

# Environmental Stressors and Migration: Evidence from Vietnam<sup>1</sup>

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## Abstract

While various studies predict large environmental migration flows due to climate change and other environmental events, the ex post empirical evidence for this phenomenon is inconclusive. We contribute to the emerging empirical literature in this field by focusing on the micro-level. We examine how and why different environmental stressors may induce internal migration. The analysis relies on original survey data from Vietnam including both migrants and non-migrants. The results suggest that long-term environmental events, such as droughts, significantly reduce migration while sudden-onset environmental events, such as floods or cyclones, significantly increase the likelihood of migration controlling for other potential reasons to migrate. These findings indicate that different types of environmental stressors can create different incentives for people to migrate or stay.

**Keywords:** environmental stressors, floods, droughts, climate change, migration, adaptation, micro-level analysis, survey

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## 1. Introduction

The debate on whether and how environmental change impairs human security and ultimately forces people to leave their homes and migrate to places more conducive to their wellbeing has experienced a strong revival in the climate change context. The Intergovernmental Panel on Climate Change (IPCC 2014a), as well as many academics and policy-makers have argued that climate change is likely to cause mass population dislocations (migration) due to extreme weather events, such as stronger and more frequent storms and floods, as well as longer-term, gradual problems, such as droughts and rising sea levels (Laczko and Aghazarm 2009; Myers 1997, 2002; for a critique, see Kniveton et al. 2008; see also Gemenne 2011, Pigué et al 2011, and Pigué 2010).

A rather large body of literature examines particular cases of environmental change and seeks to relate observed dislocations of people to observed environmental events or stressors<sup>2</sup> (Gray and Mueller 2012a, b; Doevenspeck 2011; van der Geest 2011; Massey et al. 2010; Mortreux and Barnett 2009; Jäger et al. 2009; Gray 2008; Myers et al. 2008; Henry et al. 2004).<sup>3</sup>

Most of these studies suggest that environmental stressors *can* induce migration. However, there clearly is room for further research that should address at least two shortcomings of existing work. First, the large majority of studies examine one particular environmental event such as drought and its effects on migration. By implication existing research therefore does not tell us much about whether and how effects on migration might differ across different types of environmental stressors.

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<sup>2</sup> We use the term “environmental migration” as relating to persons who are displaced primarily for environmental reasons (see Dun and Gemenne (2008) for a discussion on the definition of environmental migration).

<sup>3</sup> For a much larger review of the existing literature, see: Foresight Migration and Global Environmental Change (2011) <http://www.bis.gov.uk/foresight/migration>.

The second limitation is that many studies using micro-level data, usually collected through surveys of individuals or households, concentrate on those persons who have migrated. However, environmental stressors do not affect all people the same way and individuals do not respond to environmental stressors in a unified, singular manner (e.g. Black et al., 2011; Raleigh, 2011; Hunter 2005). Hence, studies that overlook those who have not migrated are likely to suffer from selection bias because they do not allow for any conclusions with respect to persons who, despite environmental problems, decided not to migrate.

In this paper we contribute to the environmental migration literature by addressing some of the limitations of existing work. We propose a theoretical argument that systematically links different types of environmental stressors– notably short- vs. long-term environmental events– to decisions of individuals to migrate or stay. We then examine the plausibility of this argument, using original survey data from Vietnam, including both individuals who migrated and individuals who decided to stay. We focus on internal migration because there is a strong consensus in the scientific literature that most migration flows associated with environmental factors are internal (Adamo and Izazola 2010).

The next section presents the theoretical argument. In the subsequent section we discuss the empirical approach and the results. The final section summarizes the findings and discusses their policy implications.

## **2. Theory**

Several authors have argued that environmental conditions are part of a complex pattern of causality (e.g. Black et al. 2011; Lonergan 1998; Suhrke 1994). They argue that environmental, economic, social, and political factors are interrelated and need to be examined jointly in order to understand the role environmental factors play in population movements. A very useful option for doing so is to draw on the ‘stress-threshold’ model (Wolpert 1966).

From the perspective of this model, environmental events, for instance floods and droughts, can act as ‘stressors’ that bring about ‘strains’ and motivate individuals to consider migration as a response. That is, when environmental ‘stressors’ put an individual’s wellbeing at risk, decrease her personal income, and/or lower her opportunity for future employment then she is more likely to consider migrating to places with better environmental attributes and better income opportunities. Environmental stress is, obviously, likely to be more paramount in settings where people are more directly dependent on the natural environment for their livelihood.

