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Perceptions of environmental change and migration decisions

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Abstract While climate change is projected to increase displacement of people, knowledge on this issue remains limited and fragmented. In his paper we focus on the micro-level and study the effects of individual perceptions of different types of environmental events (i.e., sudden/short-term vs. slow-onset/long-term) on migration decisions. Our results based on newly collected micro-level survey data from Vietnam shows that while slow-onset environmental events, such as droughs, significantly decrease the likelihood of migration, short-term events, such as floods, are positively related to migration, although not in a statistically significant way. When contrasting individual level perceptions with actual climatic events we observe that migrants and non-migrants perceive both long-term as well as sudden-onset environmental events in different ways. While non-migrants are slightly better in judging the actual extremeness of events such as floods and hurricanes, it is the migrants who are slightly better in judging the actual extremeness in the case of droughts.

1 Introduction

Climate change is recognized as a global issue manifesting itself in temperature increases, changes in precipitation, sea level rise, and the intensification of natural hazards, such as storms (cyclones), floods, and droughts (IPCC 2014a). The Intergovernmental Panel on Climate Change, academics and policy-makers argue that climate changes could force tens of millions of people to move permanently or temporarily within their own countries or across borders (IDMC 2015; IPCC 2014a; Laczko and Aghazarm 2009; Myers 2002).

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The existing estimates of the number of 'environmental migrants',[1] however, have been heavily criticized. It is argued that they tend to be overestimated because they are usually based on the number of people exposed to increasing risks, and not on the number of people actually expected to migrate. Furthermore, these estimates typically do not account for adaptation strategies and different levels of vulnerability to environmental change (Adger et al. 2015; McLeman 2014; Gemenne 2011; Black et al. 2011a, b; Foresight 2011; Kniveton et al. 2008). Consequently, such estimates fail to adequately acknowledge the effects of individual level characteristics as well as socioeconomic and political factors on migration behavior and hence they have not successfully isolated the environmental influences from the multitude of factors that influence migration (e.g., Adger et al. 2015; Hunter et al. 2015; McLeman 2014; Black et al. 2011a, b; Foresight 2011).

In this paper we aim at contributing towards filling this gap by exploring the link between *perceptions* of environmental change and migration decisions.[2] In particular, we examine whether individual perceptions of different types of environmental events -notably sudden vs. slow-onset environmental events- affect decisions to migrate or stay. This distinction "is useful in terms of both aiding understanding [*environmental migration*], as well as identifying key policy implications" (Black et al. 2011a: 437). In addition, we are interested in exploring whether there exists any systematic difference in the way migrants and non-migrants perceive different types of environmental events.

We contribute to the recent literature which examines the environment-migration nexus in Asian countries using survey data (e.g., Bohra-Mishra et al. 2014 (Indonesia); Mueller et al. 2014 (Pakistan); Bylander 2013 (Cambodia); Penning-Rowsell et al. 2013 (Bangladesh); Gray and Mueller 2012 (Bangladesh); Dun 2011(Vietnam); Massey et al. 2010 (Nepal)).[3] These studies although offer interesting insights into the complex relationship between environmental change and migration, they tend to report mixed results: while several scholars report that environmental changes lead to migration (i.e., Mueller et al. 2014; Dun 2011; Massey et al. 2010), others suggest that they may not have a significant effect on migration (Bohra-Mishra et al. 2014; Gray and Mueller 2012). Hence earlier findings are hard to generalize (Adger et al. 2015; Hunter et al. 2015; Black et al. 2011a, b).

In order to empirically investigate the relationship between environmental change and migration decisions we designed and conducted a new survey to collect both migration and environmental data in Vietnam. In a second step, we contrast the perceptions of environmental change and in particular perceptions of different types of environmental events as assessed by our survey respondents with actual climatic data using the Standard Precipitation Index (SPE) and the Standard Precipitation-Evapotranspiration Index (SPEI) for the corresponding location and time frames as indicated by both migrants and non-migrants.

[1] 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.

