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Determinants Of Household Decisions On Adaptation To Extreme Climate Events In Southeast Asia

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In Asia and the Pacific more people are affected by floods, droughts, and storms than in any other part of the world. This problem is set to get worse as the impact of climate change becomes more pronounced and extreme weather events become more frequent. To try and assess how best to help people respond to this challenge, a new EEPSEA study looks at how households in a range of Southeast Asian countries have adapted and responded to extreme climate events. It also assesses the factors that influence their behavior.

The study is the work of a research team led by Dr. H.A. Francisco from EEPSEA. It finds that most households rely on reactive measures (such as evacuating their homes), while richer households use more proactive measures (such as building dykes) to respond to storms, floods and other extreme weather events. As proactive adaptation measures are generally more effective at reducing the damage caused by extreme climate events, especially in the longer term, there is a need to promote such measures. The study suggests various potential strategies to do this, including improving information provision and promoting collective action.

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DETERMINANTS OF HOUSEHOLD DECISIONS ON ADAPTATION TO EXTREME CLIMATE EVENTS IN SOUTHEAST ASIA

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The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach, involving courses, meetings, technical support, access to literature and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, Lao PDR, China, and Papua New Guinea.

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EXECUTIVE SUMMARY

This paper examines the factors influencing the choice of household adaptation strategies to deal with extreme climate events in selected Southeast Asian countries. The premise is that since climate change manifests in the increasing intensity and frequency of extreme events, how households respond to these phenomena would reflect how they are responding to the changing climate. Adaptation barriers and constraints are also examined. It was found that most households undertook reactive adaptation responses in the form of evacuation, mostly led by government disaster agencies, and reinforcing their housing structures (a weak structural measure). The relatively well-off households on the other hand took proactive measures like building protective structures (e.g., dykes) and elevated structures (e.g., a second floor), and relying heavily on early warning systems in order to take the necessary safeguards in time against the extreme climate events.

The multinomial logit regression results showed that the choice of being proactive or reactive was significantly influenced by the following factors: housing type, household size, level of education, attendance at training programs on disaster preparedness, perception of the risk of future extreme climate events, the number of information channels available, and level of dependence on others for help. The probability of choosing proactive adaptation measures could be enhanced by providing those households with limited means better access to information (including early warnings), training on disaster management and adaptation options, livelihood support to enhance their economic capability, opportunities for higher education, and financial support to enable them to build stronger and more resilient housing units. Collective adaptation was hampered by the lack of cooperation among the various stakeholders and constituents, particularly in the urban areas. Therefore, community formation needs to be strengthened.

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1. INTRODUCTION

Climate change is now recognized as a global environmental problem that threatens rich and poor countries alike. Those who have the least capacity to protect themselves from the adverse impacts of climate change as is the case in most parts of Asia stand to suffer the most from them. It is also well recognized that while controlling carbon emissions (mitigation) is a must, it is equally important to support adaptation efforts in those areas most vulnerable to climate change impacts. The Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (IPCC 2007) reaffirmed the likelihood of the occurrence of extreme climate events in the 21st century as global warming causes changes in temperature and precipitation extremes. These extreme events may manifest in the form of severe typhoons, floods, and droughts.

The urgent need for adaptation support was recognized at the United Nations Climate Change Conference held in Bali, Indonesia, in December 2007. There are now several avenues for providing adaptation support, both under the United Nations Framework Convention on Climate Change (UNFCCC) and through various bilateral and multi-lateral agencies. Various aid and non-government agencies are also being mobilized to support adaptation efforts in developing and least developed economies. Research on adaptation behaviour and the needs of countries vulnerable to climate change could benefit decision-making on how to best use and allocate adaptation funds. The Economy and Environment Program for Southeast Asia (EEPSEA) responded to this challenge through a multi-country research project on adaptation behaviour.

Understanding adaptation is an important goal in itself to assist planning by policy-makers and private individuals (Smith 1997; Smit et al. 2000; Smit and Pilifosova 2001). Understanding adaptation is also important if one is interested in quantifying the impacts of climate change (Mendelsohn, Nordhaus and Shaw 1994; Seo and Mendelsohn 2008). The EEPSEA cross-country project, launched in mid-2009, was entitled ―The Climate Change Adaptation Behaviour of Households, Communities and Local Government Units in China, Indonesia, Philippines, Thailand, and Viet Nam”. The study examined the adaptation strategies and adaptive capacities of local households, communities and government units in selected Southeast Asian countries based on their responses to extreme climate events experienced.

As the link between extreme climate events and climate change is already scientifically recognized (Vellinga and van Verseveld 2000), the need to assess the behaviour of households and communities during extreme events would provide important information that can be used as guide to understand climate change adaptation behaviour. This paper presents the results of an econometric analysis used to analyse household adaptation decisions taken in response to extreme climate events using the dataset generated from the above-mentioned study. The adaptation measures implemented by the households to prepare for or cope with the extreme climate events and the barriers/constraints to their adaptation were also examined.

