Environmental Change and Migration

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Abstract

What is the role of environmentally induced migration in the climate-change context? While there is broad consensus that environmental factors might affect human mobility, the *ex-post* empirical evidence on this is inconclusive. This research contributes to the emerging empirical literature in this field by examining whether and how environmental change leads to internal (i.e., domestic) migration at the micro level. It is argued that individual perceptions of and attitudes toward different types of environmental change determine migration decisions in diverse ways. Empirically, the corresponding argument is analyzed with newly collected survey data from five developing countries, which include both individuals who migrated and individuals who decided to stay. The results suggest that individual perceptions of and attitudes toward long-term environmental events, such as droughts, have no significant effect on internal migration. However, sudden-onset environmental events, such as floods, significantly increase the chances to move. These findings suggest that "climate-refugee scenarios" are likely to be exaggerated and, hence, a more differentiated perspective on the issue of environmental migration based on adaptation is needed.

Keywords: droughts, environmental change, floods, individual perceptions, migration

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Introduction

In the debate on the consequences of climate change, attention increasingly focuses on the link between environmental change and human migration. Policymakers, public institutions, and scholars frequently argue that climate change is likely to cause mass population dislocations (migration) due to extreme sudden weather events, such as stronger and more recurrent storms or floods, as well as longer-term, gradual problems, such as droughts and rising sea levels (e.g., IPCC 2014; IOM 2010; Anthoff et al. 2006). Existing studies estimate that future environmental events could force 0.2-1 billion people to move permanently or temporarily within their own countries or internationally (Laczko and Aghazarm 2009; Myers 1997, 2002). These estimates, however, have been heavily criticized, primarily since they could overestimate the number of "environmental migrants" due to two reasons. First, these estimates are usually based on the number of people exposed to increasing environmental risks, and not on the number of people actually expected to migrate. Second, these studies do not account for different levels of vulnerability to environmental change and potential adaptation strategies (Gemenne 2011; Foresight Project 2011; Kniveton et al. 2008).[1]

Most of the existing scientific literature on environmental migration[2] treats the environment-migration nexus as self-evident. After all, weather-related events have led to considerable internal and international migration flows in various instances. For example, in the 1930s, an estimated 2.5 million North Americans are said to have left the Great Plains because of droughts and dust storms (Reuveny 2008; see also McLeman 2006); in 2005, Hurricane Katrina resulted in 1.5 million people being displaced temporarily and 500,000 permanently (Fussell et al. 2009;

[1] Piguet (2010) offers an excellent recent review of the methods to assess the role of the environment in migration.
[2] We use the term "environmental migration" as relating to persons who are displaced primarily for environmental reasons; see Dun and Gemenne (2008) for a thorough discussion of the definition of environmental migration.

Grier 2005). Unfortunately, such case-specific evidence does not allow for general conclusions with respect to whether and how environmental change does actually affect migration.[3]

Methodologically, existing work uses a diverse range of approaches including quantitative methods and modeling, qualitative research, and studies that combine both these methods (Gray and Mueller 2012a, 2012b; Beegle et al. 2011; Doevenspeck 2011; Dun 2011; van der Geest 2011; Gray 2011, 2009; Massey et al. 2010; Mortreux and Barnett 2009; Jäger et al. 2009; Myers et al. 2008; Morrissey 2008; Paul 2005; Henry et al. 2004).[4] While these studies offer intriguing insights into the complex relationship between environmental change and migration, their findings are largely inconclusive (Obokata et al. 2014; Hunter 2005). In fact, the existing literature has not yet established whether environmental change leads to migration, and we believe that this is because of at least three different, but interrelated reasons. First, we thus far lack an explanation to what extent environmental conditions determine the environment in which migration decisions are made. Second, due to the lack of theoretical work and data, we do not know which individuals decide to migrate and which decide to stay – and why. Finally, previous research has not sufficiently addressed why environmental change causes migration in some regions or countries, but not in others.

In order to shed light on these issues and, hence, on whether environmental change affects migration decisions, we first develop a theoretical argument that links individual perceptions of and attitudes[5] toward different types of environmental problems – notably (1) sudden and short-term vs. (2) slow-onset and long-term environmental events – to individuals' decisions to migrate or stay. Empirically, the corresponding argument is analyzed with newly collected

[3] One reason for this might be that the environment-migration relationship may well be conditional on various individual socio-economic and political factors (Black et al., 2011; Massey et al. 2010).

[4] For a more comprehensive and detailed review of the existing literature, see for reviews see McLeman (2013), Piguet (2010) or Foresight Project (2011).

[5] As elaborated thoroughly throughout this manuscript, we chose the terms "perceptions" and "attitudes" to express that we capture not only individuals' thinking and, eventually, the willingness to migrate, but also their capability and opportunity to actually do so (see also Most and Starr 1989).

survey data. These data comprise both individuals who migrated and individuals who decided to stay in five countries: Vietnam, Cambodia, Uganda, Nicaragua, and Peru.[6] We find that the effect of individual perceptions of and attitudes toward environmental events strongly depends on the nature of the environmental problem: while long-term, gradual environmental events, such as salinity or droughts, do not lead to migration, sudden-onset environmental events, such as storms or floods tend to increase the likelihood of migration.

Theoretical Argument: What Determines Individuals' Environmental Migration?

The existing literature on environmental migration is dominated by neo-Malthusian approaches that highlight the importance of "push" and "pull" factors. Generally, a push factor is a flaw or distress that drives a person away from a given place, while a pull factor is a benefit that attracts people to a specific location (Lee 1966). The prevailing argument holds that environmental change deprives people of their livelihood and forces them to migrate to an environment that allows for a better living, usually permanently. This argument identifies a direct and unidirectional relationship between environmental change and migration. However, it does not account for the possibility that environmental change may be only one of the factors determining whether or not people migrate and, secondly, that people can react to environmental change in several ways (Reuveny 2007). In other words, it is frequently neglected that migration is just one possible response to environmental threats (short-term or long-term) and that adaptation, as determined by, inter alia, certain individual-level characteristics, to environmental change is a possible alternative to migration (Adger et al. 2007).

