International Journal of Food and Agricultural Economics
ISSN 2147-8988, E-ISSN: 2149-3766
Vol. 4 No. 4, 2016, pp. 29-44

PERCEPTION, PREPAREDNESS AND SEVERITY OF CLIMATE CHANGE TRIGGERED EVENTS IN BEN TRE PROVINCE, VIETNAM

Trang T.H. Le
Department of Agricultural Economics and Rural Sociology,
Auburn University Agricultural Experiment Station, Auburn University, USA

Kim Anh T. Nguyen
Faculty of Economics, Nha Trang University, Nha Trang, Vietnam

Curtis M. Jolly
Department of Agricultural Economics and Rural Sociology,
Auburn University Agricultural Experiment Station, Auburn University, Auburn,
Alabama, 36849, USA, Email: cjolly@auburn.edu

Abstract

Eight provinces, including Ben Tre, located in the Mekong River Delta, are among Vietnam's most vulnerable areas to climate change (CC) triggered events. We conducted a study to identify the impacts of CC on Ben Tre Province coastal communities; to evaluate their knowledge, preparedness, perception of severity; and the effects of CC triggered events on aquaculture. We conducted three focus group discussions and a survey of 300 households. Farmers were aware of changing climatic conditions and pointed out indicators of these changes: (1) Changes in production and culturing patterns, (2) Changes in housing designs, and (3) Construction of dikes to prevent salt water intrusion. About 35, 40 and 26 percent of the total sample said they suffered losses to their aquaculture farms from typhoons, salt intrusion and erosion, respectively. Age, education and previous effects from CC events affected knowledge, preparedness, and severity of CC triggered events. Farmers who were engaged in aquaculture were more likely to be prepared for CC events than those who were not.

Key Words: *Climate, Change, Awareness, Adaptations, Aquaculture, Ben Tre, Vietnam.*
JEL Codes: Q22, Q24

1. Introduction

Vietnam is one of the most susceptible countries to climate change triggered events in South East Asia (Vien, 2011; Yusuf and Francisco, 2010; Bates et al., 2008). Eight of Vietnam's ten most vulnerable provinces to climate change engendered events are located in the Mekong River Delta including Ben Tre Province (IPCC, 2001; IPCC, 2007). In the past 50 years Vietnam has experienced an increase of 0.5-0.7^{0}C in annual average temperature, and a 20 cm rise in sea level. These climatic changes have been associated to frequent and serious occurrence of disasters like typhoons, floods, and droughts in the past twenty years. Simulations carried out by Anderson et al. (2002) have shown that there are links between weather events and average temperature increases in Asia. Temperature increases and sea level rise, which cause permanent inundation, increased flooding, as well as salt water intrusion, have together impeded agricultural and aquaculture development and posed risks to industrial production and the socio-economic systems.

Climate change impacts coupled with the interference of downstream water flow by China's water extraction upstream influence the climatic variability, the frequency, and intensity of extreme events that definitely harm agricultural and aquaculture productivity and long-term sustainable development in the south-central provinces (Zhai & Zhuang, 2009). They projected that agricultural productivity in Vietnam will decline by 12 to 23 percent due to global climate change. Climate change has major and damaging effects on fish and rice production, and affect household food consumption since about 48 percent of the poor depend on rice for their basic caloric needs (Vo, 1997; Wassmann et al., 2004).

Limiting the effects of environmental degradation on individual livelihoods and on broader prospects for sustainable economic growth can be achieved by reducing vulnerability, enhancing resilience, and promoting adaptive strategies to climate change triggered events. In order that the Vietnamese society works towards mitigation of the problem they must be aware and knowledgeable about the link between climate change and weather triggered events. Efforts to increase perception, awareness and knowledge are urgent and critical for the well-being of the farmers, fishers, forest dwellers, and urban population of Vietnam (Adger et al., 2001). Thus, the concept of human security in Vietnam is attributed to food, livelihood, and social security. It is important to examine the rural people's perception of the seriousness of climate change triggered events, their coping mechanisms and the strategies adopted to mitigate the effects.

The Government of Vietnam has identified climate change as a priority area for development assistance due to Vietnam's extreme vulnerability to climate change impacts. Ben Tre Province has been identified as one of the most sensitive and exposed regions and has suffered agricultural losses from salt water intrusion amounting to US $750,000. Salt water intrusion also resulted in decreased fresh water availability, an increase in poverty rate, decrease in land use and a population shift. From 1995 to 2005 salt water intrusion resulted in loss of 360 ha in aquaculture land and 5,289 tons of dead fish (Ben Tre PCC, 2011). Continued rise in sea level is, therefore, bound to have serious negative impacts on an already impoverished region. However, there have been no studies that evaluate the knowledge, preparedness and perception of future severity of these changes and the relationship between these changes and aquaculture production. In this study, we evaluate the factors influencing knowledge, preparedness and perception of severity and coping mechanisms adopted by households and communities in Ben Tre Province to deal with climate change and the effects on aquaculture.