2. SOUTHEAST ASIA IN THE CONTEXT OF CLIMATE CHANGE

Historically, more people in Asia and the Pacific have been affected by floods, droughts, and storms than in any other region of the world (Laplante 2010) and climate change is one of the most significant development challenges confronting Southeast Asia (SEA) in the 21st century (ADB 2009). As noted in the IPCC's 4th Assessment Report (IPCC 2007), SEA is expected to be seriously affected by the adverse impacts of climate change as most of its economies rely heavily on agriculture and natural resources. It is annually affected by extreme floods, droughts and storms with large areas of the region being highly prone to flooding. The region has the greatest number of people at risk of the adverse impacts of climate change and is expected to experience increases in frequency and intensity of tropical cyclones, storm surges, and floods, and sea level rise.

Across the region, climatic changes are expected to severely affect those most dependent on natural resources for their livelihoods such as poor farming and fishing households. Many of the poor live in coastal areas and in low-lying deltas which are expected to bear the brunt of sea-level rise and the intensification of storm surges (Dasgupta et al. 2009). .

A study by Yusuf and Francisco (2009) generated a climate change vulnerability map for Southeast Asia based on three composite indicators: exposure, sensitivity and adaptive capacity. The vulnerability mapping study found that the most vulnerable areas, which fall within the top quartile of the SEA standard, included all the regions of the Philippines; the Mekong River Delta in Vietnam; almost all of the regions of Cambodia; North and East Lao PDR; the Bangkok region of Thailand; and West Sumatra, South Sumatra, West Java, and East Java of Indonesia (Yusuf and Francisco 2009).

The vulnerability of the entire Philippines is due to its extreme exposure to tropical cyclones and other climate hazards such as floods and droughts. The Mekong River Delta in Vietnam and Bangkok are more exposed to sea level rise. Although most regions in Cambodia are not exposed to climate hazards, except those sharing borders with the Mekong River Delta in northern Vietnam, almost all the provinces in Cambodia were deemed vulnerable due to their low adaptive capacity. In the case of Indonesia, the districts of Jakarta emerged as the top most vulnerable regions in SEA with Central Jakarta ranking first in the overall vulnerability assessment even though it had the highest adaptive capacity. The study noted that the vulnerability of Indonesia came from its exposure to multiple hazards and high population densities.

The Yusuf and Francisco (2009) study concluded that exposure to hazards was dominant in Viet Nam while sensitivity was the primary factor driving vulnerability in Indonesia and low adaptive capacity was paramount in Cambodia. Using different combinations of the vulnerability indicators, the study found that adaptive capacity played a consistently important role in determining the spatial pattern of vulnerability. Understanding adaptation is thus an important element in finding ways to increase the adaptive capacity of vulnerable communities.

3. STUDY SITES

The EEPSEA cross-country study was conducted in areas most vulnerable to different extreme climate events (namely, coastal regions, low-lying deltas and upland areas), which were identified as among the top most vulnerable sites in the study by Yusuf and Francisco (2009). The specific sites are shown in Figure 1 below.

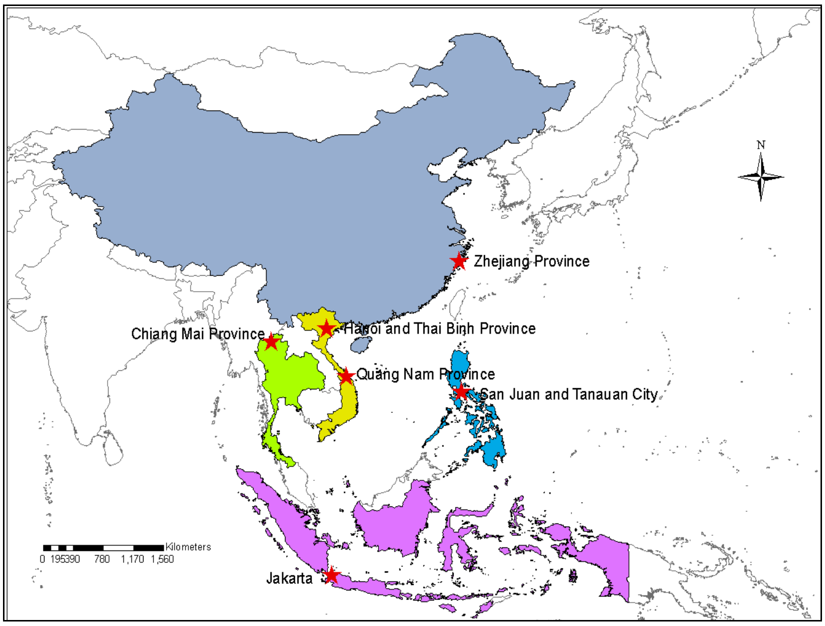

Figure 1.Study Sites

3.1 The Philippines – Typhoon Milenyo (Xangsane), September 2006

The Philippines consists of four major ecosystems: lowlands, watershed and forestry zones, agricultural areas, and coastal/fishing villages. The study focused on two sites: San Juan and Tanauan City in Batangas. Typhoon Milenyo hit the Philippines from September 25-29, 2006, and was the worst typhoon the country had experienced in a decade. It was classified as a Category 4 typhoon with a maximum wind of 230 kph. It affected the highest number of municipalities (277) and resulted in the highest total cost of damages amounting to over PhP 6.6 billion (US$ 0.1375 billion). Southern Luzon was among the hardest hit by Milenyo, particularly the provinces of Laguna, Cavite and Batangas.