In light of this, environmental conditions are clearly part of a complex pattern of causality (e.g., Black et al. 2011; Castles 2002; Lonergan 1998; Suhrke 1994). Environmental, economic,

[6] We focus on internal migration because the existing scientific literature suggests that most migration flows associated with environmental factors are, in fact, internal (Adamo and Izazola 2010; Kolmannskog 2008; Raleigh et al. 2008).

social, and political factors are interrelated, and these need to be examined jointly in order to understand the role of environmental change for population movements. However, thus far, we lack *a coherent theory of migration*, and face instead a fragmented set of approaches that are often segmented by disciplinary academic boundaries. For instance, neoclassical economists emphasize either that potential migrants calculate their expected earnings in their place of origin in comparison to various destinations (Harris and Todaro 1970; Todaro 1969); or that migration decisions are taken by the household as a whole as part of its survival strategy. Here, migration of a household member is seen as a way for the household to minimize risks and maximize its chances of survival under conditions of economic uncertainty by diversifying its sources of income (Stark and Lucas 1988; Stark and Bloom 1985; Stark and Levhari 1982). Sociologists highlight migrant networks and a "culture of migration" (Kandel and Massey 2002; Massey 1990a). Political scientists primarily stress political instability and armed violence as driving forces of migration (Raleigh, 2011; Salehyan and Gleditsch 2006; Moore and Shellman 2004; Davenport et al. 2003).

To the extent that environmental factors are considered in these studies, they are regarded as either "stressors" or "locational characteristics" that influence the likelihood of migration (Lilleør and Van den Broeck 2011; Knapp and Graves 1989; Wolpert 1966; Speare 1974). In particular, according to the "stress-threshold" model (Wolpert 1966), environmental problems, such as floods, droughts, desertification, etc., can act as "stressors" that affect individuals' life satisfaction. Not surprisingly then, a growing number of studies demonstrates that disruptions in climatic and environmental factors are associated with non-negligible changes in happiness and life satisfaction (Maddison and Rehdanz 2011; Ferrer-i-Carbonell and Gowdy 2007; Luechinger and Raschky 2009). For instance, Luechinger and Raschky (2007) find that flood disasters had a significantly negative effect on life satisfaction in 16 European countries between 1973 and 1998. A person living in a flood-prone region is likely to suffer a permanent reduction in life

satisfaction in comparison with an individual living in a flood-safe area. Accordingly, environmental stress should be more important in areas prone to natural disasters and/or where people are more directly dependent on the natural environment for their livelihood, e.g., when individuals depend on rain-fed agriculture.

When subscribing to the claim that environmental stressors reduce an individual's life satisfaction, including personal income and the opportunity for future employment,[7] and might even put the well-being at risk, we argue that the individual might consider migration to places with better environmental attributes as a response.[8] However, we submit that migration is not a "default" response to environmental change. Migration is costly, in both financial and sociological/psychological terms, since individuals tend to develop strong personal bonds over their lives with their home location (Devine-Wright 2013; Lewicka 2011; Feitelson 1991). Consequently, an individual will consider migration only when environmental change has a *major impact* on personal well-being, while the individual's efforts to adapt to and/or mitigate this impact fail (Speare 1974). In other words, the costs of migration are then lower than the costs of staying at a given place.

In line with other studies, we emphasize nonetheless that migration decisions are affected by *perceptions* of and *attitudes* toward environmental change, rather than environmental change objectively identified. This focus on the micro level explains why some people might leave their homes when facing environmental threats, while others do not. As such, Hunter (2005), among others, states that perceptions of risk act as a "mediating factor" between environmental stress and migration. Environmental change is then likely to have an asymmetric impact across the affected population, implying that while some individuals might be negatively affected by an

[7] Lilleør and Van den Broeck (2011) provide a critical review of the existing theoretical and empirical research on how climate change and climate variability in less developed countries (LDCs) could affect migration via their effect on personal income.

[8] Beegle et al. (2011), using micro-data from Tanzania, report that rainfall shocks increase the probability that people leave their villages. Similarly, Barrios et al. (2010) find that rainfall shortages raise rural out-migration in Sub-Saharan Africa.

environmental event – or at least perceive it that way, – others could have a different perception of or attitude toward this. A recent study based on micro-level data on a sample of African farmers, for example, shows that higher annual temperatures are associated with positive net revenues for livestock owners, but negative net revenues for crop producers (CEEPA 2008). In addition, perspectives on environmental change are almost by definition relative, influenced by the ability of an individual to cope with and adapt to environmental change (capability and opportunity aspects). The range of adaptive options varies across individuals, depending on, e.g., work skills, financial assets, and other attributes of the individual such as age, gender, or education. That is, perceptions of environmental change not only depend on a respective individual's exposure to environmental change (perception), but also on the adaptive capacity, i.e., the possibilities and opportunities to cope with it.[9]

Hence, we argue that the specific characteristics of environmental change and the individual as such affect the decision to migrate or stay. In terms of the environmental characteristics, we focus on the difference between *sudden (short-term)* and *slow-onset (long-term)* environmental issues.[10] Sudden or rapid (short-term) environmental events, such as floods, storms, and hurricanes can have severe impacts – at least in the short-run – on the well-being of individuals. These events cause casualties or injuries, property damage or loss (e.g., houses, land, machinery, crops, livestock, etc.), or social and economic disruption. In particular, the loss of crops/livestock and employment in all sectors due to an extreme environmental event leads to loss of income and increases insecurity. Affected individuals may, thus, migrate in the aftermath of such environmental events. The empirical implication of this theoretical argument is summarized in the following testable hypothesis:

[9] Piguet et al (2011), among others, argue that individuals who have access to resources are more likely to be able to adapt to the challenges of climate change.

[10] Renaud et al. (2011) propose a similar framework for environmentally induced migration, arguing that the type of the environmental problem – rapid-onset vs. slow-onset – determines whether migration is forced or voluntary.

Hypothesis 1: Sudden and short-term environmental changes (events) positively affect individuals' decisions to migrate.[11]

Slow-onset and long-term environmental problems, e.g., droughts, desertification, or water/land salinity, are likely to have a smaller impact on the well-being of individuals, because they can adjust their productive strategies over time when experiencing such environmental events. Here, individuals' responses include, for example, investments in irrigation systems, the use of drought or water resistant plant and animal varieties, or the diversification of income sources. Especially when the household makes a migration decision, diversification of income sources might be accomplished by having one family member migrate.[12] If so, this is likely to weaken the relationship between environmental change and migration. In addition, strong ties to the current location are likely to offset potential immediate motivations to migrate, i.e., the personal characteristics of the individual are a major determinant as well. Hence, we expect:

Hypothesis 2: Slow-onset, long-term environmental changes (events) are unlikely to positively affect individuals' decisions to migrate.