1.1. Objectives

In general, the study identifies and assesses coastal people's knowledge, their preparedness for future events and their perceived future severity of climate change triggered events. The impacts of climatic triggered events as sea level rise, salt water intrusion, coastal erosion, and typhoon/flooding in Ben Tre Province are examined in three coastal communes, namely Thua Duc of Binh Dai District, An Thuy of Ba Tri District, and Giao Thanh of Thanh Phu District.

Specifically, the study:

1. Evaluates households, aquaculture farmers and communities' knowledge, preparedness, and perception of severity of climate change events and their impacts;
2. Evaluates households that practice aquaculture knowledge, preparedness and future severity of climate change events on aquaculture;

3. Estimates the proportion of agricultural and aquaculture losses that are due to climate triggered events; and
4. Identifies the household and community adaptation measures used to cope with these impacts.

1.2. Conceptual Framework

The impacts of climate have been noted throughout the world in different ways. Though there is a general awareness of the damages of climate change triggered events by communities not all of them have developed strategies to mitigate the effects (DEFRA, 2002). The perception of climate change has been based on the understanding of the general public (Bord & O'connor, 1998) and the impacts have been publicized through various media (McCarthy et al., 2001; Parmesan & Yohe, 2003; Adger, 2003; and Tran et al., 2015). The overall perception of climate change events depends on the individual and communal sense of vulnerability and the anticipated negative impacts of climate change on one's household and survival (Adger, 2003; Lorenzoni et al., 2007). People tend to interpret the term climate change according to a particular event. In this case climate change is interpreted as salt water intrusion, and sea level rise associated to typhoons, floods, and extreme dryness.

Communities that experience the events related to climate change gather information from all sources. That means they seek to educate themselves as they become aware of the threats of climatic triggered events (Lee et al., 2015). Education and awareness-raising play an essential role in increasing the climate change adaptation and mitigation capacities of communities by enabling individuals to make informed decisions. Education helps learners understand the causes and consequences of climate change, and prepares them to live with the impacts of climate change (UNESCO, 2014). Having perceived the damages of climate change, however, does not mean that people are informed about the nature and consequences (Godfrey et al., 2009; Taderera, 2010; Ochieng & Koske, 2013). The approach to minimize the effects of climatic damages may involve mitigation and adaptation. There is hardly any difference in the two strategies since both are directed towards minimizing the effects of climatic risks (Ayers & Huq, 2007). The mitigation aspect is identifying the causes of climate change and the development of knowledge, skills and actions for individuals and society to employ coping strategies with the associated events (Nguyen et al., 2013).

Individuals and communities that perceive the threats of climate change are bound to seek knowledge about adaptive and coping mechanisms for dealing with the risks of exposure to the triggered events. As Debela et al. (2015) have stated key factors associated with public awareness and risk perceptions highlight the need to develop tailored climate communication response and strategies for individual countries. In this study, we seek to develop models to understand how individuals' knowledge of the effects of climate change, the factors that affect their preparedness and perceived severity; their coping and adaptation strategies and how these events affect aquaculture production.

1.3. Model Development

Perception, awareness, knowledge and perceived severity affect the ways in which farmers deal with climate-induced risks. Their behavioral responses to climatic change will shape adaptation and mitigation options. The process involved in coping and adaptation generates the outcomes (Adger et al., 2009; Adger et al., 2005 & Pauw, 2013). Perception awareness and knowledge of climate change among rural communities are driven by multiple forces. Different socio-demographic and farm factors influence whether and to what extent farmers perceive climate change and its impact on local agriculture (Deressa et al., 2009). The probability that an individual perceives, becomes aware or is knowledgeable about climate change will affect his/her ability to cope or adapt to the events. Hence it is important that we investigate the factors that influence the individual's knowledge, preparedness and perceived severity of climate change.

We used a logistic model to determine the probability (P) of an individual from a household being knowledgeable or not; also his or her preparedness or not and his or her perceived severity or not of future climatic triggered events on aquaculture. A binary response model is specified and estimated logistically. This procedure was used to determine the effects of socio-economic characteristics (χ) of the farmers and their farms on their choice decision.