3.2 China – Typhoon Saomai, August 2006

The ecosystems of China consist of lowlands, coastal areas, and mountains. The study was conducted in Pingyang County, Zhejiang Province. Zhejiang comprises mostly hills, which account for about 70.4% of its total area. Valleys and plains are found along the coastline and rivers. Zhejiang is very vulnerable to natural hazards like tropical cyclones and suffers from such cyclones almost every year. For 59 years from 1949 to 2007, the province experienced a total of 40 typhoons. Typhoon Saomai in 2006 was the strongest typhoon in mainland China since 1951. It resulted in great damage to household property and crops, and significant loss of lives.

3.3 Central Viet Nam – Typhoon Xangsane, September 2006

Central Viet Nam features mainly agricultural lowlands and coastal ecosystems. This study was conducted in Quang Nam Province, which has typical sloping topography from west to east with short rivers, lakes and low-lying areas. Climate events such as the Xangsane typhoon in 2006 and the massive floods of 2007 caused a range of adverse impacts on the socio-economic development of the poor communities living in the affected areas. Xangsane hit Quang Nam Province with an intensity level of 13 (134-149 kph) and coupled with heavy rains, led to the occurrence of extreme floods in Dai Loc. Many were seriously injured and the total cost of damage was estimated at VND 578 billion.

3.4 North Viet Nam – Flood in the Red River Delta, November 2008

The Red River has always been prone to overflowing its banks due to monsoon rains and typhoons. With climate change, there has been a rise in rainfall intensity from June to November in the Red River Delta which has increased the risk and severity of flooding. Deforestation has also caused a greater volume of water to accumulate in flood-prone areas. The great flood in the delta in 2008 was caused by a combination of all these factors and greatly impacted the multitude of households living in the area.

3.5 Indonesia – Flood in Jakarta, February 2007

Indonesia is primarily made up of coastal and urban areas. Different regions are vulnerable to different climate hazards, depending on the topography. Muara Baru was chosen as the study site because the area was affected by a flood in 2007 for a relatively long period of time due to its low-lying topography. Also, it has no proper sea dyke to protect it from storm surges. The 2007 flood disaster was caused by high tides and heavy rains and devastated Jakarta City, one of Indonesia‘s largest cities, inundating 70% of it. Muara Baru was the most severely affected area. The flood waters reached to as high as two meters and crippled more than 4,000 households.

3.6 Thailand – Floods in Chiang Mai Province, August-October 2005

The ecosystems of Thailand consist of agricultural lowlands and urban areas. The Chiang Mai Housing Community and Mae Kong Tai Village of Mae Ka sub-district were selected as the case study areas representing urban and agricultural areas, respectively. The 2005 floods (a series of big floods from August to October 2005) were claimed to be the worst in Chiang Mai Province in 40 decades. The floods in the province are generally caused by tropical cyclones and intense rainfall brought about by the southwest and northeast monsoons. When it rains in the upstream areas, the water from four rivers will flow into the Ping River through the center of Chiang Mai. During the floods, the rate of the Ping River reached 1,300 m^3 per second, more than three times the river‘s carrying capacity of 460 m^3 per second. The floods resulted in great damage particularly to housing and infrastructure in the urban areas and agricultural production in the rural areas.

4. DATA AND ANALYTICAL METHODS

4.1 Data

The cross-country study used primary and secondary data to analyse household adaptation behaviour. Primary data was collected through key informant interviews, focus group discussions, and household surveys. It covered 2,004 households over the five countries. For our regression analysis, we made use of the data for 1,711 of those households.

4.2 Households' Choice of Adaptation Options

4.2.1 Analytical framework

The household decision of whether or not to undertake adaptation strategies for extreme climate events was considered under the general framework of utility or profit maximization (loss minimization) (Norris and Batie 1987; Deressa et al. 2008). It was assumed that economic agents such as households used adaptation options only when the perceived utility or net benefit from using a particular option was significantly greater than in the case without it. In this context, the utility of the economic agents was not observable, but the actions of the economic agents could be observed through the choices they made. Supposing that U_j and U_k represent a household's utility for two choices, j and k respectively, the linear random utility model could then be specified as follows:

$$U_j = \beta_j' X_i + \varepsilon_j \text{ and } U_k = \beta_k' X_i + \varepsilon_k \qquad (1)$$

where U_j and U_k are perceived utilities of adaptation options j and k, respectively; X_i is the vector of explanatory variables which influences the perceived desirability of each option; β_j and β_k are the parameters to be estimated, and ε_j and ε_k are error terms assumed to be independently and identically distributed (Greene 2000).

