following bad harvests, as discussed for the case of temporary migrations.

In summary, long-term rainfall conditions as well as short-term variations of rainfall are likely to influence both temporary and permanent migrations. Although poor rainfall conditions are often believed to increase the risk of moving, the effects of rainfall may differ depending on the destination and the duration of migration. Gender differences are also expected as the motives of migration vary greatly by gender: males generally move for economic reasons whereas women's moves depend essentially on family reasons. As a result, male migration should be more sensitive to rainfall conditions, even though female migration may also be expected to rise in some circumstances (Table 1).

The decrease in soil productivity is also generally considered to be a determinant of migration in Burkina Faso. However, due to the lack of reliable data, this question is not addressed in this study. Two land degradation variables were included in preliminary analyses: a land degradation assessment obtained from the GLASOD map (Oldeman Hakkeling, & Sumbroek, 1990), and a land degradation indicator based on the rain-use efficiency index obtained by combining satellite data and rainfall data (Prince, Brown De Colstoun , & Kravitz, 1998). Neither of these indicators was retained in the models because of their low reliability (GLASOD) or the very small proportion of areas considered as degraded (rain-use efficiency index).

METHOD AND DATA

This study focuses on the determinants of village departure after age 15, using multilevel longitudinal data and event history methods. Analyses are restricted to the first out-migration from the village after age 15, retained as the age at which participation in decision making is considered to

TABLE 1

Synthesis of expected effects of rainfall conditions on different types of migration

	Type of migration		
Rainfall conditions	Rural–rural	Rural–urban	Rural–abroad
Long-term conditions	(−) Migrations from drier regions to wetter regions	(−) Migrations from drier regions to urban areas	(−) Migrations from drier regions to abroad
Short term fluctuations	(+) Migrations if rainfall deficit	(−) Migrations postponed if rainfall deficit	(−) Migrations postponed if rainfall deficit

commence (INSTRAW, 1994). The decision to focus on the determinants of the first departure from the village is justified by the fact that it represents a significant life event. Moreover, because a significant fraction of migrants return to their village, taking into account the subsequent migrations would tend to dilute the effects of environmental factors on migration. Analyses are performed separately for men and women, as we expect the effect of rainfall conditions to differ by gender. Finally, because the effects of rainfall conditions on the risk of leaving may also vary according to the destination and the duration of migration, competing risk models are used in addition to models that treat all the events the same.

As suggested by various authors, it is desirable to include factors at the community and individual/household levels to investigate the determinants of migration (Bilsborrow, 1984; Findley, 1987; Lucas, 1997). Migration behaviours depend strongly on individual and household characteristics such as age, education, economic activity and household socio-economic status (Lucas, 1997; Hugo, 1998). In addition, the characteristics of the place of residence are also likely to play a major role in the migration decision-making process (Gardner, 1981; Hugo, 1985). Place-related factors provide opportunities and constraints that make an area more or less attractive to an individual (availability of land, local labour market conditions, etc.), and factors such as its accessibility may also act as facilitators of migration or influence the awareness of potential destinations (Oberai & Bilsborrow, 1984). Environmental conditions are considered as one specific type of contextual characteristics that may influence migration decisions. In this study, both individual factors and contextual factors are included in the models. Although household-level factors may also be important determinants of migration (Hugo, 1998), few time-varying household-level variables were collected in the survey, and none was retained in this study. Actually, the relevant variables at the household level (such as the position of the migrant in the household or the agricultural practice at the household level) were not time-varying. We think that the definition of these household variables is too restricted to be relevant in this migration analysis.

A longitudinal approach was taken to study the determinants of migration. People are likely to migrate in response to changing individual or contextual conditions, and longitudinal data and methods are well-suited to incorporate such factors in migration models. This approach thus not only requires individual longitudinal data on migration (a *migration history*), but also community-level and environmental data about the places of residence in which the sampled individuals lived in the past, at every point in time. The data are presented below.

Data

This study uses data from three sources. The individual life history data come from the nationally-representative retrospective survey on migration,[3] conducted in 2000 by the UERD at the University of Ouagadougou, the Demography Department of the University of Montreal and the CERPOD in Bamako (Poirier et al., 2001). The full sample comprises 8644 individuals (men and women) aged 15–64 at the time of the survey. The questionnaire covered several topics such as migration, employment, marital and fertility histories. For each sampled individual, a complete migration history from the age of six was collected. Information on every spell of residence that lasted more than 3 months was recorded: the date of arrival, the name of the village (rural areas) or neighbourhood (urban areas), the motive for leaving the place of residence, etc. A similar approach was adopted for the employment history. This study uses data from both the migration history and the employment history.

The community-level data come from a retrospective community survey conducted of 600 settlements in early 2002. The survey was designed to be linked with the individual migration survey. It comprises all the villages in which people lived at the time of the survey and a large sample of villages in which they lived in the past. Each village for which at least three spells of residence were reported in the migration histories was covered by the survey (600 villages of a total of 1800 villages in which at least one spell of residence was reported). Retrospective data was collected from groups of community informants, consisting of ''délégués de village'' (administrative representatives), village chiefs and other knowledgeable informants. It covered a broad range of topics, including land availability, transportation, agriculture, and employment opportunities. Efforts were made to obtain retrospective information since 1960 on most village characteristics. For example, informants were asked to recall all the years in which harvests were ''particularly bad'', the year since which uncleared land was no longer available, etc. A village calendar, including national events and events directly linked to the life in the village (such as the construction of a school) was used to improve the quality of dates. The interview of several informants together, as it was done in this survey, is also believed to improve the quality of the data (Axinn, Barber, & Ghimire, 1997; Frankenberg, 2000). In addition, a detailed study of the quality of data was performed by comparing the statements of interviewees to external databases (Schoumaker et al., 2004).

As mentioned above, community-level data was only collected for a sample of settlements. Community-level variables are missing for 12.2% of the residence spells among the 3911 individuals in the analysis sample (5.6% of the 145,000 person-periods). Random hot-deck imputation supplied the missing values at the village level. The imputation is based on two classification variables: the province (45 provinces) in which the village is located and the size of the village (less than 5000 or between 5000 and 10,000 inhabitants). Adjustment cells were formed by combining these two variables, and the missing values for a village were replaced by the values from a randomly selected village in the same cell, that is a village of the same size located in the same province. Multiple imputation was performed to incorporate uncertainty due to missing community-level data (Allison, 2002).