However, the presence of environmental stressors will, in most cases, not automatically induce migration (the main exception are major environmental hazards that leave local residents with no choice but to leave). Individuals are likely to first try and abate the respective environmental problem and/or adapt to it before they consider migration (e.g. Adger et al. 2007; Roncoli et al. 2001). The reason is that migration is costly in both financial and sociological/psychological terms because individuals tend to develop strong personal bonds over their lives with their home location and its people (Devine-Wright 2013; Lewicka 2011). Consequently, an individual will consider migration only when an environmental event has a major impact on her personal wellbeing and her efforts to adapt to and/or mitigate this impact are failing (Speare 1974). To what extent this is the case depends on the form and magnitude of the environmental stressor.

The most interesting variation in this respect, in our view, is the difference between *sudden* vs. *slow-onset* and *short-term* vs. *long-term* events (see also Renaud et al. 2011). Sudden and short-term (rapid) environmental events, such as floods or storms, can have severe impacts – at least in the short run – on the wellbeing of individuals. Affected individuals may migrate in the aftermath of such natural disasters. However, migration might not be permanent. Individuals are usually tied to a particular location by lifestyle, bonds to other people, culture, social traditions and identity. For these reasons, we expect that they are likely to return once conditions improve

and rebuild their lives in a ‘familiar’ setting. The empirical implication of this argument is that *sudden and short-term environmental events have a significant effect on individuals’ decisions to migrate.*

Slow-onset and long-term environmental events, such as droughts, desertification, or sea-level rise are likely to have smaller immediate impacts on the wellbeing of individuals. People can adjust their productive strategies over time when facing such environmental stressors, for example, by investing in irrigation systems, using drought resistant plant and animal varieties, or by diversifying income sources. Moreover, diversification of income sources might be accomplished by having a single-family member migrate. The empirical implication of this argument is that *slow-onset and long-term environmental events are less likely to increase the probability of migration.*

Overall, we thus expect individuals’ reaction to environmental stressors to depend on the nature of the environmental event. In the case of sudden and short-term environmental events we expect individuals to migrate, although perhaps not permanently, while we expect no influence of slow-onset and long-term environmental events on migration decisions. The next section presents a systematic analysis of the two hypotheses.

### **3. Empirical Analysis**

Ideally, for a systematic empirical analysis of these hypotheses one needs data for both migrants and non-migrants who originally come from the same area in order to analyze whether environmental stressors influenced migrants’ decision to move to another location. Only if one compares individuals who have stayed in the area with those who have left, one is 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. Unfortunately, no data that meet these requirements exist. The only dataset that comes close to this ideal is the EACH FOR

project.<sup>4</sup> However, the limited number of observations per country case study makes the EACH FOR data difficult to use in a quantitative analysis and thus not very well suited for our purpose.

Consequently, this paper relies on original survey data specifically collected to allow for a quantitative analysis of individual level migration choices. In particular, we conducted an individual level survey in four districts in four provinces in Vietnam in September and October 2013. Our survey yielded 1,200 completed questionnaires in total of which 600 came from migrants. We focus on internal migration because of two reasons: First and as discussed above, there is a strong consensus in the existing literature that most migration flows associated with environmental factors are internal (Adamo and Izazola 2010). Second, studying internal in contrast to external migration has the advantage that certain factors, which could influence people's decision to migrate but are hard to control for, such as a country's political system, social and or cultural factors, stay constant and therefore cannot influence the decision to migrate.

We chose Vietnam as a case study because it provides an ideal testing ground for our theoretical argument. Since our theory postulates different reactions to slow-onset/long-term vs. sudden-onset/short-term environmental events, we ideally need a country in which different parts of the country experience these types of environmental stressors such that one can disentangle the effects from the two types of environmental events on migration choices. Vietnam provides exactly this type of testing ground because over the past 30 to 50 years Vietnam has experienced

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<sup>4</sup> The Environmental Change and Forced Migration (EACH-FOR) project was a research project within the Sixth Framework Programme of the European Commission (EACH-FOR 2011). It constitutes the first global survey of environmental change and migration and investigated cases studies in 23 countries in 6 regions worldwide. The goal was to find out whether there was a "discernible environmental signal in migration patterns today" (Laczko & Aghazarm 2009: 204; see also Warner 2011).