For climate change adaptation options, if a household decides to use option j, then it follows that the perceived utility or benefit from option j is greater than the utility from other options (say, k) depicted as:

$$U_{ij}(\beta_j' X_i + \varepsilon_j) > U_{ik}(\beta_k' X_i + \varepsilon_k), j \neq k \qquad (2)$$

Based on the above relationship, we could define the probability that a household will use option j from among a set of climate change adaptation options as follows:

$$P(Y = 1 \mid X) = P(U_{ij} > U_{ik}) \qquad (3)$$

Equation (3) can be expressed and simplified in the following manner:

$$P(\beta_j' X_i + \varepsilon_j - \beta_k' X_i - \varepsilon_k > 0|X) \quad (3a)$$

$$P(\beta_j' X_i - \beta_k' X_i + \varepsilon_j - \varepsilon_k > 0|X)$$

$$P(\beta^* X_i + \epsilon^* > 0|X) = F(\beta^* X_i)$$

where

P is a probability function;

U_{ij}, U_{ik},, and X_i are as defined above;

$\varepsilon^* = \varepsilon_j - \varepsilon_k$ is a random disturbance term;

$\beta^* = (\beta_j' - \beta_k')$ is a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing adaptation; and

$F(\beta^* X_i)$ is a cumulative distribution function of ε^* evaluated at $\beta^* X_i$. The exact distribution of F depends on the distribution of the random disturbance term, ε^*.

According to Greene (2000), several qualitative choice models can be estimated for the above function depending on the assumed distribution of the random disturbance term.

4.2.2 Empirical model specification

Considering the multiple adaptation options available to the households, we used the multinomial logit (MNL) model to analyze the determinants affecting household adaptation decisions. This model was similarly applied to analyze crop choices (Kurukulasuriya and Mendelsohn 2006; Deressa et al. 2008) and livestock (Seo and Mendelsohn 2008) choices as methods to adapt to the negative impacts of climate change. The advantage of the MNL model is that it permits the analysis of decisions across more than two categories, allowing the determination of choice probabilities for different categories (Madalla 1983; Wooldridge 2002). The usefulness of this model in terms of ease in interpreting estimates is likewise recognized (Deressa et al. 2008).

Based on equation (2), the general form of the MNL model is:

$$\Pr ob[Y = j] = \frac{e^{\beta_j' X_{ji}}}{\sum_j e^{\beta_j' X_{ji}}}, j = 0,1,\ldots,J \quad (4)$$

where i indexes the observation, or individual household, and j indexes the adaptation choices.

For the MNL model in equation (1), to obtain an unbiased and consistent parameter, the assumption of the independence of irrelevant alternatives (IIA) had to be met. Specifically, the IIA assumption requires that the probability of using a certain adaptation option by a given household needs to be independent of the probability of choosing another adaptation option. This means that P_j/P_k is independent of the remaining probabilities. The premise of the IIA assumption lies in the independent and homoscedastic disturbance terms of the basic model in equation (1).

The parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent (response) variable, but the estimates do not represent the actual magnitude of change or probability. Differentiating equation (1) with respect to the explanatory variables provides the marginal effects of the explanatory variables, shown as follows:

$$\delta_j = \frac{\partial P_j}{\partial X_i} = P_j\left[\beta_j - \sum_{k=0}^{J} P_k \beta_k\right] = P_j(\beta_j - \bar{\beta}) \tag{5}$$

The marginal effects or marginal probabilities are functions of the probability itself and measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable from the mean (Greene 2000).

The dependent variable is y, coded 0,1,...,j (adaptation options). The empirical multinomial logistic model to examine the choice of adaption option by households is:

Adapt Choice = f(Experience, Exposure/Sensitivity, Wealth, Household Characteristics and Belief System, Social Capital, Country Dummy Variables)

The independent/explanatory variable groups are defined in Table 1 and the descriptive statistics of the independent variables are provided in Appendix 1.

To proceed with the analysis, we classified the households using the adaptation strategies they implemented into mutually exclusive options as follows: (a) no adaptation measure (Y=0), (b) reactive measures (Y=1), and (c) proactive measures (Y=2).

Table 1. Definitions of the independent variable groups used in the model

Variable Group	Definition
Experience	
• FREQD	Frequency of extreme climate events experienced in the past
• TRAIN	Attended training about disaster preparedness in the last 5 years: 1=yes, 0 otherwise
• TKNOW	Traditional knowledge: 1=yes, 0 otherwise
Exposure/Sensitivity	
• HTYPE	Permanence of house: 1=yes, 0 otherwise
• MSTOREY	Number of storeys in house
Wealth	
• HOWN	House ownership: 1=yes, 0 otherwise
• WEALTH	Vehicle/boat ownership: 1=yes, 0 otherwise
• HELP	Asked for help from outside the household: 1=yes, 0 otherwise
Household Characteristics and Belief System	
• HHSIZE	Household size of the respondent
• EDUC	Education level of respondent
• AGE	Age of the respondent
• FATE	The extreme typhoon/flood encountered is fate which the household has little control over: 1=agree; 0 otherwise
• FUTURE	Perception of risk of future climate change-induced events: 1=more severe than what was experienced, 0 otherwise
Social Capital	
• NINFO	Number of channels for receiving information
• MEMORG	Membership in organization: 1=yes, 0 otherwise
• GROUP	Participation in collective action: 1=yes, 0 otherwise
• STAY	Length of stay in the area