Rainfall data covering the 1960–1998 period were obtained from the global monthly precipitation data set produced by the Climatic Research Unit at the University of East Anglia (New, Hulme, & Jones, 2000). These data were interpolated from a network of stations at a spatial resolution of 0.5°latitude and longitude. Monthly rainfall data were extracted from this database and two rainfall variables were constructed at the department level using geographical information systems (GIS).[4]

Analysis Sample and Statistical Model

The analysis sample is restricted to people living in rural areas at age 15,[5] and covers the 1970–1998 period. Migration is defined here as a change of residence involving a departure from the village for a duration of at least three months. Each individual is ''followed'' from age 15 until his or her first migration or until the time of censoring.[6] The data are organised as a person-period data file in which each line represents a 3-month period, and the dependant variable indicates if a migration occurs during each three-month interval.[7] Overall, the sample consists of 3911 individuals (1800 men and 2111 women), and a total of approximately 145,000 person-periods.

Binary and multinomial logistic regression methods are used to estimate discrete-time event history models (Allison, 1995). Models that do not distinguish among the event types are fitted with binary logistic regression. The statistical model is specified as follows:

$$\log\left(\frac{p_{ti}}{1-p_{ti}}\right) = \alpha_t + \beta'.\mathbf{X_{ti}} \qquad (1)$$

where p_{ti} is the conditional probability that individual i experiences the event (first migration) at age t, given that the event has not already occurred.

α_{rt} represents the baseline hazard function, and $\boldsymbol{X_{ti}}$ is a vector of individual, contextual and environmental covariates. Both time-constant and time-varying covariates are included in the models.

Multinomial logistic regression is used for competing risk analyses that distinguish among the destinations and/or types of migration. The discrete-time competing risk model assumes that the log-odds of experiencing an event of type r rather than an event of type s (the reference category) at time t are given by

$$\log\left(\frac{p_{rti}}{p_{sti}}\right) = \alpha_{rt} + \beta_r'.\mathbf{X}_{\mathrm{rti}} \tag{2}$$

where p_{rti} is the conditional probability of an event of type r occurring at time t for individual i, given that no event has occurred prior to time t. α_{rt} represents the baseline hazard function for an event of type r, and $\boldsymbol{X_{rti}}$ is a vector of covariates. Censored cases (no migration) are treated as the reference category, and the destinations (rural, urban and abroad) and/or types of migration (temporary or permanent) are distinguished as separate events. All of the models take into account the fact that the data are clustered, and the standard errors of the regression coefficients are adjusted accordingly using Huber-White standard errors (Hox, 2002). Multiple imputation was also performed to correct for the underestimation of standard errors due to missing community-level data (Allison, 2002).

EXPLANATORY VARIABLES

Table 2 presents the explanatory variables as well as the proportion of respondents in each category at age 15. The individual-level, community-level and environmental variables included in the models are discussed below. The two migration models, among men and women, include the same explanatory variables (with identical categories). Although the number of cases may be small for some categories of the explanatory variables, particularly for women, this approach has been preferred to ensure the comparability of the models across gender.

Individual Variables

Numerous studies from both developed and developing countries have shown that age is strongly linked to the risk of migration. In this sample, the

TABLE 2

Descriptive statistics of factors affecting migration considered in the analyses

Explanatory variables	% of the sample at age 15		
	Male	Female	Total
Individual-level variables			
Education			
No education	84.8	93.0	89.3
Primary	12.2	5.9	8.7
Secondary and over	3.0	1.1	2.0
Ethnic group			
Mossi	43.3	46.1	44.9
Fulani	10.6	9.2	9.8
Other	46.1	44.7	45.3
Activity			
Agriculture	83.4	76.1	79.3
Cattle-raising	8.0	0.9	4.1
Other	8.6	23.0	16.6
Community-level variables			
Uncleared land available			
Yes	30.3	26.9	28.4
No	69.7	73.1	71.6
All-season road			
Yes	41.4	44.9	43.3
No	58.6	55.1	56.7
Water conservation techniques			
Yes	28.6	27.1	27.8
No	71.4	72.9	72.2
Rainfall variables			
Average rainfall (mm)			
200–499	5.7	5.0	5.3
500–699	27.0	26.6	26.8
700–899	47.6	47.9	47.7
900 and over	19.7	20.5	20.1
Rainfall variability [a]			
< 85%	5.8	6.0	5.9
85 – 94%	30.2	31.9	31.2
95% and over	64.0	62.1	62.9
Sample size	1800	2111	3911

[a] Percentages computed on the total of person-periods.
Source: Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB), 2000.

risk of first migration among men increases with age for a few years after age 15 and then declines (Figure 2). Among females, the risk of first migration decreases sharply with age. The non-linear relationships between age and the risk of migration are modelled here by a function of age and its logarithm. These two measures form the baseline hazard of first migration.[8] The positive relationship between education and migration is also one of the most consistent findings of migration studies, especially for migrations to urban areas (Lututala, 1995; Todaro, 1997). Education is measured by a time-constant variable indicating the level attained by the individual at the age of 15[9].

Differential propensities to migrate among ethnic groups have also been shown in various studies in Burkina Faso; in particular the Mossi and the Fulani are distinguished from other ethnic groups. The Mossi, the majority ethnic group in Burkina Faso, constitute 45% of the analysis sample. Mossi people live mainly on the densely populated Central Plateau (the Mossi Plateau), but are also known for their migrations to southwestern regions (Marchal, 1975; Mathieu, 1994). The Fulani (10% of the sample) live essentially in the northern and eastern parts of the country, and are also a highly mobile population (Hampshire and Randall, 1999). Although the Fulani used to be nomadic people specialised in cattle-raising, many of

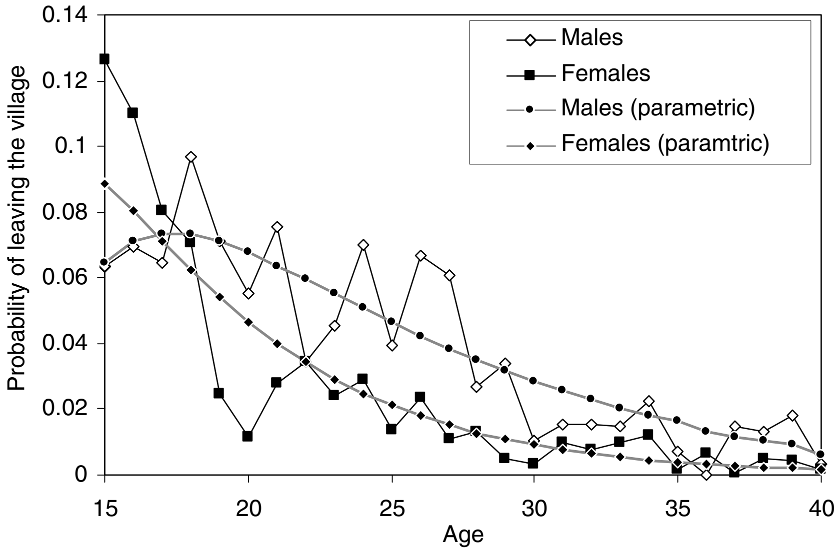

FIGURE 2. Probability of leaving the village by age and sex.