The logistic specification is suited to models where the dependent variable is dichotomous, which in this case accounts of farmer response to climate change events.

The logistic equation is represented by:

$$P_j = \frac{\exp(\beta'_j \chi)}{\sum_{j=1}^{n} \exp(\beta'_j \chi)} \qquad j=1\ldots n \tag{1}$$

One of the vectors of the coefficients β is set to zero for normalization (Wynn et al., 2001). If it is β_i, that is set to zero then:

$$\log\left(\frac{P_j}{P_i}\right) = \beta'_j \; \chi_j \; = 2 \ldots n \tag{2}$$

2. Methodology

2.1. Focus Group Discussions (FGD) in Ben Tre Province

The first focus group discussion (FGD) which had as objectives: (i) to inform the authorities of the research, and (ii) to provide a forum in which to discuss the situation of climate change in Ben Tre Province was held in the presence of eight provincial officials, namely the People's Committee of Ben Tre Province, the Ben Tre Province Bureau of the National Target Program to Respond to Climate Change, the Ben Tre Department of Aquaculture and Rural Development, the Ben Tre Department of Natural Resources and Environment, the Ben Tre Department of Science and Technology, the Ben Tre Department of Plan and Investment, and the Ben Tre Department of Finance.

The second FGD was held on the basis of the first FGD but this time in the presence of 10 Binh Dai district government officials from the People's Committee, the Department of Agriculture and Rural Development, the Department of Natural Resources and Environment, the Department of Economic Development, as well as authority representatives from Thua Duc coastal commune. The participants were mainly chosen because of their experience and knowledgeable insights in agriculture, aquaculture and climate change. This FGD focused primarily on discussing the objectives of the research project with local officials. At the same time, it served as a platform for people to share their opinions and observations on the signs and impacts of climate change and sea level rise in Binh Dai district. In addition, the research group gained insights and verified the responses of the first FGD.

After the second FGD, the research team, along with the Head of the Office of Ben Tre People's Committee and representatives from the Ben Tre Department of Natural Resources and Environment instigated investigations into climate change worst-affected areas of Binh Dai and Ba Tri coastal districts, into two clam culturing cooperatives with massive clam deaths, into three black tiger and white leg shrimp farms, erosion along the river, into damaged constructions and infrastructure and into the dam on Ba Lai river. The investigations enabled the research team to develop contact with residents of the community of the affected areas before launching the third FGD.

The third FGD welcomed the participation of 12 farmers from different communes in Binh Dai and Ba Tri district. The participants were selected by the district authority officials. Some of the participants came from the largest zones of aquaculture and agricultural production in the district. The purpose of this FGD was to exchange ideas about the objectives of the research with the farmers and determine the level of awareness regarding climate change and sea level rise.

2.2 Household Survey Analysis

2.2.1 Sampling Strategy

Three hundred households that were involved in the survey were equally divided among three studied coastal districts. In each commune, the survey covered all villages with the hope that the samples represented the population. Respondents were chosen based on the economic structure of the commune in order to involve as many occupations as possible, including agriculture, aquaculture and fishing.

2.2.2 Data Analysis

Data collected from the household surveys were analyzed using EXCEL and the Statistical Analytical System (SAS). Descriptive statistics of socio-economic and production variables were obtained. Logistic models were developed to analyze the factors that influence knowledge, preparedness, and perceived severity of climate change, and the farmers engaged in aquaculture perception of the effects of climate change triggered events.

The parameters of the model are estimated with the maximum likelihood estimation technique. The model is developed such that Pj/Pi is equal to Y, the dependent variable measuring the probability of the individual's knowledge, preparedness and future risks of climate change where X_1 to X_n is a set of independent variables representing socio-demographic and biophysical characteristics and e the error term. The model is linearly represented as:

$$P_j/P_i = Y = B0 + B1X_1 + B_2X_2 \ldots B_nX_n + e \qquad (3)$$

3. Results

3.1 Focus Group Results

The first FGD indicated that the three coastal districts, Binh Dai, Ba Tri and Thanh Phu witnessed the worst damages from climate change impacts and sea level rise. The second FGD revealed that changeable weather phenomenon, increasing temperature and salinity, together with the larger gap between day and night time temperatures and sea level rise were the revealed signs of climate change prevailing in Binh Dai district. Alternation in seasonal wind direction also caused variation in currents on river valleys, thus influencing soil erosion.

