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Climate change and migration decisions: A choice experiment from the Mekong Delta, Vietnam.

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Abstract

Forecasting the impact of climate change on migration is difficult, given widespread reliance on historical data and limited exposure to actual climate change amongst target populations. This study takes a different approach, developing a new methodology that employs a choice experiment to examine intentions to migrate among farmers living in the Vietnamese Mekong Delta, one of the areas in the world most significantly affected by climate change. The respondents are asked to make migration choices for scenarios constructed using six attributes: drought intensity, flood frequency, income change from migration, migration networks, neighbors' choices, and crop choice restriction. The results suggest that increasing the intensity/frequency of drought/flood increases the likelihood of migration; the effects are stronger for individuals with prior experience of climate change. Furthermore, the contribution of network attribute is gendered and dependent on migration experience. Finally, crop choice restriction, such as those widely employed by the Vietnamese government to control rice planting, may trigger a higher probability of migration. These findings provide insights into the debate on climate change-migration nexus in rural and lowland areas that are seriously affected by climate change. Furthermore, extensive choice experiment data on migration preferences under a diverse range of climate variabilities facilitates projections of environmentally induced migration.

Keywords: Climate change; migration; choice experiment; drought and saline intrusion; flood; Vietnam; Mekong Rivers

JEL codes: C35; D9; R23; Q51

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1 Introduction

In many parts of the world, increasing climate variability and the intensity and/or frequency of natural hazards is prompting part of the population in high-risk areas to consider migration. Farmers in poor and highly vulnerable regions tend to be the most affected group because their main livelihood is sensitive to climate conditions, and poverty can magnify the impact of climate change. Perhaps not surprisingly, therefore, over the last two decades, growing evidence has been found of the correlation between climate change and migration (e.g. Barrios, Bertinelli, & Strobl, 2006; Black, Adger, et al., 2011; Gray & Bilsborrow, 2013; Gray & Mueller, 2012a, 2012b). Most existing studies have used historical data related to climate change experiences and migration departures, drawn from surveys and/or environmental datasets, to identify environmental influences on decision to migrate (e.g. Bhatta et al., 2016; Jha et al., 2018; Koubi et al., 2016; Murali & Afifi, 2014). The use of such historical data has two major shortcomings. First, historical data captures only limited information of environmental evolution and migration experience (Piguet, Pécoud, & De Guchteneire, 2011), especially for subjects who have limited exposure to climate change. As a result, researchers can investigate the possible causal relationship between a specific set of phenomena and population movement, but they cannot easily observe the mechanism by which climate change influences migration decisions. Therefore, very few studies have analyzed the effect of increases in the frequency and intensity of natural disasters on migration in the current literature (Cattaneo et al., 2019). This gives rise to considerable uncertainty concerning future migration flows in the study of climate change and migration (Cattaneo et al., 2019), since inferences from limited and unvarying events in the past may not be extrapolated to the dynamics of environmental change in the future.

Second, it is difficult to establish causation using historical data. An important criterion for establishing causality is that the cause must temporally precede the effect (Fussell, Hunter, & Gray, 2014). In many cases, historical data collected during a period may not guarantee this temporal order because the timing of a migratory event varies across households, and climate change phenomena can take place in a more complicated manner than a single incident. Moreover, households may migrate because of anticipated changes in the future. It is particularly difficult to establish causality when investigating the effects of multiple or slow-onset climate change events, because they occur over a long period and their effect on the population is gradual. One possible solution is to use retrospective survey questions that specify the timing of migratory and climate change events. However, this method of data collection may present problems of recall bias concerning details far in the past. Another solution is to employ a longitudinal data collection method; but, in many cases, this is not possible due to financial and time constraints. The above limitations could partly explain why current studies on climate change-migration nexus show mixed results for slow-onset and multiple climate change events.

Rather than using historical data, we emply the choice experiment (CE) method to determine whether climate change phenomena affect migration decisions, and if so, to examine the mechanism of that effect. In a choice experiment, subjects are faced with a set of hypothetical decisions (e.g. a decision whether to migrate) in which the key features of the problem (e.g. drought intensity) are systematically varied. The use of CE methodology to investigate the relationship between climate change and migration offers three benefits. First, CE design provides extensive data for the observation of different migration responses in a diverse range of environmental exposures, even for people who have not been exposed to climate change. That data is manifest in different types of climate change events (i.e. through attributes enriched with descriptions of climate change), variations in intensity and frequency of the events (i.e. through levels of climate change attributes), and abundant data for each subject (i.e. through the sequence of scenarios that the respondent faces). Second, CE can be an effective method for examining the environment as an isolated driver of migration in a complex decision-making process. CE design guarantees temporal order between environmental factors and migration intention, and therefore, meets the criterion for establishing causality. Third, the CE method can enhance the validity of forecasts of future environmentally induced migration. The CE approach is novel in the sense that respondents are asked to declare their migration intentions in the context of possible future environmental changes as presented in different hypothetical but realistic scenarios.

Although CE offers many benefits, as with all methods, it has its own limitations. There is a reasonable concern that, in CEs, people's preferences as expressed in their responses to hypothetical questions may not accurately explain their real-world behavior. Nevertheless, there is evidence that stated preference provides an accurate guide to individuals' actual preferences (e.g. Scarpa et al., 2003; Wardman, 1988; Whitehead, Weddell, & Groothuis, 2016). Although the evidence is limited, stated preferences have been shown to have a significant correlation with actual migration flow (e.g. Bah & Batista, 2018; Lu, 1999; Van Dalen & Henkens, 2013).

Two previous studies have used the CE method to investigate the climate change-migration nexus (Baker et al., 2009; Lu, Lu, & Rahman, 2015). Our study goes beyond them by covering the influence of both slow and fast onset events as well as other migration drivers such as economic, network, and policy factors to better capture the complex and multi-causal nature of the migration process. In addition, to the best of our knowledge, this is the first study using a CE to examine the relationship between climate change and migration in rural and lowland areas.

Our focus on Vietnam, specifically on the Vietnamese Mekong Delta (VMD), is particularly relevant to the research topic since we can observe both great vulnerability to climate change and large volume rural-urban migration. Vietnam is extremely vulnerable to weather variability and climate change not only because its economy is largely agricultural, but also because a high proportion of the population and of economic assets are located in coastal lowlands and deltas and the level of development in rural areas is relatively low (Margulis et al., 2010). The VMD region, Vietnam's largest rice-growing area located in the south west of the country, is of particular interest, given its massive recurrent experience of climate change phenomena. The risk of flooding is common during the rainy season while the risk of salinity intrusion and drought is prevalent during the dry season (Hoang et al., 2018; Sebastian et al., 2016; Yuen et al., 2021). For example, during the dry season in 2016, the VMD experienced the most severe drought-salinity intrusion over the last 100 years, causing 50-100% yield loss in almost VMD provinces (Sebastian et al., 2016). At the same time, of all regions in Vietnam, the VMD sends by far the most migrants, with out-migration coming mainly from rural areas (Entzinger & Scholten, 2016). This therefore has drawn considerable research attention to the effect of the VMD's great vulnerability to climate change on high migrant volume from this region.