intensified flood, storm, and drought events, water and land salinity, and sea level rise, with the Mekong and Red River delta regions as well as the North and South Central Coast regions being the most affected (IPCC 2014b; ICEM 2010).<sup>5</sup>

Based on information obtained from the EM-DAT/OFDA/CRED International Disaster Database and archive research, we first identified four provinces in Vietnam that are mainly characterized by one particular environmental stressor, which can be classified either as slow-onset/long-term or sudden-onset/short-term environmental event. Then one district in each of the four provinces was randomly chosen for the location of the survey. In particular, the district of Ba Tri in the province of Ben Tre is faced with progressive salinity of its main waterway, the Mekong river, a clear slow-onset and long-term environmental event. The district of Ninh Hai in province of Ninh Thuan also experiences a long-term environmental event, however, in the form of regular droughts. In contrast, the district of Chau Phu in the province of An Giang due to its history of flooding serves as one of the testing grounds for short-term environmental events. Similarly, the district of Giao Thuy in the province of Nam Dinh is also characterized by short-term environmental events especially in the form of cyclones. See Table 1 for an overview of the different districts where the survey was conducted.

Table 1 about here

Within the four districts, three communes were again randomly chosen using a grid system in which the interviews of the non-migrants took place. More precisely, in each of the 12 communes (i.e. three communes in four districts) 50 households were randomly chosen by using

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<sup>5</sup> Several studies have also indicated that Vietnam is amongst the countries with the potential to be the most severely impacted by climate change (MRC 2009; Dasgupta et al. 2007).

a grid system with random starting points. Hence 150 non-migrants were interviewed in each of the four districts.

In contrast, random sampling of migrants is hardly possible since by definition they do not live in the same commune anymore. Furthermore, in the locations they have migrated to, they are “hidden” since we cannot know whether a specific person has migrated from the relevant areas. Hence we had to rely on snowballing or chain-referral<sup>6</sup> to find individuals who came from the exact same locations as the non-migrants but who now live in the nearest major city (Ho-Chi-Minh-City in the case of the three districts of Ba Tri, Chau Phu and Ninh Hai, and Hanoi in the case of Giao Thuy). 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 experienced the same environmental event(s) and 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.

To illustrate the congruence of the migrants’ previous location with the non-migrant population, we use GPS coordinates to plot their respective locations on a map of Vietnam (Figure 1). The blue color indicates the original locations of the migrants and the turquoise the places in which the non-migrants live. The map clearly shows the high congruence of the two types of locations providing strong confidence that the original locations of the migrants – and along with it the environmental factors – were identical to those of the non-migrants.

Figure 1 about here

All interviews were personal interviews consisting of both closed and open-ended questions lasting for about 30 minutes. We asked all individuals about their experience with the latest

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<sup>6</sup> This sampling method is frequently used in sociological studies of such hidden populations (Laczko & Aghazarm 2009).



environmental event as well certain important personal information such as age, profession or education levels. Parts of the two questionnaires relevant to this study can be found in the Appendix.

### *3.1. Operationalization of variables*

Our dependent variable measures a person's decision to migrate. It takes on the value 1 for those individuals who migrated and the value 0 for those who did not.

For our two main independent variables covering environmental stressors, sudden and short-term environmental versus slow-onset and long-term environmental events, we relied on a question asking respondents to describe the main weather event(s) they had experienced during the past five years. Both migrants and non-migrants answered this particular question. Respondents could choose between several weather events such as heavy rain/storm/flood or drought/desertification/salinity but could also list any other weather event that was not listed or were able to state that no weather events have occurred lately. If individuals mentioned that they experienced heavy rain, flood, hail, storm, cyclone, typhoon, and/or landslide/ mudslide, we coded this due to the short-term nature of the event as sudden and short-term environmental stressor. In contrast, we coded any mentioning of salinity, drought or desertification as slow-onset and long-term environmental stressor. Due to their long-term nature, we expect these latter environmental events to lead to more adaption and thus to a lower likelihood of migration while we expect the short-term environmental events to lead to an increased likelihood of migration.