[2] While there exists research that shows that environmental change can lead to international migration (Nawrotzki et al. 2015a; Nawrotzki et al. 2013; Gray and Bilsborrow 2013), in this paper, we focus on internal migration because there is strong consensus in the literature that most migration flows associated with environmental factors are of an internal nature (Hunter et al. 2015: 3; Foresight 2011).

[3] For a much larger review of the existing literature, see: Foresight Migration and Global Environmental Change (2011). For a literature review on the modeling of environmental migration, see McLeman (2012) and Piguet (2010).

2 Environmental perceptions and migration decisions

One of the research frontiers in the environmental migration literature is to directly investigate migration decisions by focusing on the motives underlying individuals' decision to stay or migrate. A theoretical starting point to analyze migration decision-making is the neoclassical microeconomic theory, which argues that migration is an individual choice whereby the rational actor is motivated to move in order to maximize his or her future welfare (Harris and Todaro 1970; Todaro 1969). In contrast, the new household economic theory places migration decisions within the context of the household and contends that migration decisions are rarely made by individual actors but rather by families and households (Stark and Bloom 1985; Massey 1990a, b). These two dominant migration theories therefore contrast with respect to their perspective on whether an individual's decision to migrate is based on what is "best for one's own future" or whether the decision is based on returns for the family or the household as a whole. However, both of these theories do not explicitly consider environmental conditions as a factor that could be crucial for migration decisions even though environmental events such as floods and droughts, can act as 'stressors' that should motivate individuals to consider migration to places with better environmental attributes as a response (Adger et al. 2015; Hunter et al. 2015; Bardsley and Hugo 2010).[4]

More precisely, we argue that migration decisions are affected by *perceptions* of environmental change, rather than environmental change as objectively identified using scientific evidence (Dessai et al. 2004). As such, perceptions of risk can act as a "mediating factor" between environmental stress and migration (Hunter et al. 2015; Black et al. 2011a, b; Meze-Hausken 2008). The reason is that environmental perception is the means by which individuals seek to understand their environment in order to arrive at the most effective response to environmental hazards given their individual and household level circumstances. For instance, environmental perception is important in adaptation as it determines decisions in agricultural planning by helping farmers to adjust their crop planting patterns to the forthcoming rains or to store their crop production to deal with an anticipated drought (Slegers 2008). Environmental perception contains both direct experience with environmental events (storms, floods and droughts) and indirect information from other people, government agencies, scientists, the mass media, and also fellow community members. In turn, both direct experience and indirect information are mediated by individual –and household- abilities, values, roles, and attitudes. Consequently, perceptions of environmental change should not only depend on a respective individual's exposure to environmental events but also on his/her adaptive capacity, i.e., the possibilities and opportunities to cope with environmental change. Hence relying on perceptions of environmental change allows explaining why some people decide to leave their homes when experiencing environmental stressors, while others do not (Hunter et al. 2015; Black et al. 2013; 2011a; Bardsley and Hugo 2010; Mortreux and Barnett 2009).

[4] Furthermore, the decision whether to migrate or to stay and adapt in the presence of environmental change should not depend on whether this decision is taken by an individual or as a household strategy. As we argue below certain environmental events, such as hurricanes, should be so severe that adaption is hardly possible. Other events, such as droughts, should allow for adaption and existing bonds to individuals' original location should keep both individuals and their entire household at their current location. Having said that we acknowledge the possibility that in the context of these slow-onset events households might want to send individual members to other locations to increase/supplement their family income. In our data, however, this phenomenon does not seem to play a crucial role.

In addition to focusing on environmental perceptions, we emphasis the distinction between *sudden (short-term)* and *slow-onset, gradual (long-term)* environmental events (see also Koubi et al. 2016; McLeman 2014; Black et al. 2013; 2011a, b; Renaud et al. 2011). While both types of environmental events have the potential to cause casualties and extensive property and infrastructure destruction, sudden environmental events such as storms and floods are more likely to produce the greatest behavioral response because they are above the perceptual threshold of direct human experience and are easily recognizable as extreme events (Loewenstein et al. 2001; see also Meze-Hausken 2004). Loewenstein et al. (2001), for instance, state that responses to risks tend to be strongly related to newness and as a result individuals tend to overreact to new risks (often low-probability events) and underreact to those that are familiar (though they may be much more likely to occur). In addition, such events tend to be more memorable because they are clearly defined in both space and time, and their physical processes are more dramatic and their impacts on individuals' well-being are more direct and understood.