To preview our results, our study suggests that increasing the intensity and frequency of drought and flood both increase the likelihood of migration. We find that drought and saline intrusion stands out as a dominant driver of decision to stay or leave in the VMD. We also find considerable heterogeneity in migration behavior among individuals with different socio-geographic characteristics, previous experience of climate change, and migration experience. For example, individuals with serious experience of climate change weight environmental factors more important than those with no/less experience of climate change do when consider migrating. Furthermore, individuals with current migration experience show greater intentions to migrate.

The paper is organized as follows. The second section reviews the existing research on the correlation between climate change and migration and the few studies that have examined that relationship using choice experimental methodology. The third section presents the experimental design, while the fourth section explains the data collection process. The results of the CE are reported in section five, and section six discusses the CE results and draws conclusions.

2 Literature review

Choice experiment approaches addressing the influence of environmental change on population mobility are relatively rare in the literature. Among them, only two, Baker et al. (2009) and Lu et al. (2015), focus on voluntary movements. These studies suggest that relocation decisions are affected by environmental stressors. Baker et al. (2009) find that relocation-related decisions of those who were displaced by Hurricane Katrina in New Orleans and other Gulf Coast areas in 2005 are negatively and significantly influenced by hurricane risk level. With a stated preference questionnaire survey, Lu et al. (2015) conclude that flooding and cyclone factors significantly affect people's location change choice in coastal and inland cities of Bangladesh. However, in these two studies, there is no income or other monetary variable in the list of attributes; therefore, valuation of options and scenarios is not possible. Furthermore, the social context of the migration decision-making process has not been paid attention in these studies.

To address those above limitations, our study includes a monetary dimension (i.e. income difference between origin and destination), allowing the valuation of different scenarios by expressing all the impacts in money terms (Bateman et al., 2002). It also considers social elements such as network and choice of neighbors as migration attributes. More importantly, it focuses on migration out of an important agricultural region, which is likely to see major changes as a result of climate variabilities.

While the majority of studies of climate change and migration in Vietnam are qualitative and descriptive analyses (Entzinger & Scholten, 2016; Kim & Minh, 2017; Van Der Geest, Nguyen, & Nguyen, 2014; Warner & Afifi, 2014), a few exceptions rely on an econometric approach (Berlemann & Tran, 2020; Koubi et al., 2016; Trinh, Feeny, & Posso, 2021). Most of this literature employs historical data and suggests that climate-related hazards significantly increase the probability of migration in Vietnam. Studies to date mainly examine the impact of occurrence of natural disasters (e.g. Berlemann & Tran, 2020; Koubi et al., 2016). However, not only occurrence of an event but also its intensity and frequency level will have impacts on migration decision (Cattaneo et al., 2019; Trinh et al., 2021). Trinh et al. (2021) examines the severity of natural disasters, but not the impact of frequency level. Our paper departs from much of existing literature by describing climate-related hazards through their occurrence, intensity, and frequency. It therefore contributes to the literature additional insights into the impact of different indicators of climate change events on migration decision.

3 Methodology

3.1 Identification of CE attributes and assignment of levels

A key issue with CE is the identification of relevant attributes of the choice of interest and the range of attribute levels to reveal preferences of the respondents. On the basis of a literature review, initial piloting, consultation with local experts, and the current situation in the VMD, six attributes were selected to capture the key elements of migration decision-making under the impact of climate change. Detailed information about the attributes and their levels is presented in Table 1.

First, the climate change attributes, flood frequency and drought intensity, are two common annual climatic phenomena in the VMD.[1] Flood and drought are also commonly used in the literature as examples of sudden-onset and slow-onset environmental events, respectively (Gray & Mueller, 2012a, 2012b; Koubi et al., 2016). Three levels of damage are assigned to each climate attribute, with the description of damage at each level based on historical events that occurred in the VMD.

Second, the income gap between migration origin and potential destination is presented as an economic driver of migration.[2] We use income gap after living costs to capture both positive impact of high earning potential and negative impact of high living cost at destination on migration decision (e.g. Ewers & Shockley, 2018). Four levels of income gap are proposed based on actual income and expenditure gaps between the VMD and the most common destination. Here, income

[1] At first site drought and saline intrusion look like very different issues. We combine them because the two phenomena often occur concurrently in the VMD, given the geographical features of the coastal areas (Loc et al., 2021).

[2] This study examines phenomena in rural areas; therefore, the main trend in this research sites would usually be rural-urban migration. As such, the income gap between origin and destination can be considered as the income gap between city and countryside.

attribute is coded as a continuous variable, allowing estimation of trade-offs or willingness to pay (WTP) (Bateman et al., 2002).

Table 1 Attributes and levels used in the CE

Attribute	Definition	Management Level	Coding
Drought and saline intrusion	This attribute refers to the intensity of annual drought and saline intrusion in the community.	**1- Mild**: Drought and saline intrusion are under control, and thus do not affect crops and aquaculture. **2- Moderate**: Moderate drought and saline intrusion, reducing crop and aquaculture yields by 30%. **3- Severe**: Serious drought and saline intrusion, reducing crop and aquaculture yields by more than 70%.	Categorical variable
Flood	This attribute refers to annual flood frequency. Major floods inundates crops, causing 50% yield loss. Furthermore, such flooding damages houses, necessitating some reinforcements.	**1-** None: No major flood. **2-** Once every two years **3-** Once every year	Continuous variable
Income	This attribute refers to the average monthly income gap between potential destination and original area (after living costs).	**1-** 1.000.000VND less **2-** Same **3-** 2.000.000VND more **4-** 4.000.000VND more	Continuous variable
Network	This attribute refers to whether the respondent has family members, relatives, or friends (e.g. previous neighbors) who are living and working at the potential destination and could provide physical support (e.g. accommodation, accommodation finding, or job finding).	**1-** No **2-** Yes	Dummy variable
Neighbor	This attribute refers to how many of the respondent's neighbors have moved to other locations to live and work.	**1-** Very few **2-** Many	Dummy variable
Crop choice restriction	This attribute refers to the existence of crop choice restriction on the respondent's agricultural land.	**1- None** **2- Partial**: Growing rice in some seasons. **3- Total**: Growing rice in all seasons.	Categorical variable

Third, the social context of migration decision is demonstrated through network and neighbor attributes. Migration network has commonly been taken into account in both theoretical models and empirical studies of migration (e.g. Black, Adger, et al., 2011; Coxhead et al., 2015; Gray & Bilsborrow, 2013; Gray & Mueller, 2012a, 2012b; Koubi et al., 2016; Winkels & Adger, 2002). However, the investigation of neighbors' choice as a migration driver in empirical studies is rare, despite the fact that subjective norms (which can be illustrated by peer choices) have been widely included in conceptual models of migration as one component shaping migration behavior (e.g. Kniveton et al., 2011; Smith et al., 2011). Here, neighbors' migration decision is expected to influence individuals' intention to migrate because in rural areas, particularly in the VMD, people in a community closely interact through information exchange and learning from others' experience.