Finally, and derived from the previous two points, the effects of environmental change on migration decisions are likely to vary with levels of economic development of the country in which an individual resides as well as the political capacity of the country's government to effectively address environmental problems. Although individuals may be willing to respond to

[11] It is worth noting, that migration in the presence of short and sudden environmental events might not be permanent. Existing research shows that such environmental events rather lead to short-term, internal displacements (Gray and Mueller 2012; Myers et al. 2008; Naik 2009; Raleigh et al. 2008). Due to the lack of a temporal dimension of our survey, we are unable to determine whether migration is temporary or permanent, though.

[12] Yang and Choi (2007) and Adger et al. (2002) find that remittances from out-migrants are an important factor in maintaining the social resilience of coastal communities in Vietnam.

environmental changes by developing adaptation strategies, their ability to do so critically depends on the availability of the technological and economic resources for developing innovations. Consequently, to the extent a country's economic development conditions individuals' migration decisions, we expect that richer countries are more likely to deal with and adapt to environmental problems, which in turn is associated with less environmental migration. Adaptation strategies are also a function of the political environment, which assists in promoting responses to environmental change. Relative to autocracies, democratic countries should experience less environmental migration as democratic leaders have an incentive in the presence of environmental problems to provide economic support, infrastructure, and social services to their citizenry for alleviating environmental hardship as a means to survive in office (Bueno de Mesquita et al. 2003). Eventually, we seek to examine a last hypothesis:

Hypothesis 3: Economic development and a democratic form of government negatively affect individuals' decisions to migrate.

Empirical Analysis

For a systematic empirical analysis of whether environmental stressors influence migrants' decision to move, we require data for both migrants and non-migrants who originally come from the same area. Only when comparing individuals who have stayed in the area with those who have left, we are able to isolate the effect of environmental stressors on the decision to migrate, since comparing individuals from the same region ensures that the context for all migrants is the same. Consequently, this paper relies on original survey data specifically collected for this purpose that allows for a quantitative analysis of individual-level migration choices.[13]

[13] The Environmental Change and Forced Migration (EACH-FOR) project is the only other data on the environment-migration nexus with surveys carried out in 23 countries in six regions worldwide (Laczko and Aghazarm 2009: 204; see also Warner 2011).

In particular, we conducted an individual, micro-level survey in five countries: Vietnam, Cambodia, Uganda, Nicaragua, and Peru over 2013-2014. Our surveys yielded 3,670 completed questionnaires in total of which 50% stem from migrants. We focus on internal migration, since there is strong consensus in the literature that most migration flows associated with environmental factors are of an internal nature (Foresight 2011; Adamo and Izazola 2010; Raleigh et al. 2008).

The five case study countries were chosen according to the following criteria: Countries have been regularly affected by weather-related events (storms, floods, droughts etc.) and are also vulnerable to climatic changes (Kreft and Eckstein 2014; ND-GAIN 2013; EM-DAT/OFDA/CRED 2013; World Bank 2013). Countries represent different regions of the world: Southeast Asia, Sub-Saharan Africa, and Latin America. Finally, since our theory postulates different individual reactions to slow-onset/long-term vs. sudden-onset/short-term environmental events, countries contain different regions experiencing these types of environmental stressors in order to disentangle the effects from the two types of environmental events. Based on these criteria, we believe that the five countries we have chosen provide an ideal testing ground for our theory.

Based on information obtained from the EM-DAT/OFDA/CRED International Disaster Database and archive research, we first identified relevant regions/provinces in each survey country that are mainly characterized by one particular environmental stressor that can be classified either as slow-onset/long-term or sudden-onset/short-term environmental event.[14] In turn, we randomly chose the departments/districts for the location of the survey.[15] Finally, we

[14] Note that there is no variation on the presence of environmental stressors, i.e., everyone experiences environmental stress. However, since we are not interested in *objectively present environmental stress*, but rather *perceptions* of and *attitudes* toward environmental stress, our research design is appropriate. In essence, only with an environmental stressor present, people can perceive it as a reason for migration (or not).
[15] Table A1 in the appendix provides the locations of the surveys.

randomly selected communes or villages in these departments or districts by using a grid system with random starting points in which the interviews of the *non-migrants* took place.

In contrast, a random sampling of *migrants* is hardly possible, since (by definition) they do not live in the same commune as the non-migrants any longer. Furthermore, in the locations they have migrated to, we do not know *ex-ante* whether a specific person has migrated from the relevant areas. Hence, we relied on snowballing or a chain-referral[16] process to identify individuals who came from the exact same locations as the non-migrants, but who now live in the nearest major city, usually the regional capital, and/or the national capital. Starting points of the snowballing were obtained by asking the non-migrant interviewees whether they knew of any individuals who had left their commune or district after having the same environmental event(s), but did not belong to the same household. In total, we strived for the same number of migrants to match the non-migrants in each district.

All interviews were personal interviews consisting of both closed and open-ended questions that lasted for about 30 minutes. We asked all individuals about their experience with the latest environmental event as well certain personal information such as age, profession, or education. Parts of the two questionnaires of this study are listed in the Appendix.

Operationalization of Variables

Migration, our dependent variable, receives the value 1 for those individuals who decided to migrate and the value 0 for those who decided to stay. While the distribution of this variable for each individual country is summarized in the appendix, we note here that 1,835 individuals in our sample are non-migrants, while 1,854 migrants are included. Hence, our sample is basically balanced for our dependent variable.

[16] This sampling method is frequently used in sociological studies of such hidden populations (see also Laczko and Aghazarm 2009).

Our two main independent variables on environmental change pertain to sudden/short-term and slow-onset/long-term events, respectively. For capturing this, we asked respondents – both migrants and non-migrants – to describe the main weather events they experienced over the past five years. Respondents could choose between several weather events such as heavy rain, storm and floods, or drought and salinity, but could also list any other weather event that was not listed, or were able to state that no weather events have occurred in the recent past. If individuals mentioned that they experienced any heavy rain, storm, flood, hail/snow, hurricane, cyclone, typhoon, and/or landslide/mudslide, we coded this event due to its short-term nature as sudden and short-term environmental change. According to our theoretical arguments, we expect short-term environmental events to lead to an increased likelihood of migration. In contrast, we coded salinity, drought, or desertification as slow-onset and long-term environmental problems. Due to their long-term nature, we expect these latter environmental events to lead to more adaption and, thus, a lower likelihood of migration.

We also consider several control variables in some of our models that are included in other studies of individual-level migration choices. Information for all of the variables comes from our survey. First, there is a respondent's gender and age, as women as well as older individuals are less likely to migrate. Following recent explanatory models of migration networks emphasizing that migration decisions are made in a broader socio-economic context, we also incorporate a binary variable on whether another family member has migrated. Such networks increase the likelihood that relatives and friends will follow once the first migrant has settled in her/his destination by sharply reducing the costs and risks associated with migration **(**Massey et al. 1993; Massey 1990b).