In contrast, slow-onset environmental problems, such as droughts, desertification, or water/land salinity, are not usually regarded as extreme enough to be significant, even when individuals recognize their short-term seasonal and/or annual variability, because these events are likely to have a smaller immediate impact on the well-being of individuals (Findley 1994; Mortreux and Barnett 2009; Van der Geest and de Jeu 2008). In addition, this type of environmental events, because they build up rather slowly, tend to have more blurred edges and hence they are less well defined and less likely to be remembered as parts in a larger category of events, say a drought.

Consequently, to the extent that migration decisions are influenced by environmental change, perceptions of sudden environmental events relative to perceptions of slow-onset/prolong ones should be more likely to affect migration decisions. Furthermore, migrants and non-migrants should significantly differ in their assessment of the two types of environmental events. Whereas both groups should not vary to a significant degree in their perception of slow-onset events, migrants' perception of sudden events should be more extreme. With regard to slow-onset events, both groups should have difficulties assessing the severity of the event due to its slow-evolving, i.e. creeping, character, resulting in an underestimation of these events. In contrast, if sudden-onset environmental events were to have an impact on migration, they need to be perceived as more intense by the migrant group. Hence we do not only expect a differentiated impact of slow-onset vs. sudden events on individuals' decision to migrate but also on how individuals perceive these types of events.

3 The case study

3.1 Vietnam

In our analysis we focus on Vietnam because it has been identified as being among the countries which will be most heavily affected by climate change mainly due to a) its long coastlines (3200 km) and the large deltas - which make it particularly susceptible to more intense and frequent natural disasters, rising sea levels, coastal erosion, and salt water intrusion; b) the high population density and the concentration of economic activity in coastal areas; and c) a heavy reliance on agriculture, fishery and forestry (IPCC 2014b). For instance, of the 84 coastal developing countries investigated in a World Bank study in terms of sea level rise, Vietnam ranks first in terms of climate impact on population, GDP, urban extent, and wetland areas, and

ranks second in terms of impact on land area (behind the Bahamas) and agriculture (behind Egypt) (Dasgupta et al. 2009). The Red River Delta and Quang Ninh province, the North Central Coast, South Central Coast and the Mekong River Delta were identified as the most vulnerable areas. Moreover, the country is already experiencing changes in fundamental climatic elements as well as extreme weather events such as storms, heavy rains, and droughts. In 2013, the year the survey was conducted, Vietnam experienced an unusually high number of natural disasters, including 15 intense typhoons followed by intensive rains, which caused 313 deaths and heavy damages on properties and infrastructure in several provinces. The total value of damage caused by natural disasters in 2013 was estimated to be around 30 trillion dong,[5] twice the 2012 cost (General Statistics Office of Vietnam 2013).

3.2 The fieldwork

Based on information obtained from the EM-DAT/OFDA/CRED International Disaster Database (Guha-Sapir et al. 2016) and archive research, we first identified four provinces in Vietnam that are mainly characterized by one particular environmental event, which can be classified either as slow-onset/long-term or sudden-onset/short-term environmental event, and are also considered to be vulnerable to climatic changes. Then one district in each of these four provinces was randomly chosen for the location of the individual level surveys. In particular the surveys were carried out in the following districts: *Ba Tri* (Ben Tre province in the Mekong River Delta) experiences progressive salinity of its main waterway, the Mekong river, a clear slow-onset and long-term environmental event; *Ninh Hai* (Ninh Thuan province in South Central Coast) also experiences a long-term environmental event, however, in the form of regular droughts; *Chau Phu* (An Giang province in the Mekong River Delta) experiences regular floods and hence it serves as one of the testing grounds for short-term environmental events; similarly *Giao Thuy* (Nam Dinh provience in the Red River Delta) is also characterized by short-term environmental events especially in the form of cyclones. In addition, within the four districts, three communes were again randomly chosen using a grid system in which the interviews of the non-migrants took place. In particular, while we sampled households, we ultimately interviewed only one member per household aged 18 to 64 and asked questions, which were related to the particular individual as well as to the household. Hence our approach of analysis while centering on the individual allows us to incorporate important household level factors, for example whether a household member had already migrated.

