

CLIMATE CHANGE AWARENESS AND IMPACTS ON AQUACULTURE IN POOR RURAL COASTAL COMMUNITIES, BEN TRE PROVINCE, VIET NAM

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ABSTRACT

Vietnam has been ranked as one of the countries in Asia with the highest vulnerabilities to climate change impacts on fisheries and aquaculture. Eight of those ten provinces are located in the Mekong River Delta, including Ben Tre Province. We conducted a study to identify the impacts of climate change events on Ben Tre province poor rural coastal communities, to evaluate their awareness and the effects of climate change events on aquaculture. 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 increase in water 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. Total losses generated by salt water intrusion amounted to VND 1,599,803,000, equivalent to USD 77,151. Age, education and previous effects from climate change events affected knowledge and perception of severity of climate change events. Farmers who were engaged in aquaculture were more likely to be prepared for climate change events than those who were not.

Key Words: Climate, Change, Community, Awareness, Adaptations

INTRODUCTION

Vietnam's 10 most vulnerable provinces are among the top 25% most susceptible regions in South East Asia [14]. Eight of those ten provinces are naturally located in the Mekong River Delta including Ben Tre province. Ben Tre region has suffered immensely from recent salt water intrusion. Temperature increases and sea level rise, which cause permanent inundation, increased flooding, as well as salt water intrusion, have together impeded agricultural development, posed risks to industrial production and the socio-economic systems [6, 12]. Over the past 50 years Vietnam has experienced an increase of 0.5-0.7⁰C in annual average temperature, and a 20 cm rise in sea level. Climatic changes have caused disasters like typhoons, floods, and droughts to occur more frequently and seriously in the past twenty years [1, 6]. Scientific calculations show that average temperature in Vietnam could probably increase by 3⁰C and that sea level is likely to rise 1 m in 2100 [13]. In the case of 1 meter sea level rise,

approximately 40,000 km² of coastal plains in Vietnam will suffer from permanent inundation, specifically, 15,116 km² in the Mekong Delta, which means 37.8% of the total area, will be permanently inundated [8]. With climate change, which generates sea level rise, salt water intrusion is believed to be more serious. In 2003, salt water intrusion caused agricultural losses amounting to US\$750,000 which affected 16,000 households [7]. By 2005 losses had increased to US\$37 million. The Ben Tre region has suffered immensely from recent salt water intrusion [9]. In 2003, salt water intrusion caused agricultural losses amounting to USD 750,000 which affected 16,000 households. By 2005, losses had increased to USD 37 million [10]. The number of people reportedly not having access to fresh water was estimated at 110,000 out of a population of 280,000. Salty droughts in 2010 also either destroyed or impeded the productivity of 1,575 ha of rice, 10,162 ha of fruits and resulted in some 4,500 ha of unproductive lands. The total damage and losses was approximated at VND 198 billion [11]. Salt water intrusion also resulted in decreased fresh water availability, an increase in poverty rate, decrease in land use and a population shift. Continued rise in sea level is therefore bound to have serious negative impacts on an already impoverished region.

Regional governments have noted these climatic changes, and have included strategies in their plans to prevent further damages and to assist residents to cope with these changes. Rural households have noted signs of climate change through the various climatic disasters and have adopted measures to deal with the changes. However, there have been no studies that evaluate the awareness, perception and knowledge of rural communities of these changes, and the relationship between these changes and aquaculture production. It is, therefore, against this background that this study was conducted. In this study, we evaluate households and communities in Ben Tre Province awareness, and coping mechanisms adapted to deal with climate change and the effects on aquaculture.

Local Settings

Geographical location

Ben Tre Province is located in the Mekong Delta and has a complex system of internal rivers with a total length of over 382 km. These branches of internal rivers originate from the Mekong River system and meet the East Sea, also called the South China Sea, at four big estuaries. Accompanying this system are fertile lands, bordering 65 km of the coastline and a privileged sea area, which is part of the exclusive economic zone of approximately 20,000 km². Mekong Delta is a low-lying plain which is a major agricultural production area in Vietnam [4].

On the map, Ben Tre has the shape of a pied fantail; the upstream source divides into dispersed smaller branches that follow the eastern direction to the sea. The province has an area of about 2,300 km². It borders Tien Giang Province in the north by the Tien River, Vinh Long Province and Tra Vinh Province in the west, and in the south the Co Chien River. Four big rivers, Tien Giang, Ba Lai, Ham Luong and Co Chien, surround and divide Ben Tre into three separate land areas (Figure 1).

Climate features

According to the reports reviewed, and official statistical sources by the Ben Tre Centre for Hydro-Meteorological Forecasting, the rainy season lasts from May to November and the dry season from December to April of the next year. The rainy season coincides with the southwest monsoon. Average annual rainfall ranges

between 1,300 mm to 1,700 mm. Coastal areas receive the lowest amount of rainfall compared to other areas. The temperature of the province is relatively high, which is favorable for the production of certain crops and livestock. The average annual temperature recorded is about 27°C. The hottest months are April and May, when the average temperature is up to about 29°C. The coolest is December with average temperature as low as 25°C [2].

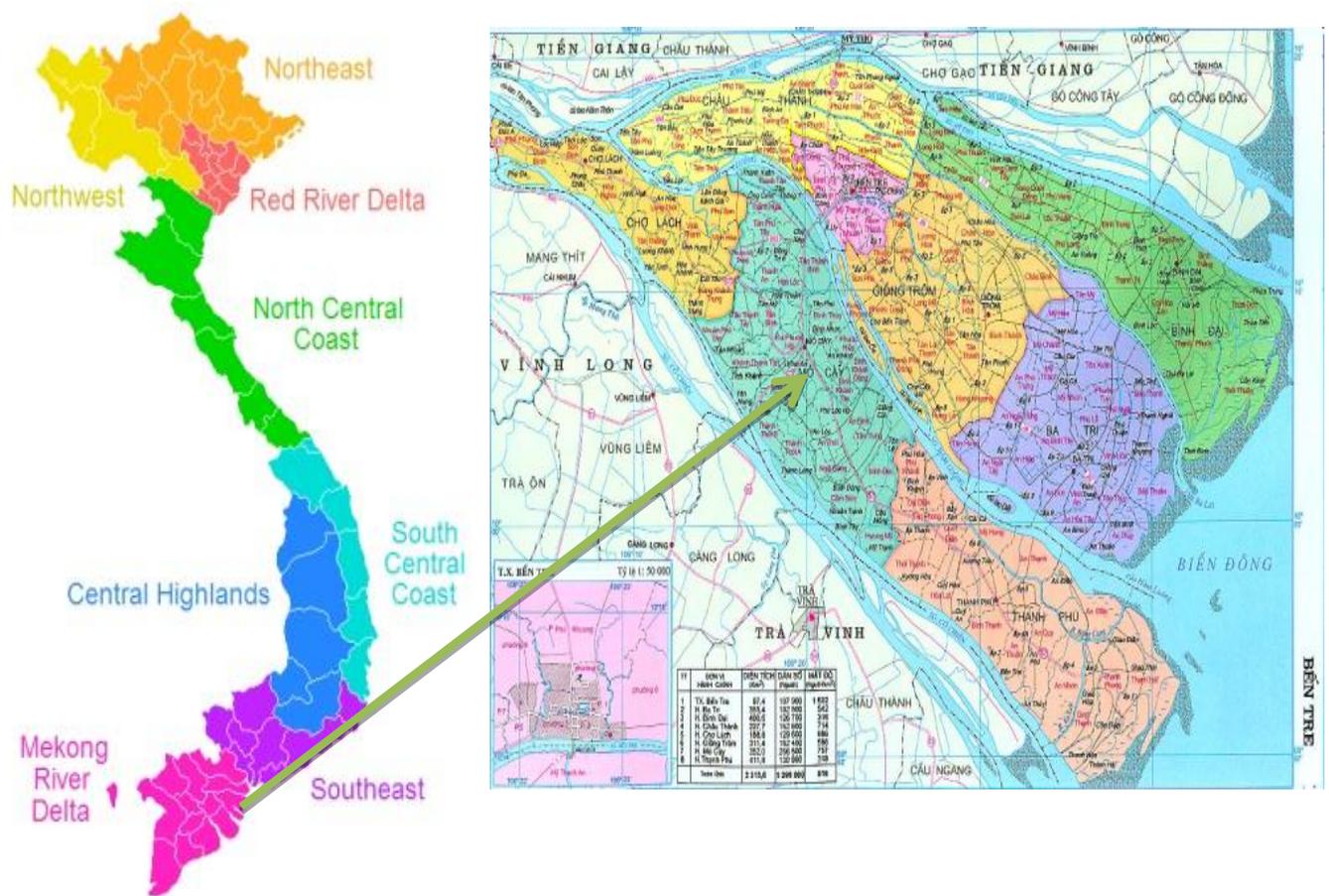


Figure 1. Maps of Vietnam and Ben Tre province

Hydrology

Ben Tre has a network of interlaced rivers, ditches, and canals forming a transportation network as well as favoring irrigation. There is a canal or channel in every 1 to 2 kilometers along the main rivers.

Ben Tre terrain is mostly below the average sea level. Most rivers are affected by the East Sea tidal regime, which enables salt water to follow tides into rivers. Moreover, many rivers and canals have relatively large width, and the width of estuaries is from 2 to 3 km. As a result, the river water is seriously contaminated with salt. In dry seasons, salt water intrusion occurs in almost every area of the province, causing severe fresh water shortages. Generally, the most serious salinity problem is experienced in April. In areas close to the sea, the level of salinity is

never below 2‰. On the event of the rainy seasons, thanks to precipitation and freshwater from the upstream of the Mekong river system, the water is less saline [3].

Socio-economic features

Socio-economic data on the conditions of the Province were extracted from The Ben Tre Statistical Yearbook 2010. The total population of Ben Tre (2009) is 1,255,946 with households numbering 358,691. The average household size is four. About 90% of the population lives in rural areas. The average monthly income per capita (2008) is VND 891,440 (USD 43) and VND 1,165,390 (USD 56) in rural and urban areas, respectively. The unemployment rate (2009) is about 11.7%. Most residents have little formal education. The primary occupations are farming, fishing, labor required for manufacturing, labor for construction, petty trade and motorcycle repairing. Approximately 50% of all employed residents are working in agriculture. Gross output of agriculture in 2010 was VND 12,017,951 million (USD 579,569,396) of which approximately 59% was attributed to crop production. Of the 178,000 ha cultivated in 2010, paddy accounted for 80,900 ha, with the total production of 363,000 tons. The main livestock in 2010 included pig production (431,562), chickens (2,937,969) and ducks (1,764,566). The production of fisheries amounted to 290,585 tons in 2010 with the gross output of VND 7,478,813 million (USD 360,668,065) of which 67.5% was supplied by aquaculture. The industrial output value reached VND 9,575,873 million (USD 461,799,430) in 2010 of which 93.6% came from manufacturing.

OBJECTIVES OF THE STUDY

In general the study identifies and assesses rural people's awareness of climate change. The impacts of climatic 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 are chosen as studied sites.

Specifically the study:

1. Evaluates households, aquaculture farmers and communities perception, knowledge and awareness of climate change events and their impacts;
2. Examines the perceived effects of climate change on aquaculture.

METHODOLOGY

We conducted three focus group discussions (FGD) in Ben Tre Province.

The first focus group discussion

The first FGD 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 two objectives of the first FGD were: (i) to inform the authorities of

the research objectives, and (ii) to provide a forum in which to discuss the situation of climate change in Ben Tre Province.

The second focus group discussion

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 chosen mainly 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 into the peoples' perception on climate change effects and the same time verified the responses of the first FGD.

The third focus group discussion

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 districts. 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 districts. 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.

Household Analysis

Sampling strategy

Three hundred households 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 represent 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.

Data Analysis

Data collected from the household surveys were analyzed using EXCEL and SAS. Descriptive statistics of socio-economic and production variables were obtained. Logistic models were developed to analyze the factors that

influence awareness, knowledge, preparedness and perceived severity of climate change. The perception of farmers who were engaged in aquaculture production was also analyzed using the logistic models developed.

RESULTS

Focus Group results:

It was illustrated from the first FGD that the three coastal districts Binh Dai, Ba Tri and Thanh Phu witnessed the worst damage from climate change impacts and sea level rise. 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 causes variation in currents on river valleys, thus influencing soil erosion.

The farmers showed initial awareness of climate change and sea level rise as well as initiated planned action against the situation of climate change as follows: (i) Changing the seasonal culturing schedule, (ii) In the past, people were accustomed to leaving small holes in the walls near the roofs for ventilation. They, nevertheless, realized that those holes are the reasons why their houses were unroofed when typhoons swept by (especially the one in 2006); (iii) Most house basements and the edges of farming ponds are also raised to avoid possible floods in the future as well as to prevent salt water intrusion; (iv) Buying or building containers to reserve rain water during rainy seasons for later use in the dry seasons when water is often salty; and (v) Building underground shelters to hide from typhoons which may occur in the future.

Household survey results

Of the 300 households interviewed 286 of them were considered appropriate for analysis. Descriptive statistics showed that the age of respondent ranged from 20 to 85. The average age was 47.67 and the median was 47. Farmers had an average of 5.5 years of schooling.

A number of respondents could not tell that there were changes in climatic events but 38 percent were sure that about the phenomenon of climate change while 61.72 percent were not sure. 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 (Table I).

Knowledge and awareness of climate change

We used a logistic model to determine the factors that influence knowledge of climate change. We found that age, education and previous experience of effects of 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. Those with knowledge of climate change were 3.05 times more likely to say they experienced salt water intrusion on their property (Table II).

Education, previous affliction by climate change events and observation of community flooding influenced the perception of severity of climate change. Heads of households who perceived that the future of climate change would be severe were less educated. These individuals had their communities affected by floods during previous climatic events and had been noted communities affected by salt water intrusion.

Table I: Descriptive Statistics for Categorical Variables of Surveyed Households

Variable		Frequency	Percent	CHISQ	PROB
Knowledge of Climate Change	Yes	114	38.38	16.03	<.0001
	No	183	61.62		
Preparedness for Future Climate Changes	Yes	104	35.02	26.67	<.0001
	No	193	64.98		
Perception of Severity for future changes	Yes	182	61.28	15.11	0.0001
	No	115	38.72		
Salt water intrusion	Yes	267	90.51	193.63	<.0001
	No	28	9.49		
Community affected by coastal soil erosion or sea level rise	Yes	124	42.03	7.49	0.0062
	No	171	57.97		

Age, education and having noticed their community being affected by flooding or sea level rise affected the degree of preparedness for climate change by households. Head of households who said they were prepared for climate change events tended to be older and more educated. Heads of households who were somewhat prepared for climate change events were 1.73 times more likely to have had their community previously affected by coastal erosion or sea level rise.

Table II: Analysis of Awareness and Perception of Climate Changes

Variable	Estimate	Pr > Chi-Square	Odds Ratio Estimate	Rsquare/MaxRsquare
Knowledge of Climate Change				
Age	0.0380	0.0012*	1.0387	(0.1442 - 0.1953)
Education	0.2464	0.0000	1.2794	
Community affected by flood between 2001- 2010	0.1074	0.4843	1.2397	
Salt water intrusion	0.5579	0.0112*	3.0522	
Community affected by coastal soil erosion or sea	0.1856	0.1766	1.4495	

level rise				
Perception of Severity for Future Climate Changes				
Age	(0.0086)	0.4318	0.9915	(0.0837 - 0.1134)
Education	(0.1282)	0.0029*	0.8797	
Community affected by flood between 2001- 2010	(0.2962)	0.0437*	0.5530	
Salt water intrusion	(0.3962)	0.0590	0.4528	
Community affected by coastal soil erosion or sea level rise	(0.2957)	0.0262*	0.5535	
Preparedness for Future Climate Changes				
Age	0.0294	0.0101*	1.0298	(0.0680 - 0.0941)
Education	0.1291	0.0029*	1.1378	
Community affected by flood between 2001- 2010	0.0086	0.9557	1.0174	
Salt water intrusion	0.3320	0.1755	1.9424	
Community affected by coastal soil erosion or sea level rise	0.2680	0.0433*	1.7093	
* p < 0.05				

Effects of climate Change on Aquaculture

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 III). 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 200,000,000 VND (\$10,000USD). These farmers had also suffered damage to their homes. 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. Fish farmers were 0.3 times less likely to be prepared for climate change events than those who were not involved in aquaculture production. 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 IV).

Table III: 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	49	4675510.	1234855.6	8643989.5	0	50,000,000
Loss in Fishing Income	49	7875510.	4591882.8	32143179	0	200,000,000
Education Level	50	5.42	0.3939232	2.7854579	0	12

Table IV: Analysis of Aquaculture Practice

Variables	Estimate	Pr > Chi-Square	Odds Ratio Estimate	FIT
Age Group	(0.1301)	0.4471	0.7710	(0.0802 - 0.1344)
Knowledge of Climate Change	0.1672	0.4669	1.3971	
Aware of community affected by coastal soil erosion or sea level rise	(0.5248)	0.0035*	0.3501	
Household's properties been affected by coastal erosion or sea level rise	0.1332	0.5989	1.3053	
Education Groups	(0.2059)	0.2438	0.6624	
Preparedness for Future Climate Changes	0.6242	0.0031*	3.4848	
Perception of Severity for future changes	(0.4968)	0.0290*	0.3702	
* p < 0.05				

CONCLUSIONS

Results from the survey shows that the average age of households studied were about 47 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. 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 had noticed communities being devastated by climate change events. However, a number of households did not believe that climate change would be severe in the future. 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. 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 (USD 185,811) on essential activities to deal with damages caused by typhoons. Similarly, it cost households VND 1,310,100,000 (USD 63,180) to implement actions to cope with the impacts of erosions. 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.

Those who were engaged in aquaculture production tended to be less aware of communities that were affected by climate change; they were less likely to be prepared for climate change events and were also believed that future climate change events would be less severe.

ACKNOWLEDGEMENT

We are extremely grateful for the financial support from the EEPSEA program. Without this funding, the papers would not have been possible. We are also sincerely thankful for the technical guidance from the Worldfish Center. We extend our deep appreciation to Ben Tre Province's government and people who contributed to our study process. Deepest gratitude is extended to all the members of our steering group who were dedicated in their task of seeing the papers through to completion.

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