To control for potential economic reasons of migration, we rely on four different proxy variables from our survey, which we introduce into our models separately due to collinearity issues. First, we consider a respondent's level of education via three dummy variables: whether a

respondent has no formal education, whether a respondent received at maximum primary education, or whether a respondent received at maximum secondary education. Individuals with higher education levels serve as the baseline category.

Second, there is the interviewers' classification of the respondents' economic household status. In particular, interviewers classified whether a household is economically below average, at average, or above average. We constructed two dummy variables – below and above average – based on this information, while those individuals with an average economic status serve as the baseline category.

Third, we use the respondents' self-assessment as to whether economic reasons influenced their decision to migrate or not. In particular, all migrants were asked about their reasons to migrate and they could choose between, e.g., social, political, environmental, or economic reasons. For all respondents who stated that economic reasons contributed to their decision to migrate, we assigned the value of 1 to the variable *Economic Reason* (0 otherwise). Since we could not ask the non-migrants the same question, we asked them whether they have ever thought about migrating from their location and, if so, which were the reasons for doing so. For those respondents who stated that they thought about migrating due to economic reasons, the *Economic Reason* also receives a value of 1 (0 otherwise). However, this self-assessment might be problematic as individuals might want to over- or understate certain factors due to personal reasons (e.g., non-migrants might not want to admit that they are not doing well economically).

The final variable to control for the opportunity costs of migration captures a respondent's profession as a proxy for economic well-being. We include the following five professions in our models, while individuals working in the agriculture sector are the baseline category: civil servants, individuals living from business sales, workers (industry, handicrafts, etc.), individuals

with elementary professions such as day labor, and individuals living from remittances or other sources of income.[17]

Empirical Findings

How do perceptions of and attitudes toward short-term and long-term environmental events affect individuals' decision to migrate? In a first step, we provide an analysis per country before moving to the full sample. This allows us to assess whether environmental events are likely to have the same effect in each of the different country contexts. In a second step, we pool the data and rely on a multilevel regression framework.

Table 1 reports the results of multilevel logistic regression models for each of the five countries. We use a random-intercept approach that accounts for the hierarchical sampling procedure within countries. As described above, we deliberately chose specific regions in each of the countries, because of the environmental problems they face, and then relied on random sampling below this level. Hence, we must control for the fact that certain regional factors might influence our results. To this end, we incorporate a regional-specific intercept in each of the models in Table 1, which accounts for unobserved heterogeneity at the regional level (Rabe-Hesketh and Skrondal 2009).[18] This regional-specific random intercept is modeled according to a normal distribution (Gelman and Hill 2009).

Table 1 about here

Table 1 reveals some interesting similarities and differences across our sample countries. In all of these states, gradual environmental events lead to a lower likelihood of migration. This

[17] The appendix reports the corresponding descriptive statistics.

[18] Our results are robust across different specifications of the structure of the covariance matrix for the random effects, including allowing all variances and covariances to be distinct.

finding is in line with our argumentation that individuals rather stay and arguably adapt instead to migrate. Interestingly, however, only in Nicaragua and Vietnam are short-term environmental events, such as storms or floods, associated with a higher likelihood of migration. Contrary to our theoretical expectation, we do not observe this migration inducing effect of short-term environmental events in Peru, Uganda, and Cambodia.

Most of the control variables show the expected influence. Older individuals are less likely to migrate, while respondents with a higher level of education are more likely to move. If a household member has already migrated, we observe an increase in the likelihood of migration in all countries except for Uganda and Cambodia. Finally, while we expected women to be less likely to migrate, our results point to the opposite effect in three of the countries – Nicaragua, Peru, and Cambodia.

These country-level results provide a first answer to the question whether environmental events relate to individual level decisions to migrate in a specific country context. However, they do not allow for an overall assessment as to whether and how environmental events, on average, indeed increase migration. In a second step, we thus pool the data and analyze them while taking into account country-level specificities. Table 2 summarizes the results of four random-intercept logistic regression models, all of which incorporate a country-level as well as a regional-level intercept to account for the specific hierarchical, two-level nature of the pooled data set.

Table 2 about here

The findings suggest that long-term, gradual environmental events, such as droughts or salinity, do not lead to migration. This finding is consistent with our theoretical argument that people are unlikely to migrate in response to longer-term environmental stressors, since adaptation should be the preferred option. In contrast, short-term, sudden-onset environmental

events, such as storms or floods increase migration. However, while we consistently obtain a positive coefficient estimate for sudden environmental events, it only reaches conventional levels of statistical significance in two out of the four models of Table 2. That is, when relying on the more subjective measures of economic motives of migration – interviewers' assessment of household type and individual self-assessment of economic reasons to migrate – the coefficient is not significant. A possible explanation for this result might be the high costs and uncertainties associated with moving, even temporarily. As coefficients in non-linear models like the hierarchical models for binary variables we employ cannot be interpreted directly, we also calculated predicted probabilities for Migration=1 and first differences for *Sudden Events and Graduals Events*, i.e., the change in the probability of a migration when raising either environmental threat variable from 0 to 1 while holding all other variables constant at their observed values. Figures 1 and 2 display these substantive effects.

Figures 1 and 2 about here

Again, the control variables are mostly in line with earlier studies and out expectations. While older individuals are less likely to migrate, respondents of which a household member has already migrated are more likely to move to a new location. In addition, in the combined models, the effect of the gender highlights that women are actually more likely to migrate. It thus seems that gender plays a complex role in the process of environmental migration.

With regard to the economic reasons for migration, Model 6 suggests that individuals with lower levels of education than our baseline category (higher education) are less likely to migrate. This matches the interpretation that those individuals who most likely have better job opportunities because of their advanced education are more likely to look for these opportunities

in a location other than their original home.[19] Similarly, Model 7 shows that individuals who are assessed to live in a wealthy household are more likely to migrate than individuals who come from an average-level household (baseline category), although individuals who are assessed to live in a poor household are less likely to move. This result also hints to opportunity-based motivations of migration rather than need-based motivations. In Model 8, we rely on an individual's self-assessment on whether economic reasons were an important driver of migration or whether one would migrate because of economic reasons (in case of the non-migrations). The effect of this variable strongly supports the idea that economic reasons are a major driving force behind individuals' decision to migrate or not. Finally, Model 9 stresses the fact that individuals with a profession other than our baseline category (agriculture) are less likely to migrate. This result provides some support to the assertion that environmental stress is more likely to be felt by individuals who are directly dependent on the natural environment for their livelihood and, hence, the ones who are more likely to decide to move.