In Thua Duc commune, productivity of shrimp from extensive farming within mangrove forest decreased noticeably (from VND 7-10 million per crop prior to 2007 to only VND 5 million per crop after 2007). Increases in temperature and salinity thickenend the exoskeleton of black tiger and white leg shrimp; hence slowing down their growth. Such harsh conditions also lengthenend the culture period by an average of one month. Fishing productivity, similarly, experienced major declines. In 2010, massive clam deaths (up to 90%) inflicted enormous losses on farmers. The clam culturing areas were assessed to be highly vulnerable to climate change and sea level rise changed the environmental conditions and the ecology. During the third FGD the farmers showed initial awareness of climate change and sea level rise as well as initiated planned actions against the situation of climate change.

3.2 Household Survey Results

Of the 300 households interviewed 286 of them were considered appropriate for analysis. Descriptive statistics showed that the average age of respondent was 49 that ranged from 26 to 86 (Table1). There were 51 females and 235 were males. About 7.0 % of the sample reported having no schooling, 51.7 % had only received primary education, 29.7% had received some secondary education, 11.3 % had high school education but only 0.3 % attended college. A total of 203 of the households indicated that their primary occupation was farming, and of these 52 were involved in aquaculture. Most farm households owned their homes and land.

Table 1. Descriptive Statistics of Socio-demographic Variable for Households in Ben Tre Province, 2012

Variables	N	Mean	Std Dev	Minimum	Maximum
Age	286	49.220	11.933	26.000	86.000
Ownedland (sq meters)	286	7,341.260	9,376.250	-	43,000.000
Distht (meters)	286	3,146.300	4,941.810	9.000	25,000.000
Disth20 (meters)	286	285.549	472.159	9.000	4,000.000
Educ	286	5.395	3.174	-	13.000
Floodht (meters)	286	0.021	0.166	-	2.000
Depratio	286	23.398	20.360	-	75.000
Hhsize	286	4.318	1.424	1.000	10.000
Numcredit	286	3.636	2.729	-	15.000
Numwithjob	286	2.510	1.324	-	8.000
Numfemale	286	2.129	1.109	-	7.000
NumfloodC	286	0.745	0.490	-	3.000
Numfloodh	286	0.668	0.479	-	2.000
Nummale	286	2.189	0.991	-	5.000

Note: Ownedland - Area of owned farm or fishery land; Distht - Distance of house to the coastline during high tide; Disth20 - Distance of house to the nearest body of water; Educ - Education of household head; Floodht - Highest flood level that inundated house (last 10 years); Depratio - Household members below 15 and above 64/household size *100; Hhsize - Household size; Numcredit - Number of contacts household made to access credit; Numwithjob - Number of family members with jobs; Numfemale - Number of female family members; NumfloodC - Number of floods that affected the community (last 10 years); Numfloodh - Number of floods that inundated house (last 10 years); Nummale - Number of male family members.

A number of respondents could not tell that there were changes in climatic events but 38 percent were sure about the phenomenon of climate change. There was a significant difference between those who said they knew about climate change and those who had no knowledge.

About 35 percent said they were prepared for climate change events and 61 percent perceived the severity of climate change. An overwhelming 90.5 percent noticed salt water intrusion, but only 57 percent observed communities were affected by coastal erosion or sea level rise.

3.3 Knowledge, Preparedness and Perceived Risks

The logistic model showed that age, education and previous experience with salt water intrusion on ones' property influenced knowledge of climate change. Heads of households with knowledge of climate change tended to be older and more educated. We found that age, education and previous observations of salt water intrusion damages on ones' property influenced knowledge of climate change. Those with some schooling were 1.2 times more likely to state that they had some knowledge of climate change than those who had received no or limited formal education. Heads of households who were previously affected by climate change events were 3.05 times more likely to affirm that they experienced salt water intrusion on their property than those who had never been affected (Table 2).

Table 2. Logistic Model Results of Dependent Variables Knowledge, Preparedness and Perception of Severity of Climate Change in Ben Tre Province, (2012)

Variable	Estimate B	Pr > Chi-Square	Odds Ratio Estimate	Rsquare/ MaxRsquare
Knowledge of climate change				
Age	0.038	0.001*	1.039	(0.144 - 0.195)
Education	0.246	0.000*	1.279	
Community affected by flood between 2001- 2010	0.107	0.484	1.240	
Salt water intrusion	0.558	0.011*	3.052	
Community affected by coastal soil erosion or sea level rise	0.186	0.177	1.449	
Preparedness for future climate changes				
Age	0.029	0.010*	1.029	(0.068 - 0.094)
Education	0.129	0.003*	1.138	
Community affected by flood between 2001- 2010	0.009	0.956	1.017	
Salt water intrusion	0.332	0.176	1.942	
Community affected by coastal soil erosion or sea level rise	0.268	0.043*	1.709	
Perception of severity for future climate changes				
Age	(0.009)	0.432	0.992	(0.084 - 0.113)
Education	(0.128)	0.003*	0.879	
Community affected by flood between 2001- 2010	(0.296)	0.044*	0.553	
Salt water intrusion	(0.396)	0.059**	0.453	
Community affected by coastal soil erosion or sea level rise	(0.296)	0.026*	0.554	