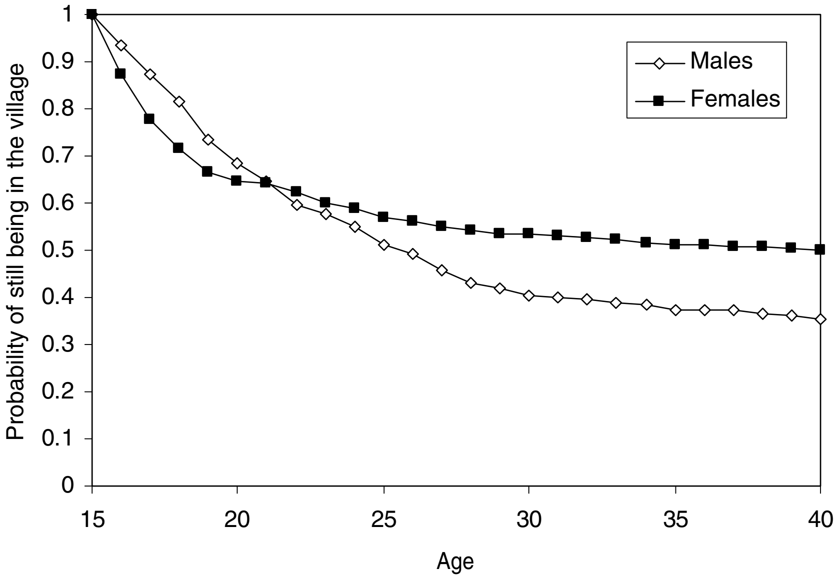

FIGURE 3. Probability of still being in the village by age and sex.

them settled under the influence of the colonial power and the independent State (Copans, 1975). They are still dominant in cattle-raising activities however: 57% of the men engaged in cattle-raising at age 15 are Fulani. The third category assembles 10 ethnic groups, among which the Senoufo (14%), the Gourmantche (8%) and the Gourounsi (7%) are the most represented.

Finally, a time-varying variable indicates the principal activity performed by the individual at each point in time. Three categories are compared in the models. Cultivators represent the large majority of the sample (79% of the population at age 15). A little more than 4% of the respondents declared that they were cattle-raisers, and 17% of the sample is engaged in other types of activities, mainly craft and petty trade of food (students account for 3% of the total).

Rainfall Variables

Two variables measured at the department level are used to capture two dimensions of the potential impacts of rainfall on migration: the mean annual precipitation over the 1960–1998 period and the percent of normal precipitation over the three preceding years.[10] Besides their simplicity, the two indicators used in this study were selected on an empirical basis. Several rainfall indicators were tested to predict the occurrence of poor harvests reported in the community survey, and the two indicators retained were the only significant predictors of the poor harvests.

People living in regions with a higher vulnerability to drought are expected to be more likely to leave their villages — temporarily or permanently — than those living in regions with more rainfall. The first variable (mean annual precipitation) is considered a good indicator of agricultural productivity and of vulnerability to drought. Four categories are compared: less than 500 mm per year, 500 to 699 mm per year, 700 to 899 mm per year, and more than 900 mm per year (Figure 6). These categories correspond to areas where crops with similar yield responses to water are cultivated (Doorenbos & Kassam, 1987). In addition, we tried to have a sufficient number of observations in each category.

Overall, it is also expected that the risk of first migration will increase if the preceding years were unfavourable, although unfavourable conditions could also have an opposite effect if people postpone migrations in periods of economic stress (Findley, 1992; Nelson, 1983). The second variable is a time-varying variable indicating the extent to which rainfall in the department over the three preceding years differed from the long-term rainfall conditions in the department. The measure is the ratio of the mean rainfall over the three preceding years to the mean rainfall over the 1960–1998 period, and three categories[11] are compared in the models (less than 85%, 85 – 94%, and more than 95%). Several time windows (1, 2, and 3 years) were tested and the three-year window was selected for several reasons. First, rural households may have sufficient stocks of cereals or enough money, livestock and assets to purchase cereals following a poor harvest (Lallemand, 1975; Reardon et al., 1988). In other words, people may be able to cope with one poor harvest without resorting to migration. They are more likely to have depleted their assets after two or three consecutive bad harvests however, a situation that could force them into migration. Moreover, several consecutive years of poor precipitation may also increase people's perception of worsening rainfall conditions and affect their decision to move to better watered regions. A longer time window would dilute the relevance of this time-varying factor.

Community-level Variables

Three community-level variables are included to capture the effects of opportunities and constraints at the village level that may influence migration behaviour. The first community-level variable is a time-varying binary variable indicating, for each year, if uncleared land was still available in the village.[12] The common hypothesis is that out-migration tends to be more pronounced from areas where land is no longer available or no longer sufficient to maintain people's levels of livelihood (Hugo, 1985; Tallet, 1985). In Burkina Faso, the Mossi Plateau is very densely populated compared to the eastern and southern parts of the country, and some authors have suggested that migrations from the Mossi Plateau may be induced by the lack of land (Tallet, 1985).[13]

The second time-varying community-level variable indicates if the village is connected by an all-season road. Transportation networks can have complex impacts on the risks of migration (Bilsborrow, 1984). The usual assumption is that higher accessibility increases the risk of migration, especially short-term migration (Findley, 1987). However, access to roads may also contribute to reducing out-migration by creating opportunities for income diversification (Reardon et al., 1988) or by facilitating food aid distribution in periods of drought (Coulibaly & Vaugelade, 1981).