By incorporating a country-level random intercept, we control for the fact that we study internal migration in five rather different country contexts. However, one could model these diverse country contexts more directly by including relevant factors that might affect migration patterns within the states. Two factors seem most relevant from this perspective: the political system and a country's economic development. Both factors could influence a country's capability to react to specific environmental events and, thus, individuals' decision to stay or to migrate. Our findings for this are summarized in Table 3, which mirrors the models of Table 2, but we now include a variable on a country's political system, measured by the polity2 variable from the Polity IV data (Marshall, Gurr, and Jaggers 2013), and GDP per capita in current US Dollars as taken from the World Development Indicators.. For both variables, we use data from 2012 to ensure that they are measured before the surveys were conducted. The results in Table 3

[19] This may lead to a regional "brain drain" (see Docquier et al. 2007; Beine et al. 2008).

show, however, that in none of these country-level variables has a significant effect on migration.

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Table 3 about here

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Robustness Checks

This paper focused on the relationship between environmental events and individuals' migration decisions. Since short-term and long-term environmental events are clearly exogenous to all other variables in our model, we do not face the problem of reverse causation here. Individual-level decisions with regard to migration, education, or occupation choices simply cannot affect environmental events such as droughts or storms. However, one might argue that some of the control variables in our model are not fully exogenous to migration. For example, a person's education or her occupation could depend on her anticipation to migrate in the future. That is, if someone plans to migrate and, therefore, decides to obtain a specific educational level or to work in a specific occupation, the possibility of reverse causation arises.

Since all econometric techniques that allow for simultaneous effects require some exogenous information to estimate the potentially endogenous factors, we would need some piece of information to estimate a person's educational or occupational choices that is at the same time unrelated to a person's migration decision. Unfortunately, our survey data do not offer such data. However, since the goal of this study is not to study the effect of education or occupation on migration decisions, but the effect of environmental factors, our major concern must be to show that the estimates for the environmental events variables are not biased. A first indication that these estimates are indeed not influenced by the potential endogeneity of the educational and occupational variables is given by Table 2. The effect of long-term and short-term environmental

events does virtually not change across the regression models, regardless of whether we include education, occupation, or the other variables to capture economic incentives for migration. We are therefore confident that the effect is indeed unbiased.

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Table 4 about here

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Furthermore, Clarke (2005, 2009) shows that the inclusion of control variables can actually increase the bias instead of decreasing it. Table 4 then reports the results when dropping the control variables. Again, our finding that long-term environmental events are associated with a decreased likelihood, while short-term environmental events are associated with an increased likelihood of migration, is robust to the inclusion and exclusion of control variables.

Conclusion

Various academics and also policymakers and public institutions have suggested that one major consequence of climate change could be that environmental events force millions of people to migrate permanently or temporarily. Migration on such a massive scale could lead to additional adverse outcomes, such as social unrest and even armed conflict (Laczko and Aghazarm 2009; Myers 1997, 2002).

However, both the theoretical and empirical foundations for such claims are rather thin. We sought to contribute to addressing this by developing a theoretical argument that considers different types of environmental stressors and their likely effects on individuals' choices to migrate. Empirically, our research improves on existing work in at least three ways. First, we introduced new survey data from five different countries, which makes our study one of the first relying on a quantitative and comparative perspective. Second, our survey allows us to differentiate between different environmental events. In particular, we considered both sudden-

onset and long-term environmental problems for which we hypothesized different effects on migration. Third, our survey covers people who migrated and those who decided to stay, which is indispensable for an understanding of whether environmental events indeed lead to migration or rather to adaption.

The results show that the effect of individual-level perceptions of environmental events strongly depends on the nature of the environmental problem: while long-term, gradual environmental events, such as salinity or droughts, are unlikely to lead to migration, sudden-onset environmental events, such as storms or floods tend to increase the risk of migration. This supports our theoretical argument that individuals tend to stay, and most likely adapt to an environmental problem instead of opting for the more costly option of migration when facing long-term environmental shocks.

The policy implications of our research are, *inter alia*, that a more differentiated perspective on the issue of environmental migration is in need. It remains possible that abrupt and extreme climatic changes could force people to migrate permanently from some areas of the world, particularly from low-altitude coastal areas in developing countries. However, if the past provides any insights into what may happen in the future, our results suggest that most people prefer adaptation over migration, especially if faced with slow-onset, longer-term environmental problems. The main implication is, therefore, that "climate refugee" scenarios (Laczko and Aghazarm 2009; Myers 1997, 2002) are probably exaggerated. Improving the targeting of aid to areas affected by environmental disasters and the financial and technical support for adaptation to environmental degradation resulting from climate change could be the most productive policy-option.

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Table 1. Individual Country Results

	Model 1 Nicaragua	Model 2 Peru	Model 3 Uganda	Model 4 Cambodia	Model 5 Vietnam
Sudden Events	0.41**	-0.88***	-0.45***	-2.60***	2.52***
	(0.193)	(0.291)	(0.165)	(0.905)	(0.325)
Gradual Events	-0.44**	-1.12***	-0.61	-0.33	-1.01***
	(0.209)	(0.327)	(0.667)	(0.284)	(0.200)
Female	0.74***	0.70***	-0.42	0.59*	-0.31*
	(0.188)	(0.200)	(0.355)	(0.304)	(0.165)
Age	-0.02*	-0.06***	-0.00	-0.18***	-0.09***
	(0.008)	(0.009)	(0.006)	(0.021)	(0.008)
Household Member Migrated	0.46**	0.98***	-0.53***	0.27	0.49***
	(0.201)	(0.215)	(0.176)	(0.275)	(0.166)
No Education	0.09	-0.29	-15.75***	-2.40***	-1.85***
	(0.392)	(0.533)	(0.949)	(0.665)	(0.715)
Primary Education	-0.18	-0.81***	-15.60***	-2.47***	-2.60***
	(0.293)	(0.292)	(1.508)	(0.363)	(0.302)
Secondary Education	-0.51*	-0.65***	-13.03***		-1.52***
	(0.266)	(0.240)	(1.501)		(0.224)
Constant	-0.32	2.83***	16.93***	8.43***	2.61***
	(0.509)	(0.502)	(1.369)	(1.157)	(0.498)
Variance Sub-National	0.58	0.23		0.08	0.23
	(0.396)	(0.183)		(0.126)	(0.199)
Observations	589	603	627	599	1,196
Number of Groups	5	5	–	8	4
Log Likelihood	-353.59	-340.51	-405.86	-182.66	-497.63
Wald χ^2	33.27***	101.34***	56.32***	145.21***	318.82***

Table entries are coefficients from multilevel logistic regression models with district level random effects; Model 3 is based on a regular logistic regression, as the likelihood-maximization process encountered a discontinuous region due to the low number of respondents in some of the regions; Model4 discards *Secondary Education* due to the lack of variance for this item; standard errors in parentheses.