A fourth attribute is specific to Vietnam. The Government imposed crop choice restrictions on many rural areas of Vietnam, including the VMD, in an effort to address the problem of shrinking paddy land area due to industrialization and changes in the agricultural structure. The restrictions mandate farmers in the designated plots to cultivate at least one rice crop during the year and prohibit them from converting paddy land to other purposes. Studies have shown that crop choice restrictions are lowering agricultural productivity (Le, 2020; World Bank Group, 2016). This may prompt rice farmers to diversify their income by engaging in nonfarm activities in cities or other provinces. Therefore, the crop choice restrictions are expected to have significant impacts on migration rate in the VMD. The levels of this attribute reflect the practical content of the crop choice restrictions in Vietnam.

3.2 Econometric specification and CE design

Discrete choice models are usually derived under an assumption of utility maximizing behavior by the decision maker (Train, 2009). As such, the models can be derived in a manner referred to as random utility models (RUMs) (Marschak, 1959; Train, 2009). Accordingly, the utility of a choice consists of the deterministic component (V) and an error component (ε), which is independent of the deterministic part and follows a predetermined distribution, to yield

$$U_{ij} = V(X_{ij}) + \varepsilon_{ij}$$

where, U_{ij} represents the utility a respondent *i* derives from choosing alternative j on a choice situation and X_{ij} is the vector of observed attributes contributing to migration intention.

According to the random utility maximization hypothesis, a decision maker *i* will select alternative *j* if and only if the utility provided by alternative *j* is the largest utility, i.e. $U_{ij} > U_{ih}$ ($j \neq h$). In this study, the respondents are considering whether they will stay at the origin (i.e. the countryside) or move to another place (i.e. a city). In other words, a decision maker *i* will compare the utility at the origin (U_{io}) and at the destination (U_{ic}), and choose to move if the utility in the city is larger than the utility at origin, i.e. $U_{ic} - U_{io} > 0$. Because we consider both push factors from the origin and pull factors from the destination, U_{ic} *and* U_{io} are asymmetric in terms of attributes:

$$U_{io} = \alpha_o + \alpha_1 Drought_i + \alpha_2 Flood_i + \alpha_3 Income_{io} + \alpha_5 Neighbor_i + \alpha_6 Restriction_i + \varepsilon_{io} \quad (3.1)$$
$$U_{ic} = \alpha_c + \alpha_3 Income_{ic} + \alpha_4 Network_i + \varepsilon_{ic} \quad (3.2)$$

A more natural characterization of the decision process is to think of the respondent as having utility associated with both push and pull factors:

$$U_{ic} – U_{io} = (\alpha_c - \alpha_o) - \alpha_1 Drought_i - \alpha_2 Flood_i + \alpha_3 (Income_{ic} - Income_{io}) + \alpha_4 Network_i - \alpha_5 Neighbor_i - \alpha_6 Restriction_i + (\varepsilon_c - \varepsilon_o)$$

or

$$U_i = \beta_0 + \beta_1 Drought_i + \beta_2 Flood_i + \beta_3 \Delta Income_i + \beta_4 Network_i + \beta_5 Neighbor_i + \beta_6 Restriction_i + \varepsilon \quad (3.3)$$[3]

Sociodemographic control variables can be included in the models without interacting with choice-specific attributes. This also allows interactions between CE attributes and sociodemographic variables to capture the variation in valuing of migration attributes by different people. The dependent variable measures a person's intention to migrate. It assigns a score of one to four corresponding to four degrees of intention to migrate: 4 indicating definitely move, 3 indicating probably move, 2 indicating probably stay, and 1 indicating definitely stay. As a result, the reduced form of the model is:

Intention to migrate = *f* (CE attributes, individual characteristics,

CE attribute * individual characteristics)

The D-efficient method (Carlsson & Martinsson, 2003; Huber & Zwerina, 1996; Kuhfeld, Tobias, & Garratt, 1994) was applied to draw a sample of 32 scenarios. . Prior assumptions for betas were used to improve statistical efficiency (de Bekker-Grob, Ryan, & Gerard, 2012; Huber & Zwerina, 1996). Prior coefficients of flood and network were inherited from Koubi et al. (2016). Since all the attributes were expected to have positive impacts on the probability of choosing to move, all other priors were given positive values, which range from 0.03 to 1.5.

In order to avoid learning and fatigue effects, the 32 scenarios were randomly divided into four sets of eight scenarios. To control for possible biases from order effects (Bateman et al., 2008; Hensher, Rose, & Greene, 2005) the order of the scenarios in each set was randomized to create one new version, producing eight sets of eight scenarios in total.

Each respondent was randomly provided one set of scenarios and asked whether they would choose definitely stay, probably stay, definitely migrate, or definitely migrate under each scenario. This setting of more nuanced choices was aimed at obtaining more detailed information and arriving at a more comprehensive understanding of the formation of migration intentions (Petzold & Moog, 2018). Before the experiment, the respondents were fully instructed about the selected

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[3] We relabel the coefficient as follow: $\beta_i = \begin{cases} -\alpha_i, & i = 1,2,5,6 \\ \alpha_i, & i = 3,4 \end{cases}$. Positive β_i presents positive effect of the corresponding migration factor on intention to migrate and vice versa.

attributes and their levels, the experimental procedures, the number of scenarios, and the initial context. Additionally, colored pictograms and show cards were used to facilitate the comprehension of each scenario (see Appendix Figure A-1 for a sample scenario).

Visually, the CE departs from some conventional choice experiment designs in that the choice set shows only one alternative that contains conditions at both origin and destination, and the respondents are asked to choose between moving or staying. This style is similar to the vignette-based studies that are widely used in healthcare and marketing research based on an underlying random utility framework (e.g. McFadden et al., 2005; Wason, Polonsky, & Hyman, 2002). Itis more straightforward and easier for the respondents to grasp, especially for people in rural areas who have relatively low educational attainment.

4 Data collection

The survey was conducted in two provinces in the VMD, Kien Giang and Long An (エラー! 参照元が見つかりません。). Kien Giang has experienced drought and saline intrusion for many years; most recently a severe event recorded in the dry season of 2016. In contrast, Long An is regularly subject to flooding during the wet season (refer to risk map in Appendix Fig. A-2).