* $p < 0.05$;*$P<0.10$

Age, education and having noticed their community once affected by flooding or sea level rise influenced the degree of household preparedness for climate change events. Older heads of households were 1.02 times more prepared for future climatic events than younger ones. Heads of households who had some schooling were 1.13 times more likely to be prepared for climate change events than those who had no or little education. Heads of households who were somewhat prepared for climate change events were 1.73 times more likely to have had their communities previously affected by coastal erosion or sea level rise than those who had never had their communities previously affected by coastal erosion (Table 2).

Education, previous affliction by climate change events and observation of community flooding influenced the perception of severity of climate change. Educated heads of households were 0.87 less likely to perceive the future of climate change events to be severe. Heads of households whose communities were previously affected by flooding were 0.55 less likely to perceive the future effects of climate change to be severe while those whose communities had been affected by salt intrusion were 0.45 less likely to perceive that the future effects of climate change to be severe. Heads of households whose communities had suffered from coastal erosion were 0.55 less likely to perceive that future climate change effects would be severe.

Table 5. Actions Undertaken by Households During and After Typhoons

Action	No. of household	Average expense (VND)	Total expense (VND)	Average in USD	Total in USD
House improvement	172	14,275,640	2,455,409,406	688	118,413
Evacuation	60	24,561	1,399,406	1	67
Planted trees around properties	2	250,000	500,000	12	24
Replanted farm	11	1,872,917	22,474,406	90	1,084
Replaced fish stock	11	7,409,091	81,499,406	357	3,930
Reinforced cages/ponds	31	10,523,333	315,699,406	507	15,225
Joined savings groups/cooperative	1	600,000	600,000	29	29
Pursued other means for additional income	1	100,000,000	100,000,000	4,823	4,823
Withdrew savings	0	0		0	0
Borrowed money	31	22,064,516	683,999,406	1,064	32,986
Financial aid from local government	37	3,235,000	129,400,000	156	6,240
Build sand dike around farm	3	14,000,000	42,000,000	675	2,025
Increase floor relative to ground	1	5,000,000	5,000,000	241	241
Build underground shelter	1	15,000,000	15,000,000	723	723
Total expense			3,852,981,436		185,811

Note: The exchange rate of VND/USD on 25 Jan 2012 was 20,736 (www.vietncombank.com.vn)

3.3.1 Knowledge, Preparedness and Perceived Severity of Aquaculture Practitioners

Of the 286 heads of households who were interviewed 52 were engaged in aquaculture. The ages ranged from 23 to 85 years and they had about five years of schooling. The average area farmed was about 48.5 ha, with an average of 6.6 ha in fish ponds (Table 3). About 49 of the 52 fish farming households stated that they had suffered losses due to climate change and the average financial loss amounted to 200 million VND ($10,000USD). These farmers had also suffered damage to their homes.

Table 6. Actions Undertaken by Households to Deal with Salt Water Intrusion

Action	No of households	Average expense (VND)	Total expense (VND)	Average in US$	Total in US$
Harvested rainwater	270	3,994,925	1,062,650,000	193	51,247
Tapped from a different source	32	1,721,563	55,090,000	83	2,657
Treated water	0	0	0	0	0
Pumped freshwater into ponds/farms	0	0	0	0	0
Buy fresh water from vendors	143	1,478,021	211,357,000	71	10,193
Built dike of sand around farms/ponds	41	19,845,500	793,820,000	957	38,282
Total expense			2,122,917,000		102,378

From the results of a logistic model it was found that heads of households who practice aquaculture were 0.35 times less likely to be aware of their community being affected by coastal erosion or sea level rise than those households who were not involved in aquaculture. Heads of households who were involved in aquaculture were 0.37 times less likely to perceive the severity of future climate changes than those who did not practice aquaculture farming (Table 4). Fish farmers were 3.48 times more likely to be prepared for climate change events than those who were not involved in aquaculture production.