*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 2. Full Sample Multilevel Logistic Regression Models

	Model 6	Model 7	Model 8	Model 9
Sudden Events	0.40***	0.10	0.12	0.39***
	(0.114)	(0.121)	(0.136)	(0.112)
Gradual Events	-0.62***	-0.36***	-0.67***	-0.69***
	(0.107)	(0.115)	(0.133)	(0.106)
Female	0.21**	0.29***	0.33***	0.11
	(0.087)	(0.094)	(0.106)	(0.085)
Age	-0.06***	-0.06***	-0.08***	-0.08***
	(0.004)	(0.004)	(0.005)	(0.004)
Household Member Migrated	0.35***	0.38***	0.33***	0.41***
	(0.088)	(0.095)	(0.108)	(0.088)
No Education	-1.69***			
	(0.211)			
Primary Education	-2.07***			
	(0.147)			
Secondary Education	-1.58***			
	(0.123)			
Poor Household		-1.03***		
		(0.134)		
Rich Household		0.72***		
		(0.178)		
Economic Reason			3.34***	
			(0.114)	
Civil Servant				-0.56***
				(0.187)
Business Sales				-0.53***
				(0.115)
Craft and Trade Workers				-1.36***
				(0.151)
Elementary Occupation				-0.79***
				(0.131)
Other Sources of Income				-0.53**
				(0.257)
Constant	3.52***	2.46***	1.14**	3.23***
	(0.541)	(0.603)	(0.454)	(0.438)
Country Variance	0.53	0.86	0.00	0.00
	(0.890)	(1.108)	(0.000)	(0.000)
District Variance	4.01***	4.04**	4.18***	4.16***
	(1.547)	(1.572)	(1.511)	(1.473)
Observations	3,614	3,125	3,625	3,477
Number of Groups	5	5	5	5
Log Likelihood	-1,784.51	-1,545.24	-1,310.41	-1,807.08
Wald χ^2	658.62***	370.51***	1,006.68***	554.26***

Table entries are coefficients from multilevel logistic regression models with country level and district level random effects; standard errors in parentheses.

*** significant at 1%; ** significant at 5%; * significant at 10%.

Table 3. Alternative Models with Multilevel Logistic Regression Models

	Model 10	Model 11	Model 12	Model 13
Sudden Events	0.40***	0.10	0.12	0.39***
	(0.114)	(0.121)	(0.136)	(0.112)
Gradual Events	-0.62***	-0.36***	-0.67***	-0.69***
	(0.107)	(0.115)	(0.134)	(0.106)
Female	0.21**	0.29***	0.33***	0.11
	(0.087)	(0.094)	(0.106)	(0.085)
Age	-0.06***	-0.06***	-0.08***	-0.08***
	(0.004)	(0.004)	(0.005)	(0.004)
Household Member Migrated	0.35***	0.38***	0.34***	0.41***
	(0.088)	(0.095)	(0.108)	(0.088)
Democracy	-0.05	0.06	-0.05	-0.04
	(0.099)	(0.114)	(0.085)	(0.084)
GDP per capita	-0.00	-0.00	0.00	-0.00
	(0.000)	(0.000)	(0.000)	(0.000)
No Education	-1.69***			
	(0.211)			
Primary Education	-2.07***			
	(0.147)			
Secondary Education	-1.58***			
	(0.123)			
Poor Household		-1.03***		
		(0.134)		
Rich Household		0.73***		
		(0.178)		
Economic Reason			3.34***	
			(0.114)	
Civil Servant				-0.56***
				(0.187)
Business Sales				-0.53***
				(0.115)
Craft and Trade Workers				-1.36***
				(0.151)
Elementary Occupation				-0.79***
				(0.131)
Other Sources of Income				-0.53**
				(0.257)
Constant	3.78***	2.47***	1.15*	3.39***
	(0.731)	(0.839)	(0.624)	(0.605)
Country Variance	0.38	0.79	0.00	0.00
	(0.794)	(1.031)	(0.000)	(0.000)
District Variance	4.01***	3.98***	4.12***	4.10***
	(1.543)	(1.544)	(1.491)	(1.453)
Observations	3,614	3,125	3,625	3,477
Number of Groups	5	5	5	5
Log Likelihood	-1,784.21	-1,545.08	-1,310.23	-1,806.85
Wald χ^2	658.67***	370.69***	1,006.55***	554.37***

Table entries are coefficients from multilevel logistic regression models with country level and district level random effects; standard errors in parentheses.

*** significant at 1%; ** significant at 5%; * significant at 10%.

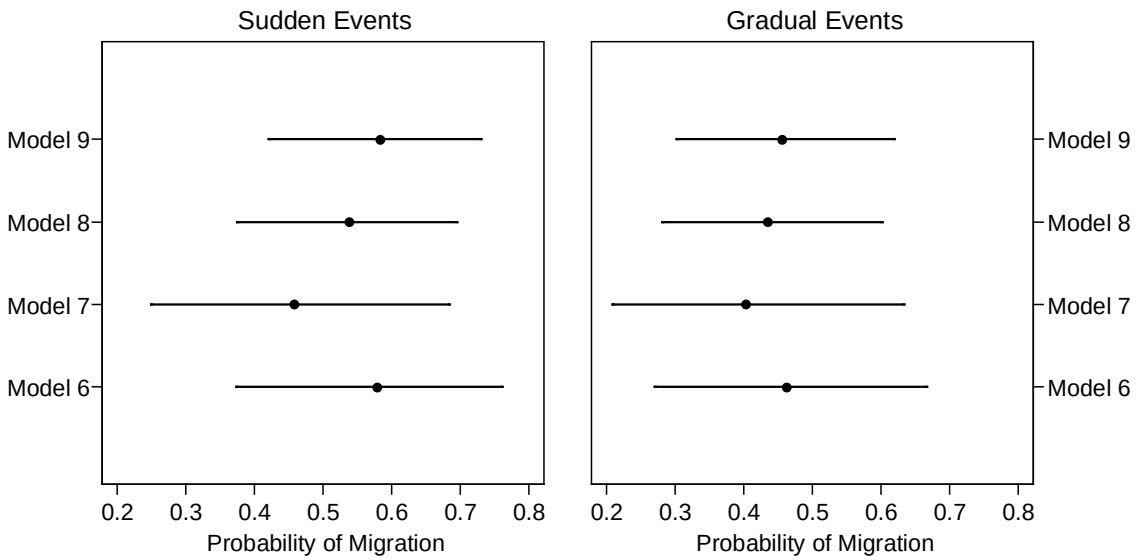
Table 4. Baseline Multilevel Logistic Regression Model

	Model 14
Sudden Events	0.57
	(0.757)
Gradual Events	-0.65***
	(0.115)
Constant	0.04
	(0.774)
District Variance	3.90
	(5.702)
Observations	3,674
Number of Groups	27
Log Likelihood	-2,248.74
Wald χ^2	62.36***

Table entries are coefficients from multilevel logistic regression models with district level random effects; standard errors in parentheses.