The third time-varying community-level variable indicates whether or not contour stone walls (*diguettes*) are used in the village.[14] This soil and water conservation technique not only reduces erosion but also improves the availability of water for cultivation by encouraging infiltration (Bandre & Batta, 1998). Such techniques have been shown to significantly improve cereal yields in Burkina Faso (Bandre & Batta, 1998), and are expected to reduce out-migration.

RESULTS

Descriptive Results

Figure 2 compares the risk of leaving the village for the first time after the age of 15 for men and women, and Figure 3 shows the corresponding survival curves, that is the probabilities of still being in the village by age. Before the age of 18, women's risks of leaving the village are significantly higher than men's risks, but are two to three times lower after that age. The survival curves cross at around 21, and the probability of remaining in the village is eventually much higher for women (50%) than for men (35%). These gender differences are probably largely explained by marriage migrations. Women's marriages are concentrated in a narrow age range and are often accompanied by a migration to the husband's place of residence, which means that a large proportion of women will migrate for the first time after age 15 at the time of their marriage (see below). Women's migrations for marriages before the age of 15 may also explain why, overall, a lower percentage of women leave their village after the age of 15.

Table 3 gives some characteristics of first migrations. Gender differences are even more patent for these characteristics than for the timing of first migration. While almost two-thirds of males's first migrations are directed to a foreign country, only 15% of their female counterparts engage in such migrations. On the other hand, 70% of women's first migrations are directed to another village, whereas this concerns only 23% of men's first migrations. Urban areas represent 14% of the destinations of first migration among both men and women. As seen in Table 3, motives for first migration also vary strongly according to gender. Almost 80% of

TABLE 3

Characteristics of first migrations from rural areas

Characteristics of migrations (% of migrations)	Males	Females	Total
Destination			
Rural	23.0	70.4	48.2
Urban	13.6	14.3	14.0
Abroad	63.4	15.3	37.8
Type of migration			
All destinations			
Short-term ($\leqslant$2 years)	31.3	5.2	17.4
Long-term (>2 years)	68.7	94.8	82.6
Rural areas			
Short-term	12.7	1.5	4.0
Long-term	87.3	98.5	96.0
Urban areas			
Short-term	19.3	9.1	13.8
Long-term	80.7	90.9	86.2
Abroad			
Short-term	40.6	18.3	35.8
Long-term	59.4	81.7	64.2
Migration motives			
Economic motives	68.1	14.0	39.7
Family	6.2	78.1	44.0
Schooling	6.4	1.3	3.7
Other	19.3	6.6	12.6
Sample size	1010	960	1970

women move for family reasons (65% for marriage), and only a low 14% for economic motives. A completely opposite pattern emerges among men, where economic reasons are reported for two-thirds of migrations. Finally, Table 3 also shows that 83% of those leaving do not return to their village within 2 years, indicating that short-term migrations are not the dominant type of move. Strong gender differences are observed however: while only 5% of women go back to their village within two years of departure, almost one-third of their male counterparts are involved in short-term migrations. Migrants to foreign countries are also much more likely to return to their village within 2 years than those moving to urban and rural areas.

Multivariate Results: All Destinations Combined

The main hypothesis is that individuals who live in areas with unfavorable rainfall conditions — including long-term conditions and short-term fluctuations — are expected to have a higher risk of leaving their village than those who live in areas with more favorable rainfall conditions. We first look at the factors influencing the risk of the first departure from the village, treating all migration types the same. All of the models are fitted separately for males and females (Table 4). The first model includes the individual-level variables and the rainfall variables (models 1a and 1b); the community-level variables are added in the second series of models (models 2a and 2b).

Individual-level variables. Models 1a and 1b (Table 4) show that, as expected, the risk of leaving the village for the first time is higher among educated people (2.41***). Among men, the risk of moving is significantly higher only for those who have had some secondary schooling (2.04***). The effect of primary education is more pronounced among women, while there is no difference between those who reached primary school and the few women that went to secondary school. The type of activity (time-varying variable) is also strongly related to the risk of moving. The odds of leaving the village are twice higher among people engaged in non-agricultural activities (2.06***). The risk of leaving the village is higher among women engaged in cattle-raising (2.78***, only a few women). On the other hand, males engaged in cattle-raising (0.92) are slightly (but not significantly) less likely to move than those involved in agriculture (reference). The higher propensity to migrate among the Mossi (reference) is in line with the literature on the specificity of Mossi migration.

TABLE 4

Event history models of individual, contextual and environmental effects on the risk of leaving the village, 1970–1998a

	Males		Females	
Explanatory variables	Model 1a	Model 2a	Model 1b	Model 2b
Baseline hazard				
Age	0.87**	0.86***	0.83**	0.83***
Log age	2.03	2.07***	1.30	1.35
Education				
No education (R)	1.00	1.00	1.00	1.00
Primary	1.12	1.08	1.66	1.46+
Secondary and over	2.72	2.41***	2.46	2.04***
Ethnic group				
Mossi (R)	1.00	1.00	1.00	1.00
Fulani	0.68	0.64+	0.42+	0.39***
Other	0.62*	0.62***	0.60+	0.59***
Activity (time-varying)				
Agriculture (R)	1.00	1.00	1.00	1.00
Cattle-raising	0.91	0.92	2.49	2.78***
Other	2.08	2.06***	1.51+	1.58***
Average rainfall (mm)				
200–499	0.92	0.91	1.18	1.04
500–699	0.87	0.91	1.33	1.43
700–899	0.80+	0.72	1.10	0.97
900 and over (R)	1.00	1.00	1.00	1.00
Rainfall variability (time-varying)				
< 85%	0.88+	0.89	0.78+	0.78+
85–95%	0.83+	0.83	1.01+	1.00
95 and over (R)	1.00	1.00	1.00	1.00
Water conservation techniques (time-varying)				
No (R)		1.00		1.00
Yes		1.11		1.00
Uncleared land available (time-varying)				
No (R)		1.00		1.00
Yes		0.96		1.05
All-season road (time-varying)				
No (R)		1.00		1.00
Yes		1.50***		1.88**

R – Reference category; [a] Results expressed as odds-ratios; ***$p < 0.01$; ** $p < 0.05$; * $p < 0.10$; +: $p < 0.20$ (two-tailed tests).