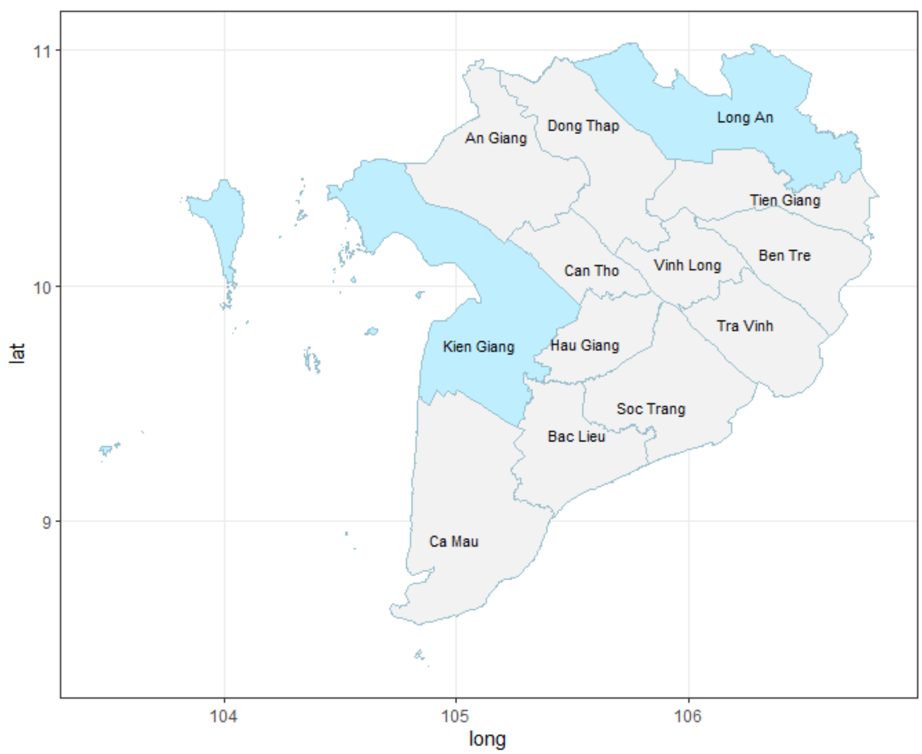

Fig. 1 Map of the VMD showing the two surveyed provinces

In each province, two districts, which are comparable in terms of main source of livelihood and income levels but which represent different levels of climate change impact, were chosen (see

Appendix Table A-1 for main features of the selected districts and sub-sample means). In each district, one commune was randomly selected. In each commune, three to four villages were selected for conduct of the survey. The selection of villages followed two rules: the distance between villages must be large enough to avoid spillover effects; and priority is given to high population villages so as to increase representative feature. For each selected village, households were randomly selected using the sampling interval approach (Lavrakas, 2008). The targeted respondents were household heads or their spouses or the individual in the household who make the most important decisions. The survey was carried out in March and May 2019. The research team visited 359 farm households; nine cases refused to be interviewed or did not complete the interview. In total, 350 households were interviewed in 13 villages, with a response rate of 97.5%.

For the CE, the eight sets of eight scenarios were equally distributed over the total survey sample. That is, given 350 questionnaires, each set would be used in 44 survey forms out of the total sample. As with any CE, the most important condition is that the respondents understand the experiment set-up, and make choices consistently on the basis of the hypothetical information provided. As trained, the enumerators always asked the reasons for the respondents' choices for the first scenario to confirm the relevance of the answers. The enumerators would then ask for further explanation if there was any indication of random answering or if there was a switch in choices between move and stay[4]. The enumerators were attached to the experienced Southern Institute of Social Sciences in Ho Chi Minh City, who also handled logistics and local liaison.

5 Results

5.1 Descriptive analysis results

The interviewees were predominantly male (70.86% male and 29.14% female), partly because in most Vietnamese families, the head and decision maker is typically male. The average educational level in the areas surveyed is relatively low: more than 85% of the respondents had secondary education level or lower. The average household size, 4.7 members, is higher than the national average of 3.6 (GSO, 2019b). Concerning the occurrence of climate-related hazards, 80% of the respondents said that droughts occur more frequently and 48% of the respondents said that droughts have been more severe. Meanwhile, the equivalent proportions for flood were 18% and 13%, respectively.

Table 2 presents a descriptive analysis of the people who said they would never move (i.e. never-move people) and those who said they would move in at least one of the scenarios presented (i.e. move people). Tests of difference between the two groups are summarized in Appendix Table A-

[4] One scenario is said to weakly dominate another when it is at least as good as the other in terms of every attribute. We used a dominance test for choice consistency to determine respondents' ability to understand the CE questions or the degree to which they took them seriously. Among the test samples, 93.93% passed the test of logical consistency, suggesting that the CE was well designed and implemented.

2. The results suggest that the observed differences are statistically significant. On average, move people are younger and have higher level of education than never-move people. Move people in general own less land and earn less than the never-moves. Additionally, the more members there are in a household, the more likely the family is to choose to stay. People with past and current experiences of migration in their households are more likely to choose moving. Finally, the stronger effect of climate change events on a family, the more likely the household is to choose to move.

Table 2 Main characteristics of move and never-move people

	Move people			Never-move people		
	Mean	Min	Max	Mean	Min	Max
Frequency	139			211		
Percentage (%)	39.71			60.29		
Age	45.73	26	72	50.12	26	78
Education	6.35	0	13	5.90	0	14
Household size	4.53	2	12	4.82	2	15
Land (hectare)	2.32	0.2	10	2.87	0.13	25
Annual income per capital (million VND)	25.20	3.33	100	29.00	2.67	140
Number of current migrant	0.74	0	4	0.53	0	4
	Percentage (%)			Percentage (%)		
Having migration experience	59.71			47.87		
Being severely impacted by climate change	56.12			42.65		
Drought damage	50.36			46.45		
Saline intrusion damage	26.62			20.85		
Flood damage	15.11			10.9		
Storm damage	25.9			18.48		
Unusual heavy rain damage	38.85			30.81		

5.2 Operationalization of variables

Selection of the control variables used in the econometric models is based on descriptive analysis results and the literature on individual-level migration (e.g. Abu, Codjoe, & Sward, 2014; Gray & Mueller, 2012a). Those control variables are socio-economic variables such as age, gender, income, land, household size, and risk attitude and variables accounting for migration and climate change experiences. Furthermore, a dummy for Long An province and distance to the most common destination are included to capture the influence of community characteristics on individual-level migration decision.

To examine preference heterogeneity, we incorporate several interaction terms of climate and non-climate-related attributes. First, climate change attributes are interacted with variables indicating respondents' experience of climate change (i.e. climate change and 2016 drought), to test whether people's perception of drought and flood effects vary with regard to the consequences of past events. Second, climate change attributes are interacted with socio-demographic variables because environmental impacts can be the interaction between climate-related events and the underlying social vulnerability of the population, which can be measured by socio-demographic characteristics such as age, gender, household size, migration status, risk attitude, and income (Abu et al., 2014; Black, Kniveton, & Schmidt-Verkerk, 2011). In addition, given that contribution of having a network may correlate with respondent migration profile, network attribute is interacted with variables indicating prior and current migration experience. Second, the interaction of network attribute and gender variable tests the hypothesis of gender differences in migration network. Studies have shown that effects of social network may be different for men and women since costs, risks, benefits, and network resources of migration differ by gender (Curran, 2003; Toma, 2014). Interactions of province dummy with income and crop restriction variables are expected to capture the main differences between the two surveyed provinces. Finally, income gap attribute is interacted with the respondent's risk attitude index since it is expected that risk attitude and economic behavior may be correlated, and therefore, the effect of prospective migration income may vary across individual attitude toward risk.

5.3 CE model results

Table 3 shows the results of three ordered logit regression models[5]. The main effect model (Model 1) and the model with control variables (Model 2) are included for reference. As can be seen, the main effects coefficients are all significant, with the anticipated sign in Models 1 and 2, except for the coefficient on partial crop restrictions. Model 3, which show the results using all dependent variables and the above-justified interactions, is our focus. A robustness check that contains a still fuller regression does not change the main results (see appendix Table A-4).

[5] Since the increase of the dependent variable from one to four indicates an increase in the likelihood of migrating decision, we use ordered logit models. All models include standard errors clustered at the household level.