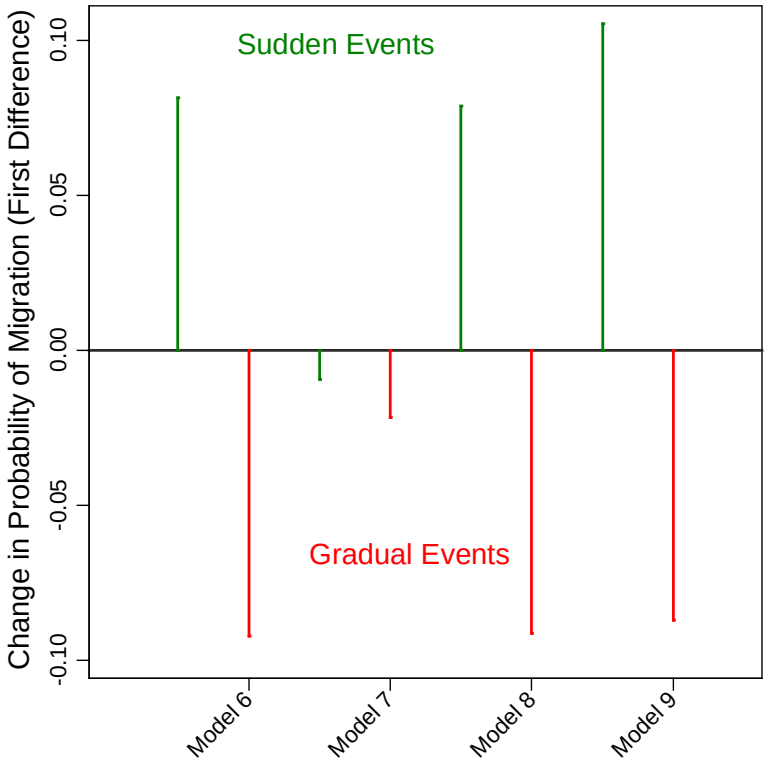
*** significant at 1%; ** significant at 5%; * significant at 10%.

Figure 1. The Probability of Migration



Graph shows predicted probabilities for *Migration*=1; horizontal bars pertain to 90% confidence intervals; left panel captures probabilities for *Sudden Event*=1, while right panel pertains to probabilities for *Gradual Event*=1; all other variables held constant at their means; calculations are based on Table 2 and include both fixed and random effects.

Figure 2. First Differences



Graph shows changes in the probability of *Migration*=1 when changing either *Sudden Events* (green bars) or *Gradual Events* (red bars) from 0 to 1, while holding all other variables at their observed values; calculations are based on Table 2 and include both fixed and random effects.

Appendix

Table A1. Overview of Surveys

	Vietnam	Uganda	Cambodia	Nicaragua	Peru
Non Migrants: Subnational Locations and Type of Environmental Problems	Ba Tri (salinity) Chau Phu (flood) Giao Thuy (cyclone) Ninh Hai (drought)	Kotido and Moroto (drought, heavy rain/flood)	Cheung Prey Kang Meas Koh Sotin Krouch Chhma (storm/flood/ Khsach kandal Koaoh Thum Lvea Aem S'ang (flood/drought)	Managua, Chinandega, and Leon (drought) R.A.A.N and R.A.A.S (storms)	Cusco (flood, cold weather) Puno (drought) Piura (drought/flood) Arequipa (flood) Lima (drought)
Migrants: Regional and Capital Cities	Hanoi Ho Chi Minh city	Kampala Kotido Mbale	Phnom Penh Kampong Cham	Managua, Leon Chinandega	Cusco, Puno, Piura, Arequipa, and Lima
Political System	Autocracy Polity IV: -7	Anocracy Polity IV: -1	Anocracy Polity IV: 2	Democracy Polity IV: 9	Democracy Polity IV: 9
Income – GDP per capita 2012	1,755 USD	653 USD	946 USD	6,424 USD	1,777 USD
Number of Participants (50% Migrants)	1,200	672	600	600	617
Survey Period	Sept-Oct 2013	Sept-Oct 2013	Jan-Feb 2014	Mar-Apr 2014	Jul-Aug 2014

Table A2. Individual Country Data Overviews

Vietnam

Variable	*Yes*	*No*	*N*
Migrants	600	600	1200
Sudden events	982	218	1200
Gradual events	352	848	1200
Female	685	515	1200
Family member has migrated	459	739	1198
No education	21	1177	1198
Primary education	232	966	1198
Secondary education	642	556	1198
Poor household	300	479	779
Rich household	153	626	779
Economic reason to migrate	565	635	1200
Civil servant	63	1137	1200
Business sales	237	963	1200
Craft and trade workers	125	1049	1200
Elementary occupations	151	1049	1200
Other sources of income	6	1194	1200

Uganda

Variable	*Yes*	*No*	*N*
Migrants	353	319	672
Sudden events	194	478	672
Gradual events	632	40	672
Female	427	243	670
Family member has migrated	247	406	653
No education	522	140	672
Primary education	109	553	662
Secondary education	15	647	662
Poor household	533	134	667
Rich household	23	644	667
Economic reason to migrate	342	330	672
Civil servant	6	611	617
Business sales	145	472	617
Craft and trade workers	16	601	617
Elementary occupations	72	545	617
Other sources of income	55	617	672

Cambodia

Variable	*Yes*	*No*	*N*
Migrants	300	300	600
Sudden events	567	33	600
Gradual events	315	285	600
Female	367	233	600
Family member has migrated	339	260	599
No education	61	539	600
Primary education	164	436	600
Secondary education	147	453	600
Poor household	157	368	525
Rich household	86	439	525
Economic reason to migrate	288	312	600
Civil servant	22	484	506
Business sales	89	417	506
Craft and trade workers	21	485	506
Elementary occupations	17	489	506
Other sources of income	105	495	600