Rainfall and community-level variables. Models 1a and 1b (Table 4) also include the two rainfall variables. Contrary to our expectation, results show that men living in poor agro-climatic regions tend to have slightly lower risks (0.92) of moving than those in areas with greater rainfall (reference), but the relationship is not statistically significant. Among women, there is no relationship between the agro-climatic region and the risk of leaving the village. Unexpectedly, results for the second rainfall variable suggest that, for both men and women, the risk of moving is in fact slightly higher if the previous years were favourable (reference) than if they were unfavourable (0.88). However, these results are not statistically significant either. The effects of the individual-level and rainfall variables do not change notably with the inclusion of community-level variables (models 2a and 2b, Table 4). As expected, the presence of an all-season road increases the overall risk of moving (1.50^{***}), and is the only statistically significant community-level variable. However, people living in villages where uncleared land is still available do not have a lower risk of leaving the village. Finally, there is no significant effect of the use of a water conservation technique on the risk of moving.

Multivariate Results: Distinction Between Destinations

As discussed before, there are reasons to expect that the effects of explanatory variables —notably environmental variables — may differ across destinations. Three types of destinations (rural areas, urban areas and abroad) are distinguished with competing risk models. Results are reported in Table 5 (models 3a and 3b). The results are presented in three separate columns, each column pertaining to the contrast between a single destination and no migration (reference).

Individual level variables. The effects of the individual-level variables vary strongly depending on the destination. The relationship between education and the risk of moving for the first time to urban areas is very strong and positive (5.82^{***}), but is weak and non-significant towards rural areas (1.88) and rather negative for migrations to a foreign country (0.56). The fact that educated people are more likely to move to urban areas than the uneducated is thus clearly confirmed in Burkina Faso. The link between ethnic group and the risk of leaving the village for the first time also varies strongly by destination. While the Mossi are overall more likely to leave their village when no distinction is made between destinations, Fulani males have the highest propensity to leave their village for another village (rural-rural migration, 1.67). This is not observed among females however,

TABLE 5

Competing risk models of individual, contextual and environmental effects on the risk of leaving the village for different destinations, 1970–1998[a]

	Male (Model 3a)			Female (Model 3b)		
	Rural vs. no migration	Urban vs. no migration	Abroad vs. no migration	Rural vs. no migration	Urban vs. no migration	Abroad vs. no migration
Baseline hazard						
Age	0.98	0.87***	0.80***	0.84***	0.73*	0.84**
Log age	0.98	1.80**	3.26***	1.24	2.69	1.25
Education						
No education (R)	1.00	1.00	1.00	1.00	1.00	1.00
Primary	0.61+	1.34	1.18	1.36	2.71***	0.92
Secondary and over	1.88	5.82***	0.56	0.61	6.82***	0.16*
Ethnic group						
Mossi (R)	1.00	1.00	1.00	1.00	1.00	1.00
Fulani	1.67	0.35**	0.30***	0.49***	0.06**	0.48+
Other	0.77	0.68	0.57***	0.53***	0.36**	1.88**
Activity						
Agriculture (R)	1.00	1.00	1.00	1.00	1.00	1.00
Cattle-raising	1.50	0.36	0.71	2.39**	0.53	8.99***
Other	4.25***	4.40***	1.00	1.34**	3.68***	1.51
Average rainfall (mm)						
200–499	3.16**	1.10	0.61	1.69+	0.58	0.46+
500–699	2.73***	1.57	0.67	2.52***	1.22	0.38**
700–899	1.81**	1.62	0.51**	1.43	1.39	0.48**
900 and over (R)	1.00	1.00	1.00	1.00	1.00	1.00

TABLE 5 (*Continued*)

	Male (Model 3a)			Female (Model 3b)		
	Rural vs. no migration	Urban vs. no migration	Abroad vs. no migration	Rural vs. no migration	Urban vs. no migration	Abroad vs. no migration
Rainfall variability						
< 85%	1.58*	0.62	0.70+	0.78+	0.37+	1.27
85 – 95%	1.42**	0.76	0.69**	0.99	0.60**	1.48+
95 and over (R)	1.00	1.00	1.00	1.00	1.00	1.00
Water cons. Techniques						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.69+	0.78	1.38*	1.13	0.42**	1.13
Uncleared land available						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.97	0.68	1.01	1.21	0.47+	0.95
All-season road						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.57+	3.30***	1.31+	1.97**	3.30***	1.16

*** : $p < 0.01$; ** : $p < 0.05$; * : $p < 0.10$; +: $p < 0.20$ (two-tailed tests)
[a] Results are expressed in odds-ratio

where the risk of moving to another village among the Fulani (0.49^{***}) is only half the risk of the Mossi.[15] The Mossi, both men and women, have a much higher propensity to move to urban areas than the other ethnic groups, and Mossi males are also significantly more likely to leave for Côte d'Ivoire, confirming a known characteristic of foreign migration from Burkina Faso (Blion, 1995; Cordell et al., 1996; Deniel, 1967).

The effect of the type of activity on the risk of moving for the first time also differs across destinations and gender. Regardless of gender, individuals involved in cattle-raising are more likely to move to rural areas than those involved in agriculture. On the other hand, males involved in cattle-raising are less likely to move to urban areas. As far as temporary moves are concerned, this could be explained by the year-round commitment required: cattle-raisers cannot easily leave their herds just for a few months (Hampshire & Randall, 1999). No explanation was found for the higher risk of moving abroad among females involved in cattle-raising, but only a few women are involved in such activities. Finally, people involved in activities other than agriculture or cattle-raising are overall much more likely to leave their village.

Rainfall variables. The relationships between rainfall variables and the risk of leaving the village for the first time also vary significantly across destinations. The link between average rainfall conditions and migration is especially clear in rural areas. As expected, the odds of leaving the village for another village are three times higher for men living in the poorest agro-climatic region (3.16^{**}) than for those living in areas with an average rainfall over 900 mm (reference) (Table 5). Even though the relationship is less pronounced for women, those living in wetter areas (reference) are also less likely to move to another rural destination than women living in the drier regions (2.52^{***}). The relationship between the average rainfall and the risk of migrating to urban areas is much less consistent. There is however a significant relationship between the agro-climatic conditions and the risk of leaving for a foreign country, among both males and females. Results indicate that those living in the wetter areas (reference) are in fact much more likely to leave their village for a foreign country (0.61). Although it may seem surprising, this result is not completely unexpected. First, this could partly be interpreted as a proximity effect, since the wetter regions are located near Côte d'Ivoire. However, migrations to Côte d'Ivoire are generally directed to the more remote areas in the forest zone, and this suggests that factors other than distance are at play. One tentative explanation is that people from the wetter regions of Burkina Faso must necessarily go further south (out of Burkina Faso) to find better watered areas.