3.3. Typhoon Damages, Coping and Adaptive Strategies

Of three hundred surveyed households, there were 205 affected by typhoons. The damages from the most recent typhoons caused total damages of US $154,155 (Table 1 in Appendix). One hundred and seventy-two of 205 households reported that their houses suffered damages from the most recent typhoons which summed up to more than VND one billion (equivalent to more than US $51, 000).

Table 7. Actions Undertaken by Households to Cope with Erosion

Actions	No of households	Average expense (VND)	Total expense (VND)	Average in US$	Total in US$
Installed permanent protective structures	3	73,000,000	219,000,000	3,520	10,561
Installed temporary protective structures	27	17,151,852	463,100,000	827	22,333
Permanently evacuated	1	300,000,000	300,000,000	14,468	14,468
Planted mangrove along the shoreline	6	250,000	1,500,000	12	72
Reinforced cages/ponds	5	59,300,000	296,500,000	2,860	14,299
Replaced lost land	1	30,000,000	30,000,000	1,447	1,447
Total			1,310,100,000		63,180

Agriculture and aquaculture also incurred considerable losses VND 348,040,000 (US $16,784) and VND 1,099,100,000 (US $53,004), respectively. The loss to aquaculture made up for the largest share of total damages. The loss to aquaculture as noted in Figure 1 is 35% compared to 33% for housing damages, 12% for fishing and 11% loss for agriculture. This loss does not account for the precautionary action or repair costs made due to the typhoons which amounted to US $185,811 (Table 5). A total of US $118, 413 was spent for measures undertaken to repair or reduce the damages from the most recent typhoon. The other adaptive strategy of significance was to borrow money which translated into loans of US $32,986. In terms of aquaculture, the repair of fish cages and ponds amounted to US $15, 225 while restocking ponds cost US $3,930.

4.2. Salt Water Intrusion Damages, Coping and Adaptive Strategies

Of 300 households, there are 271 households (90%) reporting being affected by salt water intrusion. According to household's reporting, salt water first intruded inland about nine years ago and each occurrence lasted for 168 days on average. All respondents agreed that the level of salinity has increased over years. Sixty-five respondents reported that their agricultural production (average of $537.36 per household) was harmed by salt water intrusion which resulted in a total loss of VND 710,810,000 (or US $34,279). Aquaculture production of 14 households (average of $2,218.57 per household) was impeded by salt water which led to monetary losses of VND 644,050,000 (US $31,060). Salt water caused 146 households to suffer from lack of freshwater (an average of $71.13 per household) for family routine which cost them VND 215,343,000 (US $10,385). Total losses generated by salt water intrusion amounted to VND 1,599,803,000, equivalent to US $77,151 (Table 2 in Appendix).

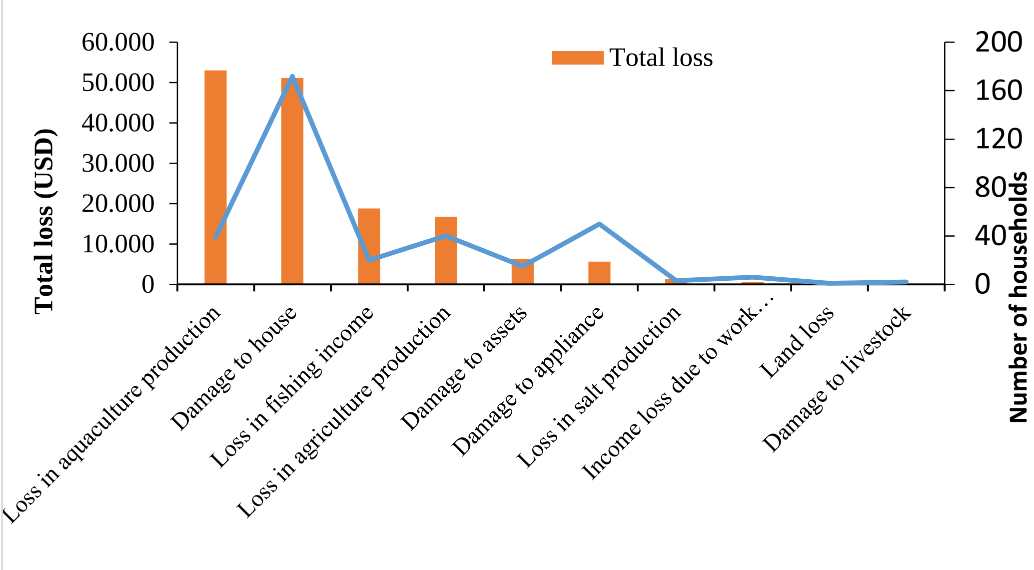

Figure 1. **Damages From Most Recent Typhoons**

Agriculture suffered the greatest loss (44%) due to salt water intrusion and next was aquaculture and lack of fresh water for households which generated losses of 40% and 14%, respectively. It must be noted that the number of people who experienced losses from aquaculture was only 14 compared to 65 for agriculture and 146 households who suffered losses due to lack of portable water (Appendix Table 2). This means that each household practicing aquaculture suffered disproportionately compared to those in agriculture.