Table 3 Regression results

VARIABLES	Model 1: Main effects model		Model 2: With control variables		Model 3: With interactions	
Moderate drought	0.330*	(0.173)	0.363**	(0.181)	-0.155	(0.289)
Severe drought	1.116***	(0.130)	1.192***	(0.140)	0.864***	(0.191)
Flood frequency	0.619***	(0.161)	0.647***	(0.170)	0.325	(0.243)
Income gap	0.198***	(0.0288)	0.210***	(0.0299)	0.468***	(0.0898)
Network	0.436***	(0.107)	0.464***	(0.112)	0.369**	(0.185)
Neighbour	0.320***	(0.112)	0.342***	(0.120)	0.347***	(0.121)
Partial crop restrictions	-0.126	(0.137)	-0.109	(0.136)	-0.198	(0.201)
Total crop restrictions	0.355**	(0.175)	0.368**	(0.180)	0.620**	(0.242)
Climate change			0.222	(0.199)	-0.186	(0.265)
Drought 2016			0.0772	(0.224)	-0.246	(0.280)
Age			-0.0351***	(0.0128)	-0.0367***	(0.0128)
Income			-0.227	(0.168)	0.0286	(0.235)
Household size			-0.282***	(0.0904)	-0.287***	(0.0911)
Current migrant			0.493***	(0.145)	0.586***	(0.160)
Migration experience			0.451	(0.277)	0.375	(0.301)
Long An			-0.421*	(0.227)	9.480*	(5.691)
Risk attitude			0.0651	(0.0529)	0.122**	(0.0585)
Female			-0.120	(0.222)	-0.257	(0.239)
Moderate drought * Climate change					0.539*	(0.286)
Severe drought * Climate change					0.644**	(0.258)
Moderate drought * Drought 2016					0.531*	(0.279)
Severe drought * Drought 2016					0.0986	(0.260)
Flood frequency * Climate change					0.164	(0.231)
Flood frequency * Drought 2016					0.513**	(0.226)
Income gap * Risk attitude					-0.0388***	(0.0135)
Network * Current migrant					-0.237*	(0.123)
Network * Migration experience					0.216	(0.249)
Network * Female					0.485**	(0.193)
Partial crop restrictions * Long An					0.0550	(0.279)
Total crop restrictions * Long An					-0.562*	(0.300)
Income * Long An					-0.584*	(0.336)

Robust standard errors in parentheses; Clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

Because the interpretation of the quantitative significance of coefficients can be unclear in ordered logit models, Table 4 uses the results from Model 3 in Table 3 to show the probability of choosing to move under different values of the CE attributes. Those probabilities are then compared to the baseline scenario to reveal the marginal effect of the attributes. As can be seen in Table 4, all attributes except partial crop restriction significantly raise the probability of moving compared to the baseline, indicating that all selected attributes have significantly positive impacts on intention to migrate, as expected. The results also suggest that drought, which shows the largest difference with the baseline, stands out as a dominant driver of the decision to stay or leave.

Table 4 Probability of probably moving and of definitely moving

Scenarios	Probability of probably moving	Difference from baseline	Probability of definitely moving	Difference from baseline
Baseline	0.0353***		0.0179***	
	(0.00802)		(0.00412)	
Moderate drought	0.0481***	0.013**	0.0255***	0.008**
	(0.00779)		(0.00432)	
Severe drought	0.0951***	0.06***	0.0573***	0.039***
	(0.0147)		(0.0103)	
One flood/2 year	0.0462***	0.011***	0.0241***	0.006***
	(0.00822)		(0.00427)	
One flood/year	0.0603***	0.025***	0.0329***	0.015***
	(0.00942)		(0.00524)	
2 million Dong income higher	0.0510***	0.016***	0.0268***	0.009***
	(0.0101)		(0.00548)	
4 million Dong income higher	0.0735***	0.038***	0.0408***	0.023***
	(0.0134)		(0.00793)	
Having network	0.0525***	0.017***	0.0276***	0.01***
	(0.00955)		(0.00528)	
Many neighbor have moved	0.0478***	0.012***	0.0250***	0.007***
	(0.00874)		(0.00526)	
Partial crop restriction	0.0304***	-0.005	0.0152***	-0.003
	(0.00756)		(0.00409)	
Total crop restriction	0.0471***	0.012*	0.0249***	0.007*
	(0.00964)		(0.00508)	

Standard errors in parentheses; Clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

Note. Baseline: Probability of moving given all CE attributes are set at the base level (i.e. zero); other scenarios: Probability of moving at a specific level of one attribute given other attributes be set at the base level (i.e. zero). The difference between any two probabilities is calculated using the 'mlincom' command in Stata (Long & Freese, 2014).

The findings indicate that both sudden-onset and slow-onset events significantly increase the likelihood that an individual will opt for migration. While this result aligns with those of some existing studies (e.g. Berlemann & Tran, 2020; Warner et al., 2012), it tends to contradict the findings by Koubi et al. (2016), who find that slow-onset disasters significantly reduce the likelihood of migration. One possible explanation is the possibility of location selection bias in

Koubi et al. (2016). Although the authors proposed to select two provinces with sudden-onset events and two provinces with slow-onset events, the descriptive analysis reveals that the respondents' experience of sudden-onset events is nearly three times higher than their experience of slow-onset events. Given the equal proportions of migrants and non-migrants in the sample, there is a strong possibility that insignificant and negative impacts of slow-onset events found by Koubi et al. (2016) are linked to low incidence of those events in the sampled locations. Another possible explanation is that Koubi et al. (2016) examine the occurrence of environmental stressors rather than the intensity of those events. However, studies have shown that the occurrence of an event with different intensity levels may prompt different migration decisions (Trinh et al., 2021). Therefore, the findings of Koubi et al. (2016) may not capture the fact that droughts became more severe in Vietnam over the preceding decade, which may have significantly increased the positive impact of drought on likelihood of migration.

The design of the four-scale migration intention allows for a more detailed investigation of the variation of migration probability. For example, Fig. ***2*** uses the results from Model 3 in Table 3 to show the range of proportion of movers combining the two degrees of intention to move, i.e. probably move and definitely move. Assuming that those who choose definitely move will move, Fig. ***2*** illustrates the proportion of movers when the probability for successful movement of a 'probably move' decision ranges from zero (blue circle points) to 100% (orange diamond points). The model estimates that, for instance, in moderate drought occurrence, 2.5 to 7.5% of the respondents may migrate depending on the degree of which individuals choosing 'probably move' would actually move. Although the estimation of that degree is not within the scope of this study, the setting of more nuanced choices provides more insights into migration intention compared to single-choice setting.