Rainfall conditions in the three preceding years are also significantly related to the propensity for leaving the village for the first time. As expected, the risk of moving to rural areas is significantly higher among males if there was a rainfall deficit over the three preceding years (1.58*). The odds of leaving are 60% higher if the conditions were unfavourable (less than 85% of the long-term average) than if they were normal (more than 95%). This result thus suggests that not only average rainfall but also short-term unfavourable rainfall conditions tend to push men to leave for other rural areas. Somewhat surprisingly, there is no significant effect of recent rainfall conditions on the risk of leaving among females, and they seem rather less likely to leave their village in years following poor rainfall conditions. An interesting result is the opposite pattern that emerges for migrations to urban areas and foreign countries. Overall, people are more likely to migrate to these destinations if the recent rainfall conditions were favourable. Both men and women seem to be more likely to move to urban areas in normal conditions than in unfavourable periods (0.62 for men, 0.37^{+} for women), although results are not significant. Among men, the odds of moving to a foreign country are also approximately 50% higher in normal periods than in unfavorable periods (0.69**). One tentative explanation might be that rural people are waiting for good economic conditions in the preceding years before moving to urban areas and to foreign countries (Findley, 1994; Nelson, 1983), as they may need a production surplus to finance their migration.

Community-level effects. Two of the three community-level variables are significantly related to the risk of leaving the village for the first time (Table 5). First, as expected, people living in villages connected by an all-season road are more likely to migrate to rural and urban areas than those living in places without roads. The effect is particularly strong on the risk of moving to urban areas, with odds of moving more than three times higher in places accessible by road. This agrees with results from studies in other settings (Findley, 1987). Contrary to our expectation however, there is no significant relationship between the availability of uncleared land and the risk of moving. This somewhat surprising result thus suggests that the link between land availability and migration is weak, or that a more refined analysis is needed. One tentative explanation might that agricultural intensification in more densely populated places may offset the expected effect of land availability on migration. Finally, men living in places where soil and water conservation techniques are used are somewhat less likely to migrate to rural and urban areas (not significant), while they are significantly more likely to move abroad. As discussed before, the slight negative effect in rural and urban areas could be explained by the fact that these techniques improve cereal yields and as a result may decrease the need for migration.[16] However, no explanation was found at this stage for the fact that people living in places where water conservation techniques are used are more likely to move to foreign countries.

Multivariate Results: Distinction Between Short-term and Long-term Migrations

While the previous results identify some effects of environmental conditions on the risk of leaving the village, they do not indicate whether people leave their village permanently or for a short period. In this section, we further refine the dependant variable to distinguish between short-term and long-term migrations. Six types of migrations — classified according to destination and duration — are now considered. A short-term migration is defined here as a change of residence involving a departure from the village for a duration of between 3 months and 2 years.[17] As discussed before, short-term migrations represent 17% of first migrations, but that proportion varies strongly by gender and destination (Table 3). Males are much more likely to engage in short-term migration (31%), and international migrants are also much more likely to return to their village within 2 years (36%). Multivariate results are presented in Tables 6 (males) and 7 (females).

Interesting patterns emerge for individual and community-level variables. For example, more educated men are significantly more likely to engage in long-term moves than uneducated people, and are much less likely to move for a short duration. Among males, the presence of an all-season road in the village has a stronger effect on the risk of undertaking a short-term rural-urban migration than on the risk of a long-term move. For the purpose of this paper, however, we will concentrate on the effects of the rainfall variables.

In regard to average rainfall conditions, additional insight is provided by the distinction between short-term and long-term migrations. Results from the previous section indicated that men from the drier regions were much more likely to migrate to rural areas than those from wetter regions. Table 6 shows that this is to a large extent the result of their much higher propensity to engage in *short-term* moves (21.43^{***}), although permanent migrations to rural areas are also more likely among people from the drier regions (2.18). The same conclusion applies to women. The risk of short-term migration to urban areas is also higher (although not significantly) among males (3.09) and females (2.17) living in the drier regions. Finally, the odds of a short-term migration to a foreign country is slightly higher

TABLE 6

Competing risk models of individual, contextual and environmental effects on the risk of short-term (< =2 years) and long-term (>2 years) migrations for different destinations, males, 1970–1998[a]

	To rural areas		To urban areas		Abroad	
	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration
Baseline hazard						
Age	0.98	0.96	0.87***	0.87**	0.77***	0.84***
Log age	0.95	1.47	2.08***	0.98	3.76***	2.92***
Education						
No education (R)	1.00	1.00	1.00	1.00	1.00	1.00
Primary	0.63	0.59	1.74+	0.51	0.95	1.50*
Secondary and over	2.28+	(n.a.) [1]	10.58***	0.07*	0.47	0.76
Ethnic group						
Mossi (R)	1.00	1.00	1.00	1.00	1.00	1.00
Fulani	2.05+	0.55	0.29**	8.69**	0.39**	0.22***
Other	0.75	1.10	0.38**	35.89***	0.46***	0.78
Activity						
Agriculture (R)	1.00	1.00	1.00	1.00	1.00	1.00
Cattle-raising	1.10	5.62***	0.27+	0.59	0.60	0.85
Other	3.83***	8.12***	3.28**	7.64***	1.02	0.93
Average rainfall (mm)						
200–499	2.18	21.43***	0.52	3.09	0.27**	1.61
500–699	2.37**	7.65*	1.08	3.55	0.46*	1.12
700–899	1.87**	1.43	1.37	2.27	0.39***	0.75
900 and over (R)	1.00	1.00	1.00	1.00	1.00	1.00
Rainfall variability						

TABLE 6 (*Continued*)

	To rural areas		To urban areas		Abroad	
	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration
< 85%	1.64*	1.44	0.68	0.73	0.95	0.37**
85 – 95%	1.31^{+}	2.25*	0.68	1.29	0.66*	0.73*
95% and over (R)	1.00	1.00	1.00	1.00	1.00	1.00
Water cons. techniques						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.51*	3.70***	0.59^{+}	2.45*	1.43*	1.32
Uncleared land available						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.94	1.30	0.65	1.30	1.27	0.69^{+}
All-season road						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.66^{+}	0.75	2.69**	6.23***	1.55**	1.01

***: $p < 0.01$; ** : $p < 0.05$; * : $p < 0.10$; +: $p < 0.20$ (two-tailed tests).
[1] No estimate available because no event occurred among the observations in this category.
[a] Results are expressed in odds-ratio.