In contrast, since by definition migrants do not live in the same commune any longer and are considered to be 'hidden' in their new location, i.e., we cannot know whether a specific person has migrated from the relevant areas, random sampling is hardly possible. Hence we relied on snowballing or chain-referral[6] to find individuals who came from the 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 and already interviewed migrants whether they knew of any individual(s) who had left their commune or district 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. The surveys were

[5] This corresponds to about one billion Euro.

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

conducted in September and October 2013, producing 1200 completed questionnaires in total of which 600 came from migrants.[7]

4 Perceptions of environmental events and migration decisions

The first step in our analysis consists of modeling individual level migration decisions as a function of the perception of slow-onset and sudden environmental events based on information retrieved from the survey questionnaires. Due to the binary nature of our dependent variable, migration yes or no, we use logistic regression models to analyze our data (Greene William 2003). Our two main independent variables – slow-onset vs. sudden environmental events – were coded based on respondents' recollection of their perceived environmental events within the last five years for the non-migrants and within the last five years before they left their previous homes in the case of the migrants. We coded the variable slow-onset events with 1 if respondents mentioned salinity, drought, or desertification. If they instead mentioned heavy rain, storm, flood, hail/snow, hurricane, cyclone, typhoon, and/or landslide/mudslide, we coded this event as sudden and short-term environmental change.

In addition, we control for various socio-economic factors that were found to be important drivers of migration decision in previous research. More precisely, we control for the gender and the age of the individual and his or her level of education. The expectation is that female as well as older individuals are typically less likely to migrate and educated people more likely to do so (Hunter et al. 2015). To control for migration networks (Schapendonk 2015), we asked respondents whether a member of the same household or the extended family has already migrated (in the case of migrants we asked whether someone had migrated before they have left their former locations). Such social networks are typically argued to increase the likelihood of migration by reducing the costs and risks associated with this process (Hunter et al. 2015). However, other research has shown that strong social networks may also reduce the probability of a climate-related move (Nawrotzki et al. 2015b).

We also control for other potential reasons of migration. To this end we include a variable capturing whether a migrant mentioned economic, i.e. income-related reasons, social factors, e.g. family networks, discrimination or social exclusion, or political motives, such as conflict or governmental repression, as reasons for his or her migration decision. For the non-migrants, we asked them whether they ever thought about migrating and if so which reasons, e.g. economic, social or political, were relevant.[8]

4.1 Results

The findings displayed in Table 1 suggest that short-term, sudden-onset environmental events, such as storms or floods, increase the likelihood of migration.[9] This finding confirms Dun's

[7] The response rate for the non-migrants was 76.6 % (783 contacted, 600 interviewed) and for the migrants 65.43 % (917 contacted, 600 interviewed). It is important to note that we do not look at forced migration.

[8] In the Appendix to this paper we provide further regression models including other variables, for example a respondents' profession. Furthermore, we show that our results are robust to excluding those migrants who did not migrate within the last five years but before, which might induce the so-called recall bias. We also show that our results are robust to controlling for the time since an individual has left her former location.

[9] Since two respondents did not answer the question whether a household member has already migrated our estimations are based on 1198 observations instead of 1200.