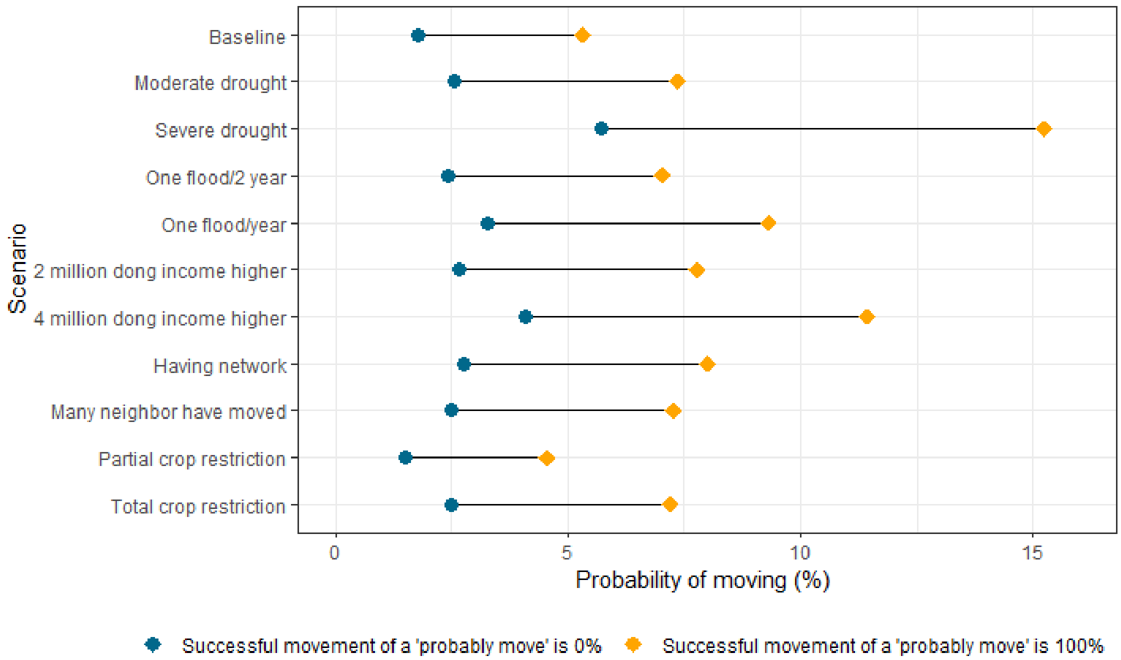

Fig. 2 Probability of moving estimated by probably move and definitely move options

Concerning the control variables, similar to other studies (e.g. Koubi et al., 2016; Warner et al., 2012), we find that the older the respondents are, the less likely they are to choose to migrate[6]. In line with our expectation, current migration experience has a positive and significant impact on decision to migrate. That finding is consistent with the results reported in Abu et al. (2014) and Koubi et al. (2016). Our results also show that income and household size have a negative correlation with likelihood of migration. Families with high income or large size may incur high migration costs when moving, which could reduce their intention to migrate.

In addition, the results show that people from Long An province are less likely to choose migration than people from Kien Giang province. This suggests that provincial characteristics significantly matter for likelihood of migration. Concerning the two provinces surveyed, the fact that people in Kien Giang are relatively more vulnerable to climate change (refer to risk map in Appendix Fig. A-2) and poorer[7] than those in Long An may help to explain the stronger intention to move among people in Kien Giang province. We also examine the effect of risk attitude on migration decision. The results indicate that risk attitude does not have a significant impact on the probability of choosing to move.

[6] Marginal effects (MEs) are estimated to examine the impact of control variables (see Appendix Table A-3). By definition, MEs are the differences in outcome probability between each level of the attribute and its base level.

[7] According to the General Statistics Office of Vietnam, GSO (2019a), monthly income per capita in Kien Giang and Long An in 2019 are about 4.0, and 4.5 million Vietnam dongs, respectively.

Past migration experience, climate change experience, gender, distance, and land ownership are not significant predictors of migration decision, although the signs of coefficients for climate change, migration experience, and income are consistent with our expectation. We conduct a LR test for land and distance variables since the magnitude of the coefficients appears to be negligible. The LR ratio statistics for land and distance variables are 1.92 and 1.04 respectively, and as a result, the null hypothesis of this test, that the coefficients are not different from zero, cannot be rejected. The test results support the decision to exclude those variables from the main model.

In this context, willingness to pay (WTP) is defined as the change in income that exactly offsets a 'one unit' increase in an attribute. It is the maximum amount of money that a person is willing to sacrifice to avoid a deterioration. Negative WTPs can be interpreted as either a decrease in rural income or an increase in city income. We calculate the WTP to examine the influence of CE attributes conditional on specific control variables with the results summarized in Table 5.

Table 5 WTP for CE attributes conditional on specific control variables

	I - Drought and flood conditional on prior climate change (CC) experience				
	(1) Base	(2) With CC experience	(3) Differences (2) – (1)	(4) With CC and 2016 drought experience	(5) Differences (4) – (1)
Moderate drought	0.330	-0.822	-1.153*	-1.957***	-2.288**
	(0.621)	(0.573)	(0.664)	(0.581)	(0.893)
Severe drought	-1.846***	-3.221***	-1.375**	-3.432***	-1.586**
	(0.514)	(0.792)	(0.625)	(0.785)	(0.715)
Flood frequency	-0.695	-1.045**	-0.350	-2.141***	-1.446**
	(0.544)	(0.533)	(0.503)	(0.587)	(0.681)

	II - Network conditional on migration experience			
	(6) base	(7) with migration experience	(8) with one current migrant	(9) with two current migrants
Network (female)	-1.820***	-2.252***	-1.316**	-1.274***
	(0.537)	(0.680)	(0.537)	(0.475)
Network (male)	-0.804*	-1.236**	-0.300	-0.236
	(0.418)	(0.527)	(0.473)	(0.362)

	III - Crop restrictions conditional on province		
	(10) Long An	(11) Kien Giang	(12) Differences (11) – (10)
Partial crop restrictions	0.292	0.427	0.134
	(0.399)	(0.435)	(0.592)
Total crop restrictions	-0.128	-1.299**	-1.172*
	(0.484)	(0.551)	(0.658)

Standard errors in parentheses; Clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

Note. Unit: millions Vietnam Dong
(1) Base: WTP of people who have not been seriously affected by either climate change events or the 2016 drought;
(2) WTP of people who have been seriously affected by climate change events but not by the 2016 drought;
(4) WTP of people who have seriously affected by both climate change events and the 2016 drought;
(6) Base: WTP of having networks for male and female with neither current migrant nor migration experience;
(7) WTP of having networks for male and female with migration experience and no current migrant;
(8) WTP of having networks for male and female with one current migrant and no migration experience;
(9) WTP of having networks for male and female with two current migrants and no migration experience.

The results suggest that the impact of prior climate change induce change in people's assessment of upcoming climatic hazards (Table 5 spanner I).[8] First, for individuals who have been seriously affected by climate change events, upcoming droughts are equivalent to a significantly higher decrease in rural income than for individuals who have not been seriously affected by any of those events (refer to column (3)). Previous damages of climate change phenomenon arouse people's concern about upcoming droughts rather than floods given the fact that droughts have occurred with greater frequency and intensity than floods in the VMD over the last 10 years. Second, the 2016 drought also has an effect on individual assessment of upcoming events. For affected individuals, the decrease in rural income caused by upcoming droughts and floods would be significantly larger than for unaffected individuals (refer to column (4) and (5)). The highest value of WTP reaches 3.4 million Dong, equivalent to about 80% of average monthly income per capita in the surveyed area.

Table 5 spanner II presents WTPs for networks attribute when interacting with gender and migration experience variables. The results show that for female respondents, having migration network is equivalent to a higher increase in city income than for male respondents. In other words, females weight network attribute more importantly than males would. Moreover, we find that respondents with prior migration experience would value network attribute more than those without prior migration experience would. Another finding is that the larger the number of family members currently migrating, the less importance respondents would attach to network attribute. The importance of having a network possibly declines because current migrants can provide support at the destination.