In addition, we incorporate several control variables in our model that are typical in the study of individual level migration choices. Information for all of the variables comes from the survey. First, we include a respondent's gender and age since women as well as older individuals are less likely to migrate all else equal. Following recent explanatory models of migration networks, we include a dummy variable capturing whether another family member has migrated.

These models emphasize that migration decisions are taken in a broader socio-economic context. Such networks by sharply reducing the costs and risks associated with migration increase the likelihood that relatives and friends will follow once the first migrant has settled in her/his destination (Massey et al. 1993; Massey 1990).

Furthermore to control whether economic problems drove the migrants' decision rather than environmental stressors, we rely on four different proxy variables based on four different questions from our survey, which we use in the four different models displayed below. First, we rely on 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 many categories (e.g. social, political, environmental, or economic reasons). For all respondents who stated that economic reasons contributed to their decision to migrate, we coded the variable "*economic reason*" as 1 and for all other respondents as 0. 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 because of economic reasons, the variable "*economic reason*" takes the value of 1 and for all other respondents 0. However, since this self-assessment might be problematic as individuals might want to over- or understate the relevance of certain factors due to personal reasons (e.g. non-migrants might not want to admit that economically they are not doing well), we use three other variables as additional proxies for the economic reasons of migration.

As the second proxy, we rely on the interviewers' classification of the respondent's economic household status. In particular, interviewers, based on a predetermined household status scale, classified whether a household is economically below average, average or above average. We include two dummy variables – below and above average – in our second model below while those individuals with average economic status serve as the baseline category.

Third, we rely on a respondent's profession to proxy his economic wellbeing. We include the following five professions in our model while individuals working in agriculture sector serve as 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. As our final variable to control for the economic reasons of migration, we include a respondent's level of education. In particular, we include 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. Those individuals with higher education levels serve as the baseline category.

Table 2 shows the descriptive statistics.

Table 2 about here

### *3.2. Results*

Since our dependent variable is binary we use logistic regression models to analyze how environmental variables relate to a respondent's decision to migrate. We cluster the standard errors by district to control for the fact that individuals from the same district might show more similar response patterns than individuals from different districts. Table 3 shows the results of four logistic regression models. Model 1 relies on the self-assessment of respondents as our first proxy for individual level economic wellbeing. Model 2 uses the classification of households' economic status as economic wellbeing variable while Model 3 includes the various professions and Model 4 the education variables.

Table 3 about here

In all models and in line with our theoretical argument, we find that sudden and short-term environmental weather events such as floods or typhoons significantly increase the likelihood that an individual opts for migration. This finding supports the idea that short-term environmental events have severe impacts on the wellbeing of individuals and affected individuals therefore migrate to other regions. In contrast, slow-onset and long-term environmental events do either not influence or significantly reduce the likelihood of migration. The finding is consistent with the argument set forth in the previous section of the paper, where we claim that people are unlikely to migrate in response to longer-term environmental stressors, such as droughts and water/land salinity, since adaptation and mitigation should be the preferred options. Hence we observe that environmental events can indeed act as stressors that motivate individuals to migrate. However, this only happens if individuals are faced with short-term environmental stressors.

Concerning the control variables, we find that female respondents and older respondents are less likely to migrate although the gender variable does not reach standard significance levels in most models. In contrast, if a family member has already migrated the average survey respondent is more likely to opt for migration, too. However, this effect is only significantly different from zero in the first model in which we use the economic self-assessment variable. This finding thus offers only limited support for the network perspective on migration. Interestingly, concerning a respondent's economic status it depends on the proxy used whether we see any effects. If we rely on the respondents' self-assessment to measure the economic reasons of migration, we do observe that economic reasons significantly increase the de-facto decision to migrate. In contrast, as shown in Model 2, the more objective classification of households into below average, average, and above average households does not significantly relate to the likelihood of migration. Model 3 shows, that relative to agricultural workers, who

serve as the baseline category, all other professions have a lower likelihood of migration. And finally, as Model 4 shows, education strongly matters for someone's decision to migrate. Relative to those individuals with a higher level of education, which serve as the baseline category in our model, individuals with lower levels of education are less likely to opt for migration. In light of potential opportunity costs, this finding suggests that well educated individuals could be more likely to opt for migration since their education level should allow them to more easily find jobs at a new location.