5. RESULTS AND DISCUSSION

5.1 Household Adaptation Behavior

In this section, we look at the adaptation strategies that were implemented by the households in response to the extreme climate events they experienced. To facilitate our understanding of household adaptation behavior, we categorized their different adaptation strategies into various types: behavioral, soft structural, technological, and financial. The survey results showed that the most prominent behavioural adaptation measures adopted by most of the respondents across the five countries were evacuation by households and moving properties to safer places (Table 2). In the case of the Philippines, Viet Nam and China, the households also practiced storing food, drinking water and other necessities in preparation for the climate event.

Table 2. Adaptation strategies and practices of households in selected SEA countries

Adaptation Strategies	China (%)	Indonesia (%)	Philippines (%)	Thailand (%)	Viet Nam (%)
A. Behavioral					
Preparing evacuation means	1	2	-	-	14
Evacuation to safer places	49	26	29	8.5	32
Moving properties to safer places	30	22	43	92	30
Storing food, drinking water and other necessities	59	5	63	1	60
B. "Soft Structural"					
Repairing/reconstructing houses using more durable materials or more resilient structures	69.0	46.0	51.5	-	51.0
Building mezzanine/ second floor	1.0	8.0	-	2.5	9.0
Building scaffolds to protect household structures	-	-	-	24.5	48.5
Use of sandbags/ concrete blocks as dykes	-	4.0	-	55.5	9.0
Reinforcing ponds and dykes	2.0	2.0	1.0	-	25.0
C. Technological					
Changing cropping patterns	1.0	-	0.5	8.0	4.0
Installing pumping machines	-	10.0	-	-	9.0
Early warning system	20.0	4.0	14.6	55.0	27.0
D. Financial					
Diversifying income sources, borrowing money, etc.	46.0	12.0	2.0	-	18.0
Buying disaster insurance	-	-	-	-	-

Source: Household survey data (2009)

For the ―soft structural‘ adaptation strategies, most of the households in China (69%), Philippines (52%), Viet Nam (51%), and Indonesia (46%) did some repairs or reconstruction of their houses using more durable materials or structures (Table 2). An example of a soft structural adaptation measure used in the Philippines and Viet Nam is where a bamboo frame was used to protect the roof. Some households put hollow blocks or heavy metal objects on top of their roofs while others tied their houses to trees or poles. In Thailand, sandbags were often used as a protective measure against floods although some households used concrete dykes for the same purpose (56%). In Vietnam, 25% of the respondents reinforced ponds and dykes. Many of the households in Viet Nam (49%) and Thailand (25%) also built scaffolds to protect their household structures. Building a mezzanine or second floor in the house was yet another adaptation strategy used by some households in Indonesia (8%) and Viet Nam (9%) and to a smaller extent, in China and Thailand (Table 2).

In terms of technological adaptation measures, not many of the households (except for the Philippines with 55% of the respondents) relied on early warning systems to prepare for the extreme climate events. There were even fewer households which used other technological means to reduce potential damage such as changing cropping patterns and using pumping machines.

Other adaptation measures practiced by the households were classified as financial adaptation strategies (Table 2). As is the case of the use of early warning systems, not many households were able to diversity their income sources to improve their economic position nor were they able to borrow money from other sources. However, 46% of the households in China, 18% of those in Viet Nam, 12% of those in Indonesia and 2% from the Philippines managed to carry out one or both of these measures. Interestingly, none of the households opted to buy disaster insurance. When asked whether they will be willing to buy such insurance, however, a sizable number expressed interest. The proportion of those willing to pay for insurance was 46% among the Chinese respondents, 37% among the Thai respondents, 33% among the Filipino respondents, and about 20% in rural Vietnam (Figure 2). Very few city residents from Jakarta and Hanoi, however, were willing to pay for disaster insurance.