Interactions of province dummy allow the investigation of how people in different provinces assess migration attributes differently. For example, we find that for people in Kien Giang, the decrease in rural income induced by the total crop restriction is 1.172 million Dong higher than for people in Long An (Table 5 spanner III). Many farmers in Kien Giang have switched to shrimp-rice rotation pattern after the 2016 drought, whereas most farmers in Long An continue implementing rice-rice pattern. Our finding is therefore consistent with the influence of crop restriction on migration decision being dependent on cropping patterns currently implemented.

6 Conclusions and discussions

The consequences of climate change are expected to have a significant influence on migration decisions. However, estimating the impact of climate change on migration is challenging, given the complex and multi-causal nature of the migration process and the requirement for intensive

[8] Socio demographic characteristics are found not to insignificantly influence people's assessment of upcoming drought and flood. Therefore, we do not consider the interactions of drought and flood attribute with socio-demographic variables in the model analyzed (Model 3).

datasets on migration movement and climate variability. The CE proposed and applied here provides an alternative method to overcome the shortcomings of the use of historical data.

Though there might be concerns about using hypothetical questions, migration intention has been shown to be a good predictor of realized migration (Creighton, 2013; De Groot, Mulder, & Manting, 2011; De Jong, 2000; Docquier, Peri, & Ruyssen, 2014; Lu, 1999; Van Dalen & Henkens, 2008; Van Dalen & Henkens, 2013). Moreover, our own CE exercise showed consistent evidence of good understanding, engagement, and intuitively sensible preferences from the respondents. In short, though a thorough validation of the method would require longitudinal data on actual decisions, this paper provides evidence that the CE approach can be effective in providing extensive data on environmental evolution and migration decisions and enabling the investigation of environmental factor as an isolated driver of migration.

We find that drought-saline intrusion stands out as a dominant driver of decision to stay or leave for the case of the VMD. The impact of drought becomes significant because over the last decade, the VMD has experienced great losses in agricultural production as a result of drought and saline intrusion. In other countries, drought has also been found to induce migration (e.g. in Ethiopia (Gray & Mueller, 2012a) and in Burkina Faso (Kniveton et al., 2011)). We also find notable heterogeneity in migration behavior among individuals with different socio-geographic characteristics, prior experience of climate change, and migration experience. In particular, an older group of respondents shows a reluctance to migrate under any circumstance, which might present a challenge to policy makers engaged in formulating climate-change adaptation policies.

We also investigate the effect of crop choice restriction on the intention to migrate. Crop choice restrictions have been found to be a barrier to agricultural productivity in Vietnam. For example, Le (2020) finds that the elimination of all land-use restrictions leads to a 37.89% increase in agricultural productivity and an 8.03% increase in real GDP per capita in Vietnam. Our study links the impact of crop choice restriction with farmers' migration intention and finds that the implementation of crop choice restrictions significantly raises the likelihood of choosing to migrate.

We have argued that the CE can provide a useful complement to observational and historical data. The ex-ante nature of and extensive data on migration behavior under a diverse range of climate variabilities provided by the CE approach have considerable advantages for detection of migration trends under different climate change scenarios. From the perspective of decision makers, projections of climate-induced migration could serve as a reference for the formulation of strategies for adaptation to climate change and as a basis for optimal preparations for both migrants and people in the sending and receiving communities.

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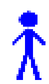
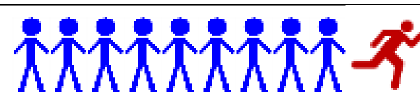
APPENDIX.

Figure A-1. Example Scenario.

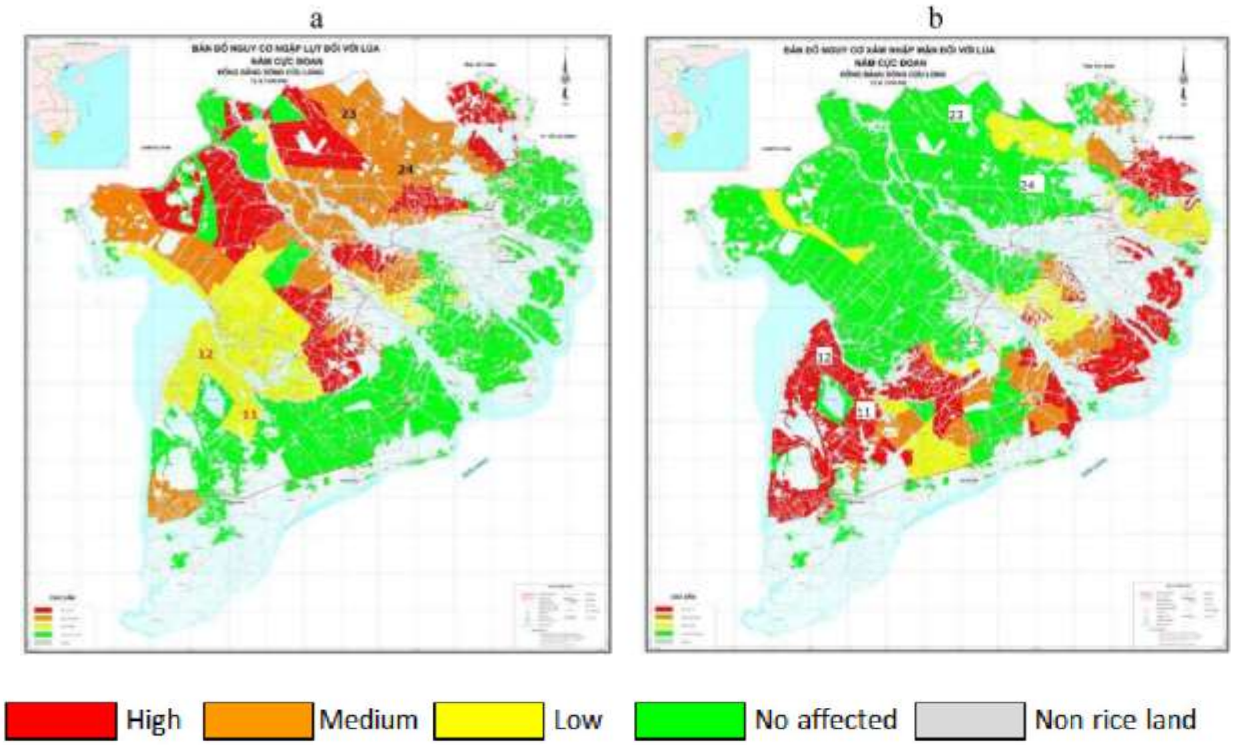
SUPPOSE that in the next 6 years, you face a situation as follows. Would you stay here or would you/your family members move to another province/city to live and work?