Since it is difficult to interpret the exact effect size in a logistic model, Figures 2 and 3 provide an illustration of what the results mean for our two main independent variables. Based on Model 1 and Model 4 respectively, we simulated predicted probabilities for the two environmental events following King et al. (2000). More precisely, Figure 2 shows the first difference estimates for the variables measuring sudden-onset as well as slow-onset environmental stressors based on the model that measures economic wellbeing with the self-assessment variable. Figure 3 shows the first difference estimates based on the model with the three education dummies. The dashed lines always signify 95 % confidence intervals and the solid line marks the zero-threshold.

Figure 2 and 3 about here

Figure 2 clearly shows that the presence of gradual environmental events does not significantly affect the likelihood of migration since the first difference crosses the zero-threshold. In contrast, the presence of sudden-onset environmental events increases the likelihood of migration by four percentage points. This does not look like a major effect, which is, however, mostly due to the overwhelming effect of the *economic\_reason* variable, which crowds out any other effects. This can be seen in relation to Figure 3, which shows the same picture but based on our estimates on

the model with the education variables. In this case, we observe a difference in the likelihood of migration of about 40 percentage points if a sudden environmental event is present. In contrast, the likelihood of migration decreases by about 18 percentage points if gradual environmental events take place. These effects are by far larger than those displayed in Figure 2, which highlights the importance of controlling for other migration related factors. Hence the exact size of the environmental variables is greatly dependent on model specification. While we always observe a significantly higher likelihood of migration in the presence of sudden-onset events, we estimate the size of this impact to be rather small if we include a respondents' self-assessment of the economic reasons that led to migration or rather large if we include her level of education instead. Since the economic self-assessment model might understate while the education model might overstate the effect because the first is probably giving too much weight to economic concerns and the second too little, the "real" effect size is most likely somewhere in between.

In summary, our results indicate that it is important to consider the specific context in which environmental stressors could, in principle, influence decisions to migrate. They show that environmental events do not necessarily force people to migrate. The prevailing option, when facing long-term environmental stress, is adaptation. Only when people are confronted with sudden-onset and short-term environmental events such as floods they are willing to accept the costs of migration.

#### **4. Conclusion**

Does environmental change cause migration? While research on the environment-migration nexus has been conducted for some time, the issue has become highly salient in the context of the climate change debate. We contribute to the existing literature by developing a theoretical argument that considers different types of environmental stressors and their likely effects on individuals' choice to migrate or stay. Empirically, our research adds to the existing literature in

at least two ways: we differentiate between two types of environmental stressors, by considering both sudden-onset and long term environmental events and we use original micro-level survey data from Vietnam for persons who migrated and for those who decided to stay.

The results suggest that sudden-onset environmental events, such as floods or typhoons, increase the likelihood that individuals opt to move whereas longer-term environmental problems, such as droughts or salinity, reduce the likelihood of migration. This result suggests that individuals tend to respond to long-term environmental events with adaptation, rather than migration, indicating that individuals are socially and economically bonded to their location.

The obvious limitation of our empirical findings is that they are limited to one country, namely Vietnam. Hence we view our contribution primarily as a conceptual and theoretical contribution, complemented by a first empirical plausibility check, however, with original and highly reliable data. While this limitation still allows for some meaningful insights, as shown in this paper, further research will have to focus on larger-scale primary data collection to compare several different countries. Furthermore, future research into the temporal dimension is also needed to determine the “threshold” by which environmental migration sets in when facing long-term degradation and which economic, political or institutional factors may best support and complement individual mitigation and adaptation strategies.

These data limitations notwithstanding, the policy implications of our theoretical argument and empirical findings are that a more differentiated perspective on the issue of environmental migration is urgently needed. It remains possible that abrupt and extreme climatic changes (or environmental changes more broadly) could force people to migrate permanently from some areas of the world, particularly from low-lying coastal areas in some developing countries. However, if the past provides any insights into what may happen in the future, our results suggest that depending on the type of environmental event people might prefer adaptation over migration. This finding appears to apply especially to slow-onset, longer-term environmental

events. The main implication is, therefore, that spectacular “climate refugee” scenarios (Laczko and Aghazarm 2009; Myers 1997, 2002) are probably exaggerated, and that financial and technical support for adaptation to environmental changes resulting from climate change or other causes is the most productive policy-option.



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*International Migration* 49 (s1), e69-e94.