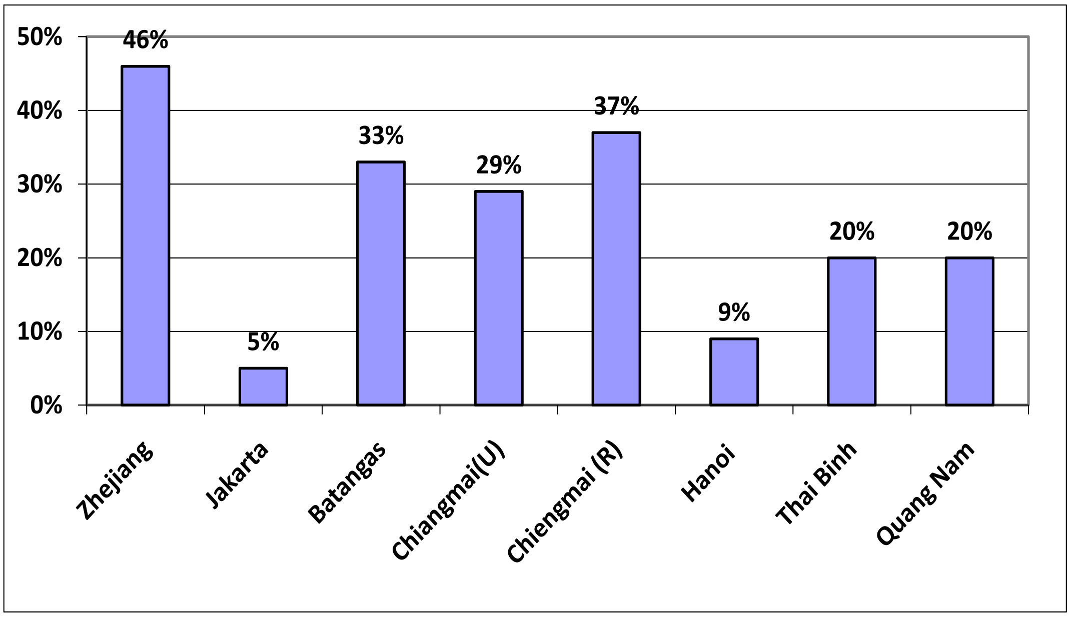

Figure 2. Proportion of households willing to purchase disaster insurance

Proactive versus Reactive Adaptation Strategies

A closer look at the adaptation practices undertaken by households in the face of extreme climate events can be broadly classified into reactive and proactive measures. Reactive measures refer to actions that are done at the very last minute or when the event is already happening. They also refer to minimal efforts to protect oneself, most likely due to lack of means to undertake more effective protection measures. The most dominant practice under this category is evacuation. Putting hollow blocks or heavy things on top of roofs, tying one's house to trees, using posts to reinforce one's house, and using sandbags to block out flood waters are examples of ‗weak' structural measures that are also classified as reactive in nature. Proactive measures, on the other hand, come from anticipating the event way in advance, for instance, by relying and acting on early warnings, constructing elevated housing units, and building concrete walls or dykes to prevent flooding. We found that 64% of the households had relied on reactive measures and about 31%, on proactive measures (Table 3). This is consistent with the fact that most households lack the means to invest in stronger housing units while many are yet to benefit from having greater access to early warnings.

Table 3. Classification of mutually exclusive household adaptation strategies in selected SEA countries

Adaptation Choice	Frequency	Percentage
No Adaptation (Y=0)	99	5.8
Reactive Measures (Y=1)	1,090	63.7
Proactive Measures (Y=2)	522	30.5
Total	1,711	100.0

Source: Household survey (2009)

5.2 Factors Influencing Household Adaptation Choices

An MNL regression analysis was performed to determine the factors influencing a household's choice of proactive or reactive adaptation strategies related to climate extreme events. The estimation of the MNL model was undertaken by normalizing one category, which is normally referred to as the ―base category". In this analysis, the ―no adaptation" option was used as the base category. The likelihood ratio statistics as indicated by the χ^2 statistics were found to be highly significant ($P<0.0000$), indicating that the model was significant and had strong explanatory power. It also had a high correct prediction percentage of 74.46% and a pseudo-R^2 of 25%.

The model was also tested for the validity of the assumption of the independence of irrelevant alternatives (IIA) using the Hausman test. The results of this test (χ^2=6.24; Pr>χ2=0.0.9992) failed to reject the null hypothesis of independence of the climate change adaptation options. This indicates that the MNL specification was appropriate to model climate change adaptation strategies of households for this study. A similar MNL model specification was used successfully by Deressa et al. (2008) to model the climate change adaptation practices of smallholder farmers in Africa.

The parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent (response) variable; they do not represent the actual magnitude of change or probability. Thus, the marginal effects of the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, were examined in this analysis. In all cases, the estimated coefficients were compared with the base category of ―no adaptation". Table 4 presents the marginal effects along with the levels of statistical significance.

For the household experience variables, only attendance at training events on disaster preparedness significantly affected the probability of a household to undertake proactive/reactive adaptation measures. Households which had received such training had a lower probability of undertaking reactive adaptation measures and were conversely more likely to opt for proactive ones. The probability of adopting reactive adaptation measures decreased by 10.5% while the probability of undertaking proactive adaptation increased by 9.8% for such households.