Table 3. Descriptive Statistics for Continuous Variables

Variable	N	Mean	Std. Error	Std. Dev.	Min	Max
Age	50	46.6	1.8963854	13.40	23	85
Total area of all your fishponds	52	6.64	1.0054843	7.250	0	25
Total area of owned fishponds	52	48.4	7.7569195	55.93	3	200
Damage/loss to house, VND*	49	4,675,510	1,234,855.6	8,643,989.5	0	50,000,000
Loss in fishing income, VND	49	7,875,510	4,591,882.8	3,214,317.9	0	200,000,000
Education level	50	5.42	0.3939232	2.7854579	0	12

*20,000VND=$1.00

The actions undertaken by the households to deal with salt water intrusion costs a total of US $102,378 and that included about half (US $51,247) for harvesting fresh water and another US $38,282 for building sand dikes to protect the fish ponds (Table 6). Hence the total cost of salt water intrusion to aquaculture production is substantial to rural households.

4.5. Erosion Damages, Coping and Adaptive Strategies

The damages from erosion amounted to US$28,492, with US$13,744 accruing to land loss, US $8,970 to loss of aquaculture production and US $5,160 for combined assets, but only US $3,419 or 11.0% to agriculture (Table 3 in appendix). The major loss from erosion triggered by climatic change events is due to land loss which bears the burden of 41% of total costs. Aquaculture came in second place with 26% followed by a combined portfolio of assets of 15 % and finally agriculture 10%.

Table 4. Aquaculture Practice, Knowledge and Perception of Climate Change Events

Variables	Estimate	Pr > Chi-Square	Odds Ratio Estimate	FIT
Age group	(0.130)	0.447	0.771	(0.080-0.134)
Knowledge of climate change	0.167	0.467	2.397	
Aware of community affected by coastal soil erosion or sea level rise	(0.525)	0.004*	0.350	
Household's properties been affected by coastal erosion or sea level rise	0.133	0.598	1.303	
Education groups	(0.206)	0.244	0.662	
Preparedness for future climate changes	0.624	0.003*	3.484	
Perception of severity for future changes	(0.497)	0.029*	0.370	

Note: * $p < 0.05$

Erosion due to climate change caused households to take precautionary measures or applied post-climatic change erosion practices. The total cost borne by the community was US$ 63,180 and of this US $14,408 or 22.80 % was due to evacuation, US $14,299 or 22.63% went to reinforce pond or fish cages, US$10,561 or 16.72% to the placement of permanent structures (Table 7).

5. Discussion and Conclusion

Climate change mapping shows that Vietnam's 10 most endangered provinces are among the top 25% most vulnerable areas in Southeast Asia, and that Ben Tre is one of these (Yusuf and Francisco, 2010). The average age of households studied were about 49 years old with an average of 6 years of schooling. Most of them had some knowledge of climate change and gave examples of recent typhoons, salt water intrusion and flooding as evidence of climate change. Environmental changes resulted in stunted fish, modification of their exoskeleton and reduction in productivity through major fish kills. A large proportion of those interviewed indicated that they had adopted certain coping mechanisms that resulted in adaptation of new measures even though they were stringent. Such measures included the borrowing of money at high interest rates during and after severe climatic events. Others adopted mitigation measures such as planting trees and building dikes to minimize the effects of climate change events effects. The coping, adaptation and mitigation strategies were not antagonistic and complemented the other. Adaptation and mitigation strategies, however, go hand in hand and should be integrated (Nyong et al., 2007).

In spite of OXFAM (2008) report of low levels of awareness of climate change events, farmers were aware of changing climatic conditions and pointed out indicators of these changes: (1) Changes in production and culturing patterns, (2) Changes in housing designs, (3) Improvement in drinking water collection and procurement, (4) Pumping of fresh water in the shrimp ponds, and (5) Building of dikes to prevent salt water intrusion. About 90 percent of respondents indicated that they suffered losses from salt water intrusion. A large proportion of the households studied indicated that they noticed communities being devastated by climate change events, but a number of households, however, did not believe that climate change would be severe in the future. It is true that the individuals noticed that members of their communities suffered from climate change triggered events but they were not conscious of the severity of the happenings. As Spence et al. (2011) stated that individuals who had direct experience of the phenomena linked to climate change were more likely to be concerned about the issue and to modify their behaviors in a more sustainable manner.