**Table 1: Sampling Procedure**

<i>Province</i>	<i>District</i>	<i>Reason for Selection</i>	<i>Non-migrants</i>	<i>Migrants</i>
Ben Tre	Ba Tri	Progressive salinity of water	150	150 in Ho-Chi-Minh-City
An Giang	Chau Puh	Regular floods	150	150 in Ho-Chi-Minh-City
Ninh Thuan	Ninh Hai	Regular droughts	150	150 in Ho-Chi-Minh-City
Nam Dinh	Giao Thuy	Regular storms; Tropical cyclone Bebinca in June 2013	150	150 in Hanoi

**Table 2: Descriptive Statistics**

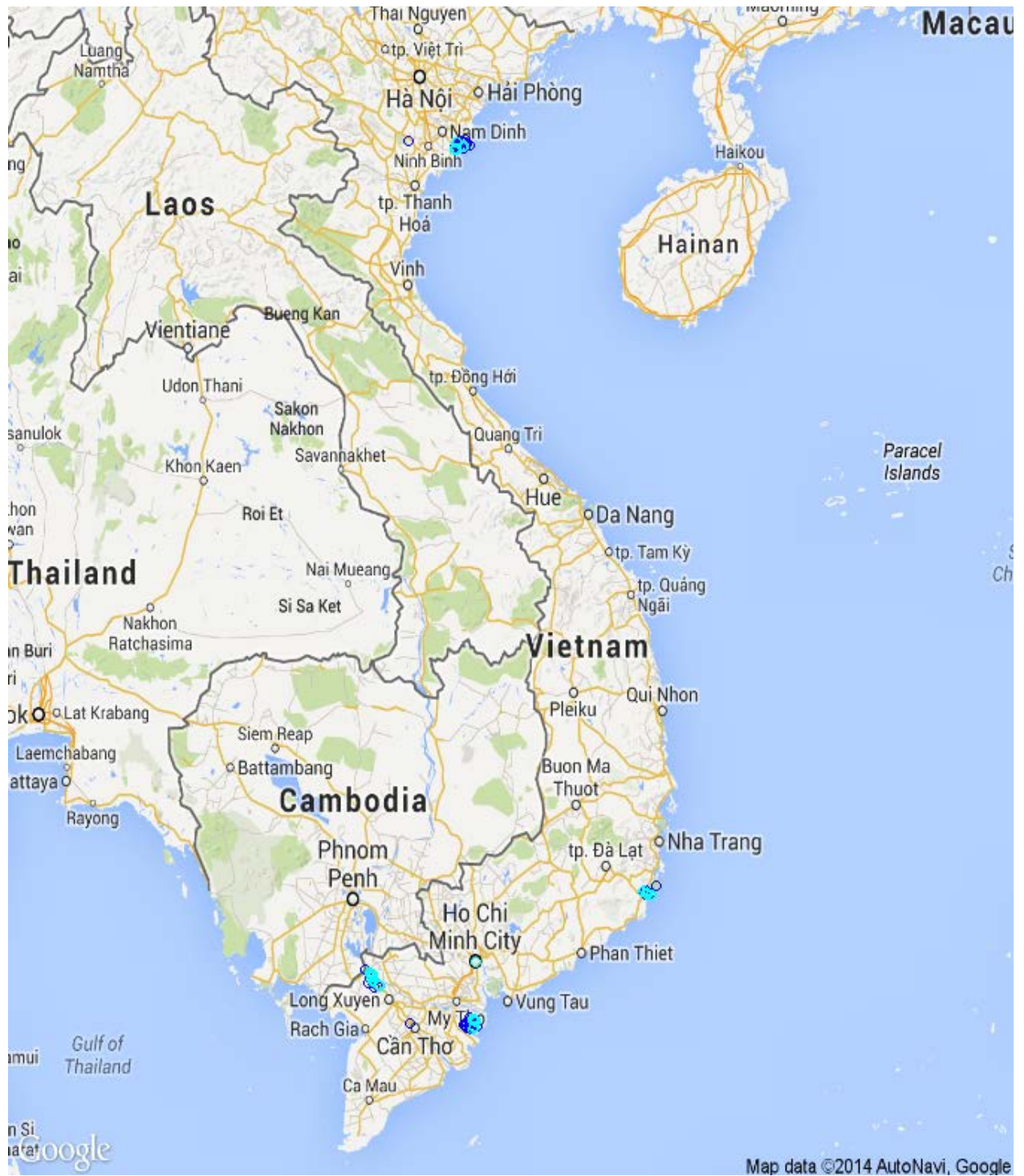
<i>Variable</i>	<i>Yes</i>	<i>No</i>	<i>N</i>
Migrants	600	600	1,200
Sudden events	982	218	1,200
Gradual events	352	848	1,200
Female	685	515	1,200
Family member has migrated	459	739	1,198
Household below average	300	479	779
Household above average	153	626	779
Economic reason	565	635	1,200
Farmers	618	582	1,200
Civil servants	63	1,137	1,200
Business Sales	237	963	1,200
Workers	125	1,075	1,200
Elementary occupation	151	1,049	1,200
Remittances	6	1,194	1,200
No education	21	1,179	1,200
Primary education	232	968	1,200
Secondary Education	642	558	1,200
Higher Education	303	897	1,200
Age	Min: 18 Max: 64	Mean: 34 Std. Dev. 12.04	1,200