Annual drought and saline intrusion	**SEVERE** **70%** yield loss	
Major flood	**ONCE EVERY YEAR** **50%** yield loss + house damaging	
Per capita monthly income in destination	**4.000.000VND <u>more</u>**	
Connections at destination	**YES**	 Information  Housing  Job finding
Neighbors	**VERY FEW** have moved	
Crop choice restriction	**PARTIAL**	Growing rice in **<u>some</u>** seasons

In this situation, what do you think you would do? *Please select one*

1= Definitely stay   2 = Probably stay   3 = Probably move   4 = Definitely move

Appendix Figure A-2: Map of flooding (a) and salinity intrusion (b) risks for rice production in severe years of the VMD



Source: (Yen et al., 2019)

Reprinted from Climate Risk Management, 24, Yen, B. T., Son, N. H., Tung, L. T., Amjath-Babu, T., & Sebastian, L., Development of a participatory approach for mapping climate risks and adaptive interventions (CS-MAP) in Vietnam's Mekong River Delta, 59-70, Copyright (2019), with permission from Elsevier.

Note: Site codes: Kien Giang – 11, 12; Long An – 23, 24

Table A-1. Demographic and socio-economic characteristics of respondents and areas

Characteristics	Categories	Percentage (%)
Gender	Male	70.86
	Female	29.14
Age	<40	23.43
	40-59	60
	>= 60	16.57
Marital status	Married	96.57
	Widowed	2.29
	Divorced	1.14
Household size	1-3	20
	4-6	70.86
	7 and above	9.14
Education level	Illiterate	4.29
	Primary school	41.43
	Secondary school	44.57
	High school	8
	College equivalent or higher	1.71
Ethnic	Kinh	94
	Khmer	5.43
	Chinese	0.57

Part B **Table 3:** Geographical characters of survey areas[9]

	Kien Giang, Vinh Thuan	**Kien Giang, An Bien**	**Long An, Tan Hung**	**Long An, Thanh Hoa**
Code	11	12	23	24
District level				
Area (km^2)	394.439	400.290	501.88	467.86
Population (thousand persons)	94.468	126.831	49.524	55.5790
Population density (people/km^2)	239	317	99	119
% of rural population (%)	82	90	89	90
% of agricultural production land/total land	80.09	84.01	81.66	85.69
Commune level				
No. Villages	9	10	5	4
No. Households	4,227	4,046	996	1,878
Poverty rate (%)	3.69	19.33	3.10	2.30

[9] Source: (1) Statistical yearbook of Kien Giang; (2) Statistical yearbook of Long An
(3) https://lmhtx.kiengiang.gov.vn/trang/TinTuc/137/1256/Xa-Vinh-Binh-Bac--huyen-Vinh-Thuan-dat-chuan-nong-thon-moi.html
(4) http://baolongan.vn/xa-vinh-chau-b-huyen-tan-hung-dat-19-19-tieu-chi-nong-thon-moi-a75803.html
(5) http://baolongan.vn/thanh-phuoc-don-nhan-xa-nong-thon-moi-a56239.html

Table A-2: T-test and Pearson chi-square test results for differences between move and never-move people

T-tests

Variables	**t-statistic**	**DF**	**p-value**
Age	10.927	349	0.0000
Education	-3.797	349	0.0001
Household size	4.643	349	0.0000
Land	5.696	349	0.0000
Income per capital	4.944	349	0.0000
No. current migrant	-6.473	349	0.0000

Chi square test

Variables	**chi2**	**DF**	**p-value**
Having migration experience	37.722	1	0.0000
Being severely impacted by climate change	48.667	1	0.0000
Drought damage	4.115	1	0.0430
Saline intrusion damage	12.529	1	0.0000
Flood damage	10.797	1	0.0000
Storm damage	21.897	1	0.0000
Unusual heavy rain damage	19.327	1	0.0000

Table A-3: MEs for outcome 3 (probably move) and outcome 4 (definitely move)

	Probably move		Definitely move	
VARIABLES	MEs	SEs	MEs	SEs
Climate change	0.0132	(0.0123)	0.0132	(0.0101)
Drought 2016	0.00702	(0.0134)	0.00597	(0.0115)
Household size	-0.0171***	(0.00531)	-0.0145***	(0.00479)
Age	-0.00219***	(0.000727)	-0.00186***	(0.000653)
Income	-0.0176*	(0.0101)	-0.0140	(0.00892)
Current migrant	0.0311***	(0.00922)	0.0263***	(0.00786)
Migration experience	0.0262	(0.0172)	0.0212	(0.0135)
Long An	-0.0264*	(0.0142)	-0.0216*	(0.0118)
Risk attitude	0.00406	(0.00329)	0.00298	(0.00277)
Female	-0.00712	(0.00329)	-0.00580	(0.0110)

Standard errors in parentheses; Clustered at household level
*** p<0.01, ** p<0.05, * p<0.1

Table A-4: Regression results – extended models with more interactions

VARIABLES	Coefficients	SEs
Drought_moderate	5.171	(4.207)
Drought_severe	1.503	(3.782)
Flood_frequency	1.144	(3.300)
Income gap	0.461***	(0.0976)
Network	0.365*	(0.197)
Neighbour	0.366***	(0.122)
Crop_restrictions_partial	-0.245	(0.206)
Crop_restrictions_total	0.561**	(0.240)
Climate change	-0.150	(0.256)
Drought 2016	-0.265	(0.281)
Age	-0.0257	(0.0165)
Income	0.0534	(0.264)
Household size	-0.139	(0.117)
Current migrant	0.528***	(0.205)
Migration experience	0.379	(0.300)
Long An	8.927	(5.667)
Risk attitude	0.119	(0.0828)
Female	-0.338	(0.298)
Drought_moderate * Climate change	0.492*	(0.293)
Drought_severe * Climate change	0.600**	(0.261)
Drought_moderate * Drought 2016	0.591**	(0.290)
Drought_severe * Drought 2016	0.0958	(0.260)
Drought_moderate * Age	-0.00875	(0.0178)
Drought_severe * Age	-0.00696	(0.0143)
Drought_moderate * Female	0.267	(0.312)
Drought_severe * Female	-0.215	(0.265)
Drought_moderate * Household size	-0.413***	(0.137)
Drought_severe * Household size	0.0167	(0.0936)
Drought_moderate * Current migrant	0.287	(0.176)
Drought_severe * Current migrant	0.0304	(0.138)
Drought_moderate * Risk attitude	0.00663	(0.0791)
Drought_severe * Risk attitude	0.0600	(0.0602)
Drought_moderate * Income	-0.206	(0.224)
Drought_severe * Income	-0.0431	(0.206)
Flood_frequency * Climate change	0.142	(0.228)
Flood_frequency * Drought 2016	0.535**	(0.227)
Flood_frequency * Age	-0.0204	(0.0133)
Flood_frequency * Female	0.248	(0.248)
Flood_frequency * Household size	-0.160	(0.106)
Flood_frequency * Current migrant	-0.0134	(0.156)
Flood_frequency * Risk attitude	-0.0443	(0.0584)
Flood_frequency * Income	0.0644	(0.181)
Income gap * Risk attitude	-0.0387***	(0.0147)
Network * Current migrant	-0.233	(0.144)
Network * Migration experience	0.217	(0.253)
Network * Female	0.511**	(0.208)
Crop_restrictions_partial * Long An	0.110	(0.284)
Crop_restrictions_total * Long An	-0.485	(0.296)
Income * Long An	-0.552*	(0.335)

Robust standard errors in parentheses; Clustered at household level
*** p<0.01, ** p<0.05, * p<0.1