Table 1 Results of the logistic regression model

	(1)	(2)	(3)	(4)
Sudden events	1.891**	1.176***	0.928	0.928
	(0.637)	(0.093)	(0.698)	(0.698)
Gradual events	-0.917***	-0.574	-1.826^{+}	-1.826^{+}
	(0.162)	(0.604)	(1.038)	(1.038)
female	-0.354	-0.189	-0.706*	-0.706*
	(0.225)	(0.515)	(0.283)	(0.283)
Age	-0.097***	-0.110***	-0.069*	-0.069*
	(0.010)	(0.013)	(0.033)	(0.033)
Household member migrated	0.498	0.701	0.755	0.755
	(0.720)	(0.755)	(1.178)	(1.178)
Economic reasons		7.434***	9.863***	9.861***
		(0.858)	(1.880)	(1.882)
Social reasons			8.993***	8.991***
			(1.897)	(1.897)
Political reasons				-2.331***
				(0.626)
No education	-1.777*	-4.446***	-3.721**	-3.720**
	(0.706)	(1.222)	(1.099)	(1.099)
Primary education	-2.516**	-3.309***	-2.909^{+}	-2.908^{+}
	(0.927)	(0.950)	(1.497)	(1.498)
Secondary education	-1.443***	-2.646***	-2.058**	-2.057**
	(0.379)	(0.416)	(0.665)	(0.666)
Constant	3.211***	1.805**	-2.629***	-2.628***
	(0.325)	(0.552)	(0.679)	(0.679)
Observations	1198	1198	1198	1198

Robust standard errors in parentheses clustered on commune level

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.5$, $^{+}$ $p < 0.1$

(2011) result that regular flooding of the Mekong Delta can trigger independent household or individual migration decisions. However, the coefficient of sudden events is only statistically significant on a conventional level if we do not control for other motives of migration. As soon as we include whether a respondent mentioned economic, social or political factors as driving his/her decision to migrate the coefficient, although it stays positive, turns insignificant. This indicates that potential economic and/or social reasons for migration seem to outweigh the significance of perceived short-term environmental events.

In contrast, long-term, gradual environmental events, such as droughts or salinity, independent of the other control variables in the model are associated with a lower likelihood of migration. This finding is in line with our argumentation above that these sorts of environmental events due to their slow-evolving, i.e. creeping, nature allow people to adapt and thus do not necessarily compel people to leave their homes. This is not to say that affected individuals never migrate in the presence of slow-onset events, such as droughts. However, on average these events allow individuals to adapt, which clearly sets these environmental events apart from the sudden-onset ones.

With respect to the control variables, we observe that while older individuals are significantly less likely to migrate, gender and whether a household member has already migrated do not have a significant effect. Individuals with lower levels of education, in contrast to the baseline category of individuals with tertiary education, which is not included in the model, are less likely to migrate. Finally, both social and economic reasons significantly increase the likelihood of migration whereas political reasons do not.

5 Perceptions of environmental change and their relation to actual environmental data

In the second step of our analysis we now turn to the question of whether migrants and non-migrants differ with respect to their perception of environmental events. To this end, we compare the mentioned environmental events with actual climatic conditions at this point in time.

Each respondent answered the question if he/she experienced an extreme flood, hurricane (sudden onset events) and/or a drought event (slow onset event) and when this event occurred. While the non-migrants where asked, if and when they experienced such an event within the last five years before the interview took place, the migrants were asked if and when they experienced such an event within the five years before they moved. So, for each individual an objective measure of the extremeness of the years mentioned can be extracted from the data described below as the current and former locations of the questionnaire participants are known.[10] Thus by calculating an objective measure for the specified events, we can analyze if these events were indeed extreme or just perceived as extreme and explore the differences between migrants and non-migrants. Individuals who did not experience any extreme event, or did not remember the year of the event were not considered. Table 2 shows the numbers of the individuals who experienced extreme events and did not remember the year of the event.

5.1 Climatic data and measures of extremeness

5.1.1 Hurricanes and floods

Hurricanes and floods are both related with extreme precipitation. Accordingly, we use a measure of precipitation to identify the severity of the years mentioned by the individuals. On the basis of the GCOS GPCC FDP version7 precipitation dataset of the World Climate Research Programme (Becker et al. 2013), which is available in a spatial resolution of 0.5 degree, we calculated the monthly Standardized Precipitation Index (SPI) (McKee et al. 1993, 1995). The SPI is a widely used precipitation index describing the number of standard deviations that the (in our case monthly) precipitation sum deviates from the climatological average. The SPI was calculated for the period from January 1961 until December 2013. To further illustrate, for example, the SPI for April 2013 was calculated as the number of standard deviations the sum of this April's precipitation deviates from the average sum for all April months from 1961 to 2013. Hence while positive values indicate wetter than normal conditions, negative values indicate drier than normal conditions.