**Table 3: Baseline Logistic Models**

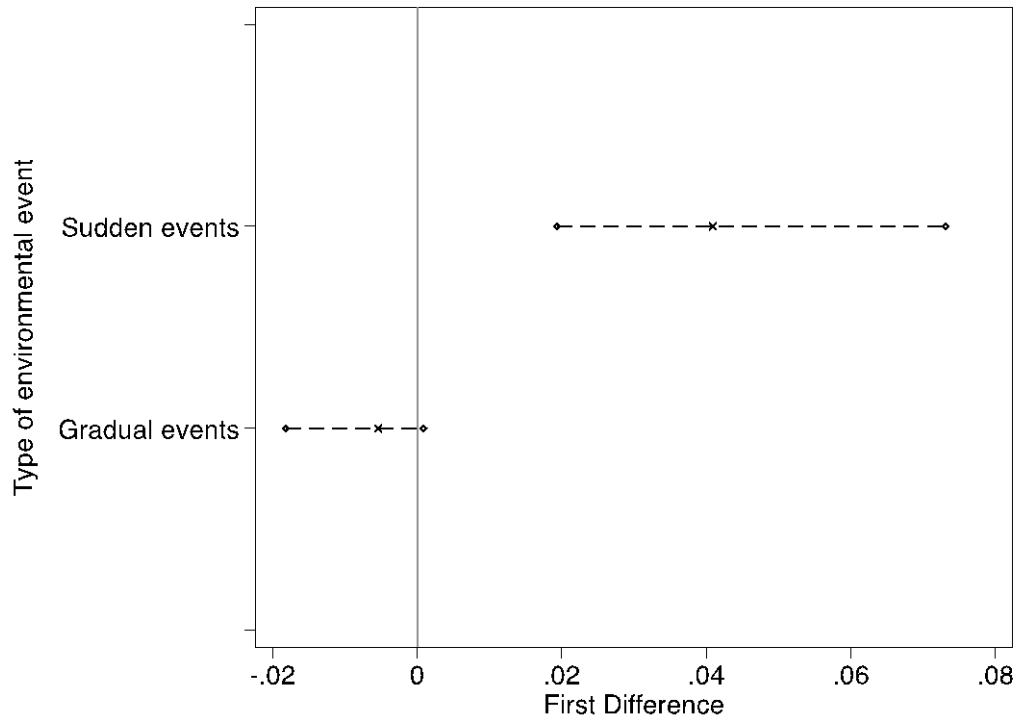
	(1)	(2)	(3)	(4)
Sudden events	1.67*** (0.229)	2.29*** (0.794)	1.89*** (0.637)	2.17*** (0.714)
Gradual events	-0.63 (0.528)	-0.55 (0.463)	-0.92*** (0.162)	-0.95*** (0.172)
Female	-0.30 (0.382)	-0.19 (0.228)	-0.35 (0.225)	-0.45*** (0.170)
Age	-0.16*** (0.019)	-0.09*** (0.016)	-0.10*** (0.010)	-0.13*** (0.012)
Family member has migrated	0.96* (0.545)	0.80 (0.857)	0.50 (0.720)	0.72 (0.649)
Economic Reason	7.12*** (0.869)			
Household below average		-0.68 (0.568)		
Household above average		0.12 (0.116)		
Civil servants			-0.40 (0.290)	
Business Sales			-0.52 (0.372)	
Workers			-1.88*** (0.303)	
Elementary occupation			-1.43*** (0.447)	
Remittances			-2.14 (1.626)	
No education				-1.78** (0.706)
Primary education				-2.52*** (0.927)
Secondary Education				-1.44*** (0.379)
Constant	1.05** (0.485)	0.15 (0.623)	3.21*** (0.325)	3.12*** (0.365)
Pseudo $R^2$	0.82	0.25	0.39	0.38
Log lik.	-146.76	-315.11	-505.89	-512.73
Observations	1,198	778	1,198	1,198