Table 4. The marginal effects of the determinants of household adaptation decisions

INDEPENDENT VARIABLES	**No Adaptation Measure**		**Reactive Measures**		**Proactive Measures**	
CONSTANT	**-0.1768**	***	**0.9650**	***	**-0.7882**	***
FREQD	0.0035		-0.0405		0.0369	
TKNOW	0.0050		-0.0264		0.0214	
HTYPE	0.0090		**-0.1586**	***	**0.1496**	***
MSTOREY	-0.0011		**-0.0981**	***	**0.0992**	***
TRAIN	0.0073		**-0.1049**	**	**0.0976**	**
HOWN	-0.0082		-0.0187		0.0269	
WEALTH	-0.0093		-0.0185		0.0279	
HHSIZE	**-0.0035**	**	**0.0120**	*	-0.0085	
EDUC	0.0012		**-0.0168**	***	**0.0157**	***
AGE	**0.0009**	***	-0.0020		0.0010	
NINFO	**0.0074**	***	**-0.0597**	***	**0.0523**	***
MEMORG	**-0.0141**	*	0.0392		-0.0252	
GROUP	-0.0014		0.0031		-0.0017	
STAY	**0.0005**	**	-0.0014		0.0009	
HELP	-0.0102		**0.1139**	***	**-0.1037**	***
FATE	0.0061		0.0452		-0.0513	
FUTURE	0.0037		**0.0600**	**	**-0.0638**	**
CHINA	-0.0216		**-0.2183**	***	**0.2400**	***
PHIL	**0.0736**	***	**-0.3696**	***	**0.2960**	***
THAI	**0.0634**	***	**-0.5946**	***	**0.5312**	***
Pseudo-R^2	0.2488					
Log likelihood function	-1046.644					
Restricted log likelihood	-1393.303					
Chi-squared	693.319					
Prob[ChiSqd>X^2-value)	**0.00000**	***				
% Correct Prediction	74.46					
No. of observations	1711					
Base category: No adaptation						
Note: ***, **, * = significant at 1%, 5% and 10% level, respectively						

The results for the exposure/sensitivity variables showed that households with permanent type of houses and more number of storeys in the houses had a higher probability of adopting proactive measures. These variables are reflective of the higher economic status of the households, indicating that wealthier households would be more likely to take proactive adaptation measures. This corresponds with the inference of the study that households which owned their own houses as well as boats or vehicles would be more inclined to undertake proactive measures.

Social capital was found to significantly influence household adaptation decisions. Asking for help from outside the household could however be interpreted as having access to social capital as well as not being economically well-off. As the other more direct social capital indicators (namely, organizational membership and participation in collective action) did not turn out to be significant, we could view this variable as a proxy of economic independence. The sign of the coefficient would be indicative of whether the household preferred reactive or proactive measures. Those who sought help from outsiders (positive sign) would more likely use reactive measures. In contrast, those who found no need to seek help from others (negative sign)—probably because they were more well-off than those who sought help— were more likely to opt for proactive measures.

The study found that increasing the number of information channels providing news about extreme climate events would decrease the probability of undertaking reactive measures. This finding lends support to the important role that information provision plays in enhancing the adaptive capacity of households.

Household size was found to be positively and significantly related to the probability of a household undertaking reactive adaptation measures. In the case of education, it was inferred that more educated households were more likely to implement proactive adaptation strategies than reactive ones.

The belief system of a household also affected its adaptation decisions. Households were more likely to undertake reactive rather than proactive measures if they perceived the risk of future climate change-induced events to be more severe than what they had previously experienced. This is contrary to expectation but could arise from an attitude of resignation. In other words, if people expected extreme climate events to become more severe, they may become resigned to such events being ‗fated‘ and thus, beyond their control. The survey had included a ‗fate‘ question to test the fatalistic attitude of the respondents and found that most of the respondents had such an attitude with a relatively smaller proportion favoring proactive measures (Appendix 1).

5.3 Barriers to Adaptation

From the study, we identified the adaptation actions of households, the reasons for undertaking them, and the barriers that prevented the households from adapting (Table 5). The adaptation barriers at the individual household level were not limited to financial constraints. The other adaptation barriers found were: (a) the lack of timely information about the occurrence of the event, (b) the lack of knowledge of what the households could do to adapt, and (c) wrong assessment by the households of the severity of the event. Some of the households which did not want to relocate gave reasons like they were too used to living in their homes and their work places were nearby. This is consistent with the findings of Adger et al. (2007) who found that strong social capital and social networks could be barriers that prevented households from relocating to safer places in the face of risk. At the community level, the main barrier to adaptation was the lack of cooperation among the various stakeholders and constituents, particularly in the urban areas.