[10] We used GPS coordinates to map interviewees' present and former location.

Table 2 Number of migrants/non-migrants (out of 600 individuals each) who according to the answers from the questionnaire experienced extreme events and did not remember the year of the event

	Migrants	Non-migrants	Total out of 1200 individuals
Experienced flood (#)	465	93	558
Not remembered year (#)	44	13	57
Not remembered year (%)	9.5	14	
Experienced hurricane (#)	373	184	557
Not remembered year (#)	30	1	31
Not remembered year (%)	8	0.5	
Experienced drought	73	230	303
Not remembered year (#)	5	192	197
Not remembered year (%)	6.8	83.5	

Since our respondents only mentioned years and not months, we selected the monthly value with the most positive, i.e. extreme, SPI value, for each respective year mentioned by the migrants/non-migrants. Thus for example if a migrant mentioned a flood in the year 2011 we selected the month with the highest 2011 SPI value.

5.1.2 Droughts

In contrast to floods, droughts are not only a function of precipitation. In addition, evapotranspiration plays a major role in their generation. Moreover, droughts are usually long-term events, which can last for several months. Therefore, instead of using the monthly SPI, we applied the 3-monthly Standardized Precipitation-Evapotranspiration Index (SPEI) (Vicente-Serrano et al. 2010). Based on a temperature-based method, potential evapotranspiration is calculated and subtracted from the precipitation sum. Similar to the SPI, these values are then normalized and positive values indicate wetter than normal conditions and negative values indicate drier than normal conditions. We use the SPEI dataset provided by http://sac.csic.es/spei/database.html, which is calculated on the basis of the GCOS GPCC precipitation dataset and the CRU TS 3.23 temperature dataset (Harris and Jones 2015). The SPEI data is available in 0.5 degree resolution and was calibrated for the period between January 1950 and December 2010.

5.1.3 Results

The findings displayed in Table 2 and Fig. 1 show clear differences in how migrants and non-migrants experience different types of environmental events. First differences already become apparent when looking at the total number of experienced events and how many events respondents remember. According to the survey data, migrants experienced in general much more sudden events (floods and hurricanes) than non-migrants. However, when comparing the mentioned events with actual climatic conditions, non-migrants are slightly better in judging the actual extremeness of the events as expressed by the higher median value (positive values indicate wet conditions) and in general smaller variability. It seems that the migrants already perceive fairly normal or even dry years as extremely wet. So it is likely, given that migrants and non-migrants where living in the same areas, that both experienced the same amount of