Robust standard errors in parentheses clustered by district; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

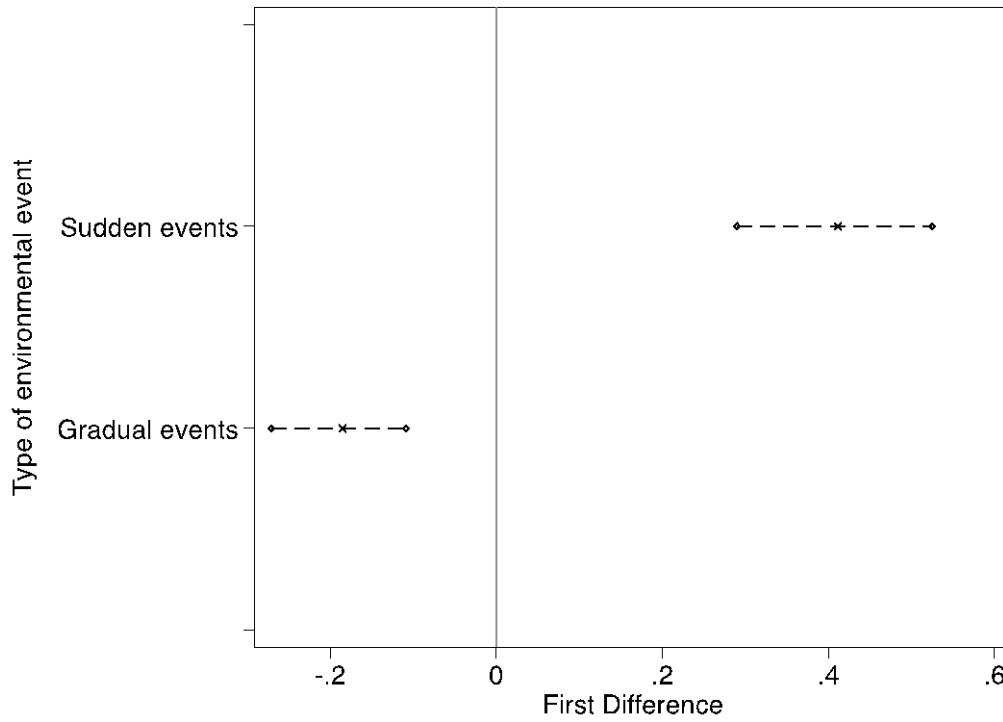
**Figure 1:** Locations of Non-Migrants and Migrants







**Figure 2:** First difference estimates calculated based on Model 1 in Table 3 using simulated parameter values (King et al. 2000). Estimate of first difference represented by x. Dashed lines signify 95 % confidence interval. Solid line marks 0-threshold



**Figure 3:** First difference estimates calculated based on Model 4 in Table 3 using simulated parameter values (King et al. 2000). Estimate of first difference represented by x. Dashed lines signify 95 % confidence interval. Solid line marks 0-threshold.

## Appendix

### Questionnaire

**Interview ID** \_\_\_\_\_ -- \_\_\_\_\_ -- \_\_\_\_\_  
**Date:** \_\_\_\_/\_\_\_\_/\_\_\_\_  
**Interviewer ID** \_\_\_\_\_

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

Coordinates: \_\_\_\_\_ Current Weather *[observed]*: \_\_\_\_\_  
Commune/Village/Town: \_\_\_\_\_ Number of households (HH) in  
District: \_\_\_\_\_ village/town: \_\_\_\_\_  
Province: \_\_\_\_\_

**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

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

1<sup>st</sup> \_\_\_\_\_  
2<sup>nd</sup> \_\_\_\_\_  
3<sup>rd</sup> \_\_\_\_\_

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]*

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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?

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