Table 5. Adaptation barriers for households in four Southeast Asian countries

Country	Most Needed Adaptation Strategy	Main Barrier to Implementing the Strategy
China	Building houses according to building codes	Not enough financial support
Indonesia	Building and heightening dykes	Believing that it is the government's responsibility
Philippines	Reinforcing/improving the house	Did not have enough money
Thailand (urban)	Using more sandbags	Did not know when the event would occur
Thailand (rural)	Harvesting crops earlier	Did not know when the event would occur
Hanoi (inland), Viet Nam	Building and reinforcing houses and animal cages	Did not know when the event would occur
Hanoi (coastal), Viet Nam	Building and reinforcing houses and animal cages	Did not have enough money
Hue, Viet Nam	Reinforcing houses	Did not have enough money

6. CONCLUSIONS AND POLICY IMPLICATIONS

The cross-country research project focused on extreme climate events such as typhoons and floods. Study areas affected by both were in China, the Philippines, and Viet Nam (Hue), whereas Thailand, Indonesia, and Viet Nam (Hanoi) were impacted only by riverine floods. The household adaptation strategies in the five countries were grouped into four categories: behavioral, soft structural, technological, and financial. The study found that most households had undertaken more than one option but generally, choices were mostly of the reactive type. Few households relied on early warning systems and other forms of technological adaptation options. Although none had bought disaster insurance, there were a sizable number which signified their willingness to do so. Most of the adaptation strategies employed were autonomous in nature while there were a few that could be considered as planned adaptation such as building mezzanine/second floors and changing crop calendars.

The household choices of adaptation strategies to extreme climate events in the study were analyzed using the MNL model. We were interested in determining the factors affecting the probability of households choosing reactive or proactive adaptation options. The explanatory variables used in the model were the household's experience, exposure/sensitivity, wealth, characteristics and belief system, and social capital. Adaptation barriers and constraints both at the community and household levels were also examined.

Adaptation decisions were significantly influenced by a number of factors based on the households' social and economic circumstances, with opposing effects on their choices to undertake reactive or proactive measures. These were: housing type, household size, level of education, attendance at training programs on disaster preparedness, perception of the risk of future extreme climate events, the number of information channels available, and level of dependence on others for help.

The marginal analysis showed that the probability of choosing reactive adaptation measures could be reduced and the likelihood of selecting proactive measures could be raised through the following: (a) providing support to households for more permanent or stronger and higher housing units; (b) providing higher education and training opportunities for household members; and (c) providing better access to information through multiple channels; and (d) reducing economic dependence (seeking help) on others. As one would expect proactive adaptation measures to be more effective than reactive measures in reducing the damage from extreme climate events, especially in the long term, there is a need to promote such measures.

Financial constraints and lack of information about the occurrence of climate events were found to limit the extent of climate change adaptation. It is therefore important that government policies ensure that household have access to adequate and timely information related to climate events. At the community level, adaptation was found to be hampered by the lack of cooperation among the various stakeholders and constituents, particularly in the urban areas. Government and non-government organizations should thus play a stronger role in strengthening community-based climate change adaptation action. The study also found that promoting collective action was likely to positively influence the buying of climate-related disaster insurance and should therefore be encouraged.

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APPENDIX

Appendix 1. Descriptive statistics of the independent variables used in the multinomial logit model

Independent Variables	No Adaptation (n=99)				Reactive Measures (n=1090)				Proactive Measures (n=522)			
	Mean	**Std**	**Min**	**Max**	**Mean**	**Std**	**Min**	**Max**	**Mean**	**Std**	**Min**	**Max**
FREQD	0.51	0.46	0.05	1	0.64	0.44	0.05	1	0.54	0.45	0.05	1
TKNOW	0.44	0.50	0	1	0.42	0.49	0	1	0.52	0.50	0	1
HTYPE	0.73	0.45	0	1	0.57	0.50	0	1	0.85	0.36	0	1
MSTOREY	0.29	0.46	0	1	0.47	0.50	0	1	0.48	0.50	0	1
TRAIN	0.11	0.32	0	1	0.08	0.27	0	1	0.14	0.34	0	1
HOWN	0.93	0.26	0	1	0.96	0.19	0	1	0.94	0.24	0	1
WEALTH	0.23	0.42	0	1	0.21	0.41	0	1	0.39	0.49	0	1
HHSIZE	3.76	1.80	1	9	4.69	2.05	1	14	4.09	1.96	1	16
EDUC	7.43	3.82	0	18	6.69	3.72	0	16	7.77	4.02	0	18
AGE	58.10	14.68	24	83	49.61	14.30	15	90	51.10	13.50	16	93
NINFO	4.66	3.78	0	12	2.94	3.08	0	12	4.43	3.19	0	12
MEMORG	0.43	0.50	0	1	0.51	0.50	0	1	0.43	0.50	0	1
GROUP	0.55	0.50	0	1	0.53	0.50	0	1	0.57	0.50	0	1
STAY	41.10	23.67	1	83	34.03	20.18	1	87	34.04	20.09	1	87
HELP	0.56	0.50	0	1	0.77	0.42	0	1	0.51	0.50	0	1
FATE	0.78	0.42	0	1	0.81	0.39	0	1	0.67	0.47	0	1
FUTURE	0.30	0.46	0	1	0.41	0.49	0	1	0.27	0.44	0	1
CHINA	0.02	0.14	0	1	0.24	0.43	0	1	0.19	0.39	0	1
PHIL	0.39	0.49	0	1	0.25	0.43	0	1	0.16	0.37	0	1
THAI	0.31	0.47	0	1	0.05	0.21	0	1	0.42	0.49	0	1

Source: Authors‘estimates

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