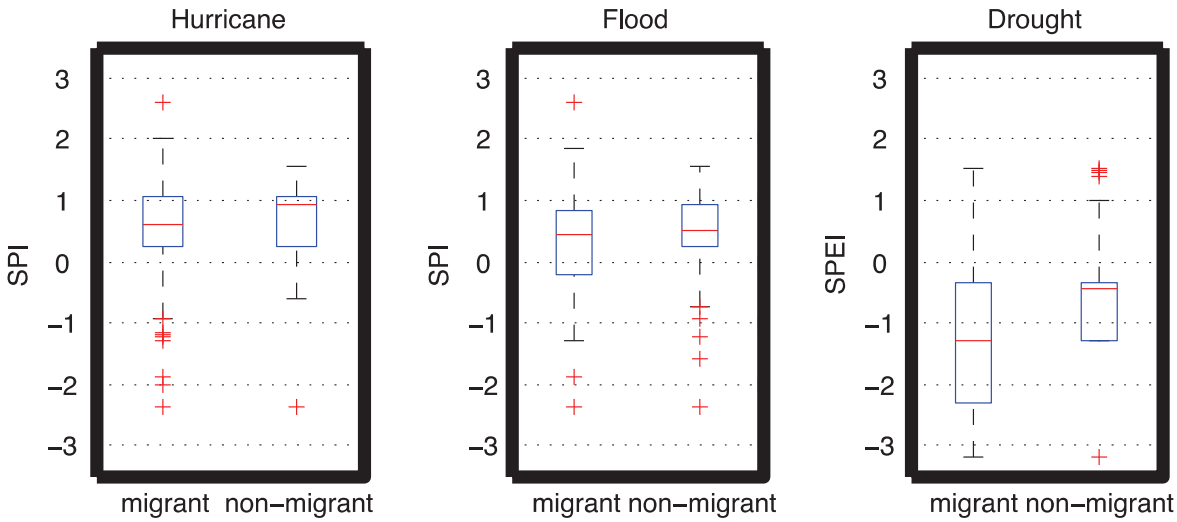

Fig. 1 Magnitude of the events mentioned by the respondents

actual extreme sudden events but migrants perceived already fairly normal climatic conditions as extreme, which would explain the higher number of experienced sudden events. One potential explanation for this finding could be the profession of the migrants. A larger fraction of the migrants was working in the agricultural sector before migrating, 62.5 %, compared to the non-migrants, 40.5 %. Accordingly, migrants were potentially more vulnerable to sudden climatic events since it is hard to adapt both given the nature of sudden events and their work in the agricultural sector (Nawrotzki and Bakhtsiyarava 2016).

In contrast, if we look at droughts non-migrants experienced much more of these events. However, the majority of the non-migrants (83.5 %) were not able to remember the year of these events. In addition, non-migrants also have greater difficulties in judging the extremeness of the mentioned droughts. This becomes apparent by the SPEI values, which have only a slightly negative median value (negative values indicate dry conditions) in the case of the non-migrants. One explanation for this pattern might again have to do with the profession of the non-migrants. Since fewer of the non-migrants depend on agriculture they might have been less affected by droughts and therefore did not remember the year of the events they experienced. On the other hand, for those individuals working in the agricultural sector, they might well remember the year of the last drought although they might have been able to cope and adapt to that event, for example by using irrigation. In contrast, as discussed above, hurricanes and floods should strongly affect daily life even if a person is not a farmer and thus they will result in more correctly remembered years.

6 Conclusion

In this paper we examine whether and how *perceptions* of different types of environmental events affect migration decisions. Our empirical results based on survey data from Vietnam show that individuals do not seem to migrate due to slow-onset environmental events, this type of events rather seem to decrease the likelihood of migration. In contrast, short-term events, such as floods or hurricanes, are associated with an increased likelihood of migration, although not in a statistically significant way.

In addition, we find that migrants and non-migrants perceive both long-term as well as sudden-onset environmental events in rather different ways. Non-migrants are slightly better in

judging the actual extremeness of events such as floods and hurricanes, which implies that migrants already perceive even regular years as extreme events. In contrast, non-migrants tend to underestimate the actual extremeness in the case of droughts, which implies that migrants tend to better remember years with extreme drought conditions. This finding could explain why drought conditions are in the case of our dataset associated with a decrease in the likelihood of migration. That said, the possibility exists that drought by depleting resources could lead to 'trapped populations', that is, populations, which, despite their vulnerability to environmental stress, still are unable to move due to lack of resources (Black and Collyer 2014). Especially where slow onset environmental change occurs, poor individuals, e.g., day laborers and temporary workers may become 'trapped' because they cannot diversify their livelihoods, or they do not have the resources and capacity to migrate. In this case, the total number of future potential environmental migrants could potentially be higher than our analysis would suggest.

While our paper offers an innovative way of understanding the relationship between environmental change and migration, it represents only a partial picture of the potential climate impacts within Vietnam because of the lack of time series data and potential interaction effects. However, we believe that the combination of environmental data with data on individuals' characteristics and their perceptions of environmental change can help shape understanding of potential future climatic impacts on migration decisions. Such understanding could be useful in generating adaptation policies and programs in the face of global environmental change.

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