TABLE 7

Competing risk models of individual, contextual and environmental effects on the risk of short-term (< = 2 years) and long-term (>2 years) migrations for different destinations, females, 1970–1998[a]

	To rural areas		To urban areas		Abroad	
	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration
Baseline hazard						
Age	0.83^{***}	1.06	0.69^{*}	0.97	0.71^{***}	1.05
Log age	1.28	0.44	3.51^{+}	0.60	2.37^{*}	0.49^{**}
Education						
No education (R)	1.00	1.00	1.00	1.00	1.00	1.00
Primary	1.36	1.15	2.96^{***}	1.29	0.80	1.35
Secondary and over	0.60	(n.a.)[1]	6.80^{***}	4.66	0.19^{+}	(n.a.)[1]
Ethnic group						
Mossi (R)	1.00	1.00	1.00	1.00	1.00	1.00
Fulani	0.46^{***}	4.39^{+}	0.06^{**}	0.24	0.51	0.24
Other	0.52^{***}	2.21	0.29^{**}	2.39	1.65^{*}	3.00
Activity						
Agriculture (R)	1.00	1.00	1.00	1.00	1.00	1.00
Cattle-raising	2.32^{**}	4.42^{+}	0.57	(n.a.)[1]	10.26^{***}	(n.a.)[1]
Other	1.36^{***}	0.37^{*}	3.83^{***}	2.76	1.58	1.29
Average rainfall (mm)						
200–499	1.56	34.41^{***}	0.51	2.17	0.40^{*}	0.73
500–699	2.46^{***}	20.45^{**}	1.14	2.55	0.34^{***}	0.58
700–899	1.41	8.33^{*}	1.23	3.98	0.37^{***}	1.28
900 and over (R)	1.00	1.00	1.00	1.00	1.00	1.00
Rainfall variability						
< 85%	0.78^{+}	0.83	0.41	(n.a.)[1]	1.31	1.12

TABLE 7 (*Continued*)

	To rural areas		To urban areas		Abroad	
	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration	Long-term vs. no migration	Short-term vs. no migration
85 – 95%	0.99	1.14	0.60*	0.60	1.79*	0.56
95% and over (R)	1.00	1.00	1.00	1.00	1.00	1.00
Water cons. techniques						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.13	0.86	0.38**	0.87	1.32	0.49
Uncleared land available						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.19	2.76+	0.51	0.00	0.95	1.00
All-season road						
No (R)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.97**	1.68	3.83***	0.99	1.20	1.06

*** : $p < 0.01$; ** : $p < 0.05$; * : $p < 0.10$; +: $p < 0.20$ (two-tailed tests).
[1] No estimate available because no event occurred in this category.
[a] Results are expressed in odds-ratio.

among males living in regions with scarce rainfall (1.61), and lower among females (0.73). These results thus indicate that men from regions with scarce and irregular rainfall are much more likely to engage in temporary migration, mainly to other rural areas and to a lesser extent to urban and foreign destinations. This agrees with results from two small-scale studies in Burkina Faso (Homewood, 1999; Reardon et al., 1988), and supports the idea that short-term migration is a way to diversify income sources in a context of severe production variability (Reardon et al., 1988). Interestingly, people living in agro-climatically poor regions are also more likely to leave their village permanently for another place in rural areas (2.37^{**} for men, 2.46^{***} for women). On the other hand, they seem rather less likely to engage in long-term migration foreign destinations than their counterparts in wetter areas.

The distinction between short-term and long-term moves also offers new insight into the link between rainfall variability and the risk of leaving the village. Overall, it seems that poor rainfall conditions in the previous years do not increase the risk of undertaking a short-term move[18]. While there is a slight increase of temporary migrations to rural areas (2.25^{*}), males are in fact significantly less likely to move abroad for a short duration (0.37^{**}), and there is no relationship for migrations to urban areas. The lower risk of moving abroad following poor rainfall conditions might be explained by the fact that such moves entail higher costs than moving to less distant areas. On the other hand, the odds of long-term male migration to rural areas do significantly increase in bad years (1.64^{*}). This is consistent with the hypothesis that people might decide to move permanently after severe rainfall deficits. The opposite effect is observed among females though: women are more likely to leave their village permanently for another village following years of relatively high rainfall. Given that most long-term female migrations to rural areas are marriage migrations, one tentative explanation might be that marriages tend to be delayed in periods of climatic stress. This runs counter to the hypothesis of increased marriages in drought periods as suggested by Findley (1994).

DISCUSSION AND CONCLUSION

The influence of environmental factors on migration has been the object of increased interest over the last few years (Lonergan, 1998). Because of the large environmental disparities within the country and the significant proportion of the rural population involved in agriculture, Burkina Faso is an interesting setting in which to investigate the links between environmental conditions and migration. Using recent longitudinal multilevel data, event history models were used to test the effects of rainfall conditions and community-level characteristics on the first migration, in addition to classical socio-demographic individual factors.

The main hypothesis was that individuals who live in areas with unfavorable rainfall conditions — including long-term conditions and short-term fluctuations — are expected to have a higher risk of leaving their village than those who live in areas with more favorable rainfall conditions. The findings for the environmental variables, of special interest in this paper, show the following points. First, there is no evidence of an effect of rainfall conditions on the risk of first migration from rural areas when no distinction by destination or duration is made. This suggests that environmental conditions either have no effect on migration, or that opposing effects are at play depending on the type of migration. Overall, these results suggest that migration behaviour is not very responsive to community-level variables and to environmental factors as measured by rainfall variables, but rather depends on individual characteristics such as the educational level, the type of activity or the ethnic group to which the individual belongs. Although these results are somewhat surprising, the absence of a relationship between rainfall variability and migration agrees with results of the 1974–1975 National Migration Survey (Coulibaly & Vaugelade, 1981). Opinion data from that survey showed that the vast majority of people declared that their migration behaviour had not been affected by the drought conditions, and only a low 4% of migrants declared that they had moved because of the drought. This is all the more surprising given that the early 1970s were characterised by a severe drought[19]. One explanation suggested by the authors was that the effect of the drought on migration was weakened by massive food distribution. The same explanation was offered by Findley to account for the fact that the volume of migration had not risen during the 1983–1985 drought in Mali (Findley, 1994). Coulibaly and Vaugelade (1981) also advanced the idea that the effect of poor rainfall conditions on migration was not more apparent was because all migrations were considered together, with no distinction by sex, destination or migration type.