Age, education and past experience with climate change events influenced knowledge, perception of severity and degree of preparedness of climate change impacts.

Climate change events had serious impacts on those who practiced aquaculture (Khang, 2008). Of the 52 households that were involved in aquaculture production, 49 of them revealed that they suffered damages from climate change events. The financial damage per household was quite significant. Households spent VND 3,852,981,436 (US $185,811) on essential activities to deal with damages caused by typhoons. Similarly, it cost households VND 2,122,917,000 or $102,378, VND 1,310,100,000 (US $63,180) to implement actions to cope with the impacts of salt intrusion and erosions, respectively. It is important to bear in mind that those figures are calculated based on a sample of just 300 households. Therefore, the value of damages is definitely much larger for the whole community. Given an average rural per capita income of $44.00 which sums up to $63,180 to implement climate change coping strategies result in U.S.$1,435 per household which is a major burden for each aquaculture household. For all climatic triggered events the losses to aquaculture were either the most or the second most costly. The loss to aquaculture and the precautionary or adaptation measures were extremely costly and affected only a small number of households. That means costs to each household per climatic triggered event were large compared to the costs for other areas like agriculture or combined asset portfolio.

Those who had previous experience were more likely to be aware of the severity of climate change triggered events. Spence et al. (2011) stated that those who experienced previous flooding were more concerned about climate change. Those who were engaged in aquaculture production tended to be less aware of communities that were affected by climate change but they were more likely to be prepared for climate change events and also believed that future climate change events would be less severe. Wolf and Moser (2011) indicated that those who were connected to certain happenings susceptible to climate change events were more likely to change behaviors and participate in sustainable protective undertakings.

Though many of the interviewees stated that they were aware of climate change events there is a need at the policy level to improve education on the effects of climate triggered events on the community and to increase awareness at all levels, but especially those involved in aquaculture. It is important to educate the populace on climate change events even if an institutional gap exists between the community administrators and those who are affected by the change. Individuals were already feeling the consequences of slow growing fish and fish kills. The coping adaptation and mitigation strategies of coastal communities should be studied in order to assist the improvement or diffusion of information. Many of fish producers affected by the climate change triggered events had taken their own initiatives to adapt practices as building dikes around their fish ponds and planting of mangrove trees for long term protection. It is imperative that policy makers develop policy measures to adopt longer term measures to mitigate the effects of climate change.

Acknowledgements: The authors would like to thank the Economy and Environment Program for Southeast Asia (EEPSEA) and the local government of Ben Tre Province for their support to carry out this research.

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Appendix

Appendix Table 1. Damages from Most Recent Typhoons

Types of damages	No of households	Total loss (VND)	In USD
Damage to house	172	1,059,900,000	51,114
Damage to appliance	50	116,510,000	5,619
Damage to livestock	2	3,100,000	149
Damage to assets	15	131,700,000	6,351
Loss in agriculture production	40	348,040,000	16,784
Loss in fishing income	20	389,600,000	18,789
Loss in aquaculture production	39	1,099,100,000	53,004
Income loss due to work stoppage	6	10,600,000	511
Loss in salt production	3	28,000,000	1,350
Land loss	1	10,000,000	482
Total loss		3,196,550,000	154,155

Appendix Table 2. Most Recent Damages from Salt Water Intrusion

Types of damages	No. of households	Total loss (VND)	In USD
Loss in agricultural production	65	710,810,000	34,279
Lack of freshwater for family routines	146	215,343,000	10,385
Loss in aquaculture production	14	644,050,000	31,060
Skin disease	4	25,600,000	1,235
Women disease	2	2,000,000	96
Tools have shorter lifetime	1	2,000,000	96
Total loss		1,599,803,000	77,151

Appendix Table 3. Most Recent Damages from Erosion

Types of damages	No. of households	Total loss (VND)	In USD
Damage to house	3	57,000,000	2,749
Damage to livestock	0	0	0
Damage to assets	4	107,000,000	5,160
Loss in agriculture production	9	70,900,000	3,419
Loss in fishing income	0	0	0
Loss in Aquaculture production	12	186,000,000	8,970
Income loss due to work stoppage	0	0	0
Land loss	10	285,000,000	13,744
Total loss		590,800,000	28,492