Nicaragua

Variable	*Yes*	*No*	*N*
Migrants	300	300	600
Sudden events	351	240	591
Gradual events	176	415	591
Female	350	250	600
Family member has migrated	205	394	599
No education	55	544	599
Primary education	181	418	599
Secondary education	258	341	599
Poor household	536	64	600
Rich household	4	596	600
Economic reason to migrate	228	372	600
Civil servant	63	537	600
Business sales	77	523	600
Craft and trade workers	131	469	600
Elementary occupations	126	474	600
Other sources of income	53	547	600

Peru

Variable	*Yes*	*No*	*N*
Migrants	301	316	617
Sudden events	497	114	611
Gradual events	113	498	611
Female	361	256	617
Family member has migrated	199	410	609
No education	23	594	617
Primary education	165	452	617
Secondary education	281	336	617
Poor household	535	82	617
Rich household	4	613	617
Economic reason to migrate	221	396	617
Civil servant	39	577	616
Business sales	121	495	616
Craft and trade workers	64	552	616
Elementary occupations	115	501	616
Other sources of income	33	584	617

Questionnaire

Interview ID _____ --_____--_____
Date: ____/____/_____
Interviewer ID _____

Location: *[to be filled out prior to interview]*

Coordinates:

Commune/Village/Town:

District:

Province:

Current Weather *[observed]*:

Number of households (HH) in village/town:

Respondent: *[based on observation]*

Household Status *[scale determined before start of interview]*

1. Very poor
2. Poor
3. Average
4. Above average
5. Wealthy

99. N/A *[Circle if interview not conducted in respondent home]*

Sex of Respondent

1. Female 2. Male

Interview Schedule

How long have you lived in this location?

1. Since birth
2. _____ [years]

99. Don't Know/Refused to Answer

Where did you come from?
Commune/Village: _____ District_____ Province_____

Were you born there?

1. Yes
2. No

99. Don't Know/Refused to Answer

How long were you in that previous location for?

_____ years

99. Don't Know/Refused to Answer

What is the highest level of formal education you have attended?
[Ask for specific number of years completed]

1. No formal education
2. Primary school _____ Years completed
3. Secondary_____ Years completed
4. Technical _____Years completed
4. Post-Secondary _____ Years completed
5. Other _____
99. Don't know/Refused to Answer

Could you tell us your age? _____
[If does not know or refuses to respond, interviewer to guess]

I will read you a list of sources of income. Could you tell us which are your household's main source(s) of income? (Non-migrant) - I will read you a list of sources of income. Could you tell us which were your household's main source(s) of income in your former location? (Migrant)
(*Circle all mentioned. If more than one was mentioned, ask to rank them in order of importance (from 1-5, 1 the most important) (Insert number in spaces provided in question BELOW)*

1. _____ Agriculture/Farm /animal /fishing income
2._____ Proceeds as shop/business owner
3._____Proceeds markets sales (non-farm)
4._____Civil servant salary
5._____Salary from industry (firm, factory, corporation)
6._____Salary from labor (handicrafts, construction)
7._____Day Labor-Temporary
8._____Artisanal Mining
9._____Remittances
10._____ Professional
11._____Other
99._____Don't Know /Refused to Answer

From your perspective, can you describe the main weather events that have happened here during the last 5 years? (Non-migrant) – From your perspective, Can you describe the main weather events that occurred during the past five years before you left your previous residence? (Migrant)
[If respondent is unable to answer freely, read the list. For each reported event follow up with questions in the following table] . [Circle all that apply] Show Card

1. Heavy Rains/Floods [*please circle]*
2. Salinity
3. Snow/Hail [*please circle*]
4. Drought/Desertification *[please circle]*
5. Storm/Cyclone/Typhoon [*please circle*]
6. Landslide/Mudslide/Avalanche [*please circle*]
7. Other_____
8. None
99. Don't Know/Refused to Answer

Circle events reported in previous question	**1. Heavy Rain/Flood**	**2. Salinity**	**3. Snow/Hail**	**4. Drought/ Desertification**	**5. Cyclone/ Typhoon/ Storm**	**6. Landslide/ Mudslide/ Avalanche/**	**7. Other**
[For short term events] When did this event last occur? *[Or for progressive environmental events]* When did this event begin?	Month Year 99. DK/RA	Month Year 99. DK/RA	Month Year 99. DK/RA	Month Year 99. DK/RA	Month Year 99. DK/RA	Month Year 99. DK/RA	Month Year 99. DK/RA
How long did this event last?	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA	1. days 2. weeks 3. months 4. years 99. DK/RA

Have you ever thought about migrating? If yes, then ask: What was/were the reason(s)? (Non-migrant) - I would like to ask you all the reason(s) why you decided to move from your former location. (Migrant)
[Allow respondents to answer without reading list and circle all responses in "Unprompted Column". Then follow up by reading list/Show Card. Additional responses should be circled in "Prompted Column"]

Social reasons: for example, Marriage; There are family/relatives in the new location; I was facing discrimination; There was insecurity (physical &/or sexual); To seek health care (inadequate health care in area); To seek schooling (e.g. no school in area); Other

Economic reasons: for example, Not enough income from livelihood sources; Unreliable harvest; No land available for farming/agriculture; Crop failure; Unemployment in that location; Job opportunity in new place; Higher income in new place; Other

Environmental reasons: for example, Water shortage/Drought [1 event]; Repeated droughts /Long Term salinity; Too much water; Short term events such as flood, storm, landslide, cyclone: Single event or Repeated Event; Other

Political reasons: for example, There was conflict; To seek political freedom; Government provided incentives for me to go; Government forced me to move; Other

Of all the reasons you mentioned, could you please rank the top three most important factors?
[Write number of code from above reason in first, second and third place below, with number 1 as the most important]

1st _____
2nd _____
3rd _____
99. Don't Know/Refused to Answer

Up until now, have members of your household left temporarily or permanently for other places or even abroad? (Non-migrant) -Up until now, have other members of your household in your previous location left temporarily or permanently for other places, or even abroad? *[Excluding respondent]*(Migrant)

1. Yes
2. No
99. Don't Know/Refused to Answer

Do you know of anyone who left after having experienced the same event(s) (drought/desertification/flood/cyclone/etc)? *[Not from the same HH]* (Non-migrant) - Do you know anyone else who left from your previous location around the same time you did? *[Other than you]* (Migrant)

1. Yes
2. No
99. Don't Know/Refused to Answer

Where did they go? *[List all locations mentioned]*

_____

Would you be willing to provide us with the name and contact information for these people so that we may ask a similar set of questions?

_____