The effect of rainfall conditions was then hypothesized to be different depending on the destination and the duration of migrations. In the case of Burkina Faso, the distinctions by destination and duration of migration prove critical in measuring a relationship between rainfall conditions and the risk of leaving the village. Overall, results indicate that environmental conditions as measured by rainfall variables are indeed linked to migratory behaviour, but in rather intricate ways depending on the varying types of migrations. A significant result from our models is that men and women living in areas where rainfall is scarce are much more likely to leave their village for another village (rural–rural migration) than are those living in areas with greater rainfall. This greater propensity to leave is to a large extent the consequence of their greater tendency to engage in *short-term moves*, which supports the theory that short-term migrations are part of a strategy to diversify income sources in a risky environment (Hampshire & Randall, 1999; Reardon et al., 1988). Interestingly, overall short-term migrations do not rise following a severe rainfall deficit: international temporary migrations are in fact less common among males in such periods. The former result agrees with a study on migrations in northern Burkina Faso that suggested that there was no increase in migrations in periods of drought (Homewood, 1999). The second result suggests that, rather than encouraging migration, rainfall deficits and bad harvests tend to limit people's ability to invest in long-distance moves (Findley, 1994). Overall, *long-term migrations* seem to be less related to environmental conditions than short-term moves, and the effects also differ across gender. In short, men are more likely to move permanently to another village if they live in a region where rainfall is scarce and in years following poor rainfall conditions. This is consistent with the hypothesis that migration rises immediately and as a long-term response to the threat of recurrent droughts (Findley, 1994). While women are also more likely to leave their village for another village if they live in the drier regions, they are *less* likely to move after bad rainfall conditions. Permanent migrations to urban areas seem to be less related to rainfall conditions. Finally, men and women from better watered areas are more likely to engage in a long-term migration to a foreign country than those living in the drier regions.

The results of this paper should not be considered as definitive and further research is needed on several topics. This study focused on the first migration, which is only one part of the story. Further analyses could investigate the effect of environmental conditions on subsequent migrations from rural areas. Perhaps more importantly, it could be fruitful to examine the effect of environmental conditions of the village of origin on the risk of *returning* to that village. One might expect that those leaving better-off places would be more likely to return to their home-village than those leaving places where rainfall is scarce. In fact, our results that distinguish migrations by duration tend to suggest that this is not the case, but more work is needed on this topic. Looking at exactly where migrants move and what they do in their new place of residence could also inform on their underlying motives for leaving their village. Many additional individual, household, community and environmental variables also remain to be investigated. Individual and household economic conditions, secondary activities, the spread of parasitic plants and the availability of off-farm activities in the community are some of the possible candidates for the formulation of more complex models. Other environmental factors could also be taken into account in migration models. The effects of land degradation on the risk of migration deserve special attention, although the lack of validated data at the national level constitutes a serious obstacle to the exploration of this issue. Finally, the characteristics of potential destinations could also be taken into account in further research (Baydar et al., 1990), although this would lead to more complex models and would require data that are not readily available. Such research will further our efforts to explain the complex interactions of the factors which influence migration in Burkina Faso.

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ENDNOTES

1. Results from the survey used in this study, ''Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso''.
2. One should note at this point that only those international migrants who had returned to Burkina Faso were included in the survey. As a result, the proportion of international migrants who return to their village is overestimated. However, analyses using information collected from other household members on international migrants who had not returned by the time of the survey confirm that these have a much higher probability of returning to their village.
3. Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB for Enquete ''Dynamique migratoire, Insertion urbaine et environnement au Burkina Faso'').
4. Burkina Faso is composed of approximately 350 departments.
5. Rural areas include all communities of less than 10 000 inhabitants (Beauchemin et al., 2002).

6. The individuals entering the risk set in 1970 may be more than 15 years old at the time of entry. This is a situation of late entry into the risk set that is easily handled in discrete-time event history models (Allison, 1995).
7. A 3-month migration definition was used to include temporary migrations in the dry season and migration related to short-term activities in urban areas (Poirier et al., 2001).
8. Models with dichotomous indicators of each age were also estimated. The estimates of the other coefficients in these models did not change. We thus chose the more parsimonious parametric specification of the baseline hazard.
9. The educational level does not vary very much after the age of 15.
10. The timing of the rains (delays in the start of the rainy season, occurrence of rains in relation to crop growth stages) could also be an important factor. The intra-annual variability of rainfall was also tested but not used in this study because this variable was not correlated with bad harvests.
11. This categorization was arbitrarily defined but several tests were performed to test the robustness of the results.
12. This information was collected in two stages. A first question was asked about the availability of uncleared land in the village at the time of the survey. In the communities in which uncleared land was no longer available, respondents were then asked to recall the (approximate) year when uncleared land was last available.
13. Preliminary analyses indicate a strong relationship between the availability of uncleared land in the village and population density measured at the province level.
14. Due to the absence of data at the household level, the presence of contour walls in a community is assumed to equally affect all community members.
15. This could be explained by the lower age at marriage among Fulani females. Since a larger proportion of Fulani females are already married by age 15, they will probably be less likely to move after that age.
16. One should note that this variable may be endogenous and that its measured effects should be interpreted with caution. For example, given that the implementation of such techniques requires a significant involvement of the workforce, the observed result for migrations to rural and urban areas might be partly explained by a greater probability of implementing soil and water conservation techniques in places where male migration is low. Further research is thus needed to fully understand the measured effects.
17. This definition is similar to that used by De Jong, Chamratrithirong, & Tran, (2002).
18. Models that only distinguish short-term and long-term moves (results not shown) in fact indicate that short-term migrations are significantly *less likely* following severe rainfall deficits.
19. Similar results were reported in Ethiopia where less than 2% of people mentioned drought as the cause for leaving their parent's home (Ezra, 2000).

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