MEASURES TO ADAPT TO EFFECTS OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION OF BẾN TRE PROVINCE

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Climate change has seriously affected agricultural production, livelihood and living standard of farmers. Thạnh Phú District is located on the coast of Bến Tre Province, and thus can hardly avoid adverse effects of climate change. Although this situation represents a bad influence on the district's business performance, it is also a good opportunity for local people to ask for assistance from the central government and international organizations. The study shows that most local residents are gaining access to information about climate change through TV and radio channels, and they are informed about the human role in the making of climate change. The study suggests several measures to adapt to climate change, which if tackled well may stabilize and develop the local agricultural production in the future.

Keywords: climate change, agricultural production, community, development

1. Introduction

Climate change which is marked by the global warming and the sea level rising has been a huge challenge to the humankind in the 21st century. It greatly affects human life in terms of the fresh water resource, power, agriculture, food security, and human health, etc. Therefore, climate change is not only related to the environmental field but also to the sustainable development of the whole world.

At the present time, rice and aquatic products are two keynote components of Vietnam's agricultural production. According the 2010 survey by the GSO, the Mekong Delta possessed around 1.8 million hectares of paddy fields in 2008, representing 55% of the total national farming area; and approximately 0.8 million hectares for aquaculture, accounting for 71% of the total one. However, it has been menaced by climate change, and the Mekong Delta is most adversely affected when the sea level rises and the hydrological cycle is altered. Being a downstream area of the Mekong Delta, effects of climate change on Bến Tre Province are the most serious and ranked eighth nationwide.

Thanks to the 50-km-long coastline and a marine zone of 24,000 square kilometers with abundant kinds of marine products, Bến Tre Province, especially coastal districts such as Thạnh Phú District, has advantage in developing the agricultural production. However, salt water intrusion, droughts, hurricanes, sea level rise,

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and other severe perils due to global climate change have been threatening the agricultural production and the life of the whole province in general and of Thạnh Phú District in particular. The paper tries to analyze how residents of Thạnh Phú District evaluate effects of climate change on the local agricultural production, and then propose some measures to cope with such effects.

2. Dataset and methodology

a. Research term and site:

The research is conducted in Thạnh Hải and An Thạnh communes of Thạnh Phú District in Bến Tre Province. The subjects include households who produce rice, vegetables, and aquatic products. The research term lasts from January 2011 to April 2011; and the secondary data is within the period 2005-2011.

b. Research goals:

- General goals:

The research looks into climate change in Bến Tre Province and analyzes the local dwellers' perception of impacts of climate change on the agricultural production in Thạnh Phú District; and then proposes some measures to address the problem.

- Specific goals:

+ Gathering information about local community's evaluations and their specific measures to cope with climate change in both coastal and inland areas of Thạnh Phú District of Bến Tre Province;

+ Proposing specific measures to overcome climate change and stabilize the agricultural production in time to come.

c. Methodology:

- Way of approach:

+ Direct interviews of farmer households and market entities, and questionnaires

+ Expert's opinions

+ Analyses, comparison, and contrasting.

- Data collation:

Secondary data are collected from local agencies such as the Department of Rural and Agricultural Development, the Department of Natural Resources and Environment, the District's Division of Agriculture, the Office of Climate Change, and reports of the People's Committee of Bến Tre Province.

Primary data are collated through structured surveys (i.e. questionnaires) and semi-structured ones (i.e. direct interviews with 100 households in Thạnh Hải and An Thạnh selected according to the stratified random sampling method). The data set are primarily about local residents' awareness of climate change, trend of changes in the climate, infrastructures, and fresh water; effects of climate change, and measures to address this problem.

- Analysis method:

The research is based on the sustained livelihood framework (DFID, 2003) (see the appendix). Approach to the livelihoods of local people under effects of climate change will include analyzing their awareness of climate change, and how it impinges on the local people's livelihood (i.e. agricultural production) as well as their financial power to cope with climate change. Besides, supportive policies of local authorities are also taken into account. Finally, the research will summarize a sustained livelihood framework adaptable to climate change to assist local people.

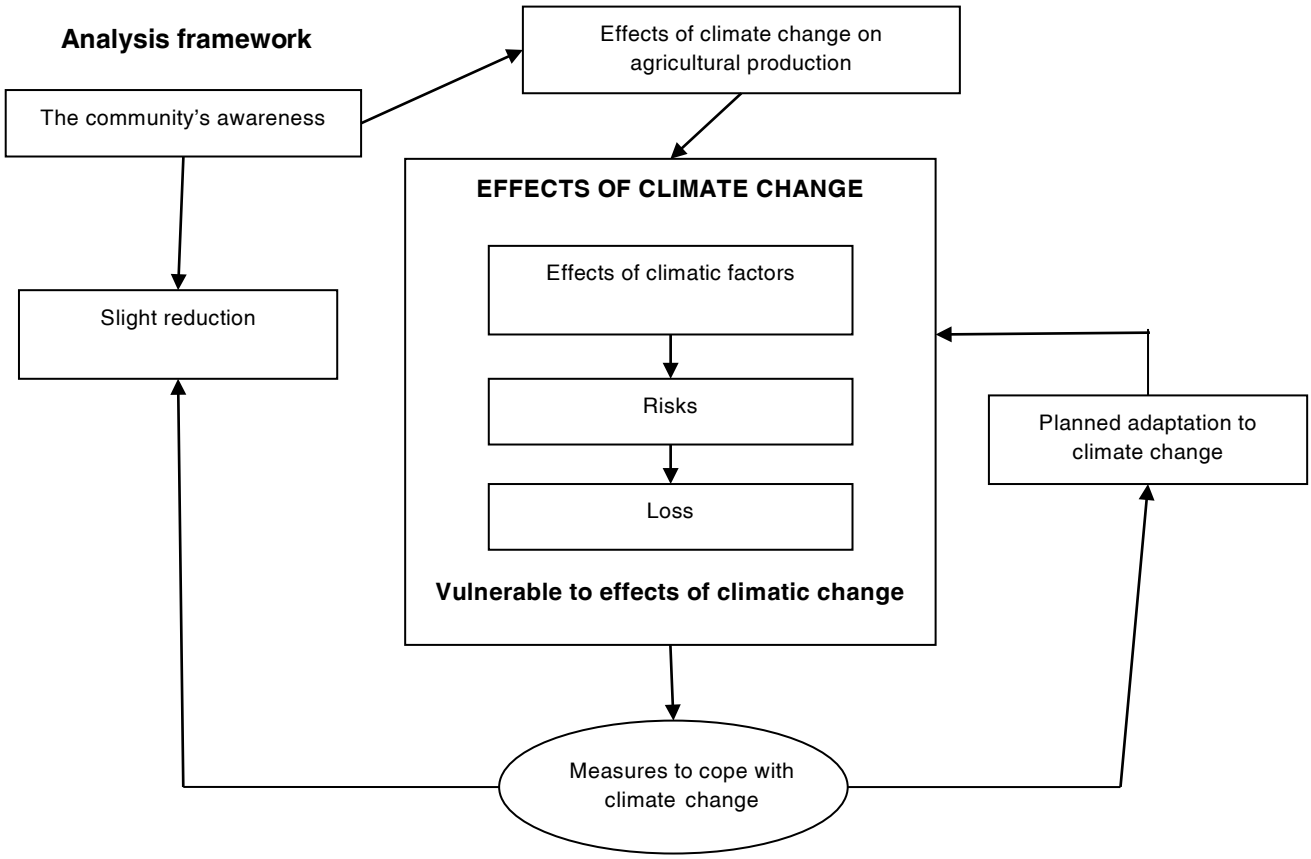
For goal 1: The SPSS software is employed to analyze collated data. The mean and percentage of variables are utilized to describe related issues. Research results are presented in statistical tables.

For goal 2: Based on analyses of the situation in Goal 1 and the plan to overcome climate change adopted by Bến Tre Province in light of the national target program, the author proposes some measures to cope with adverse effects of climate change in the future.

3. Research results and discussion

a. The local people's awareness of climate change:

- Local channels propagating effects of climate change:



Information about climate change is very useful to agriculture-dependent households in that it helps farmers promptly work out measures to sustain their production. Around 95% of dwellers in An Thạnh and 80% in Thạnh Hải attain such information through television or radio; and around 20% of residents in An Thạnh and 30% in Thạnh Hải depend on their personal experiences. The vast majority of population of the two communes live on small-sized family business, and thus personal experience is every significant. Although information about climate change propagated in newspapers, magazines, or through meetings and training programs is also important, local residents have not paid due attention to it. This can be explained by the fact that they hardly have opportunities to access such channels and the local authorities rarely hold such meeting and training courses to discuss effects of climate change. Gathering such information from books and meetings is mainly found in An Thạnh Commune.

Some 82.5% of respondents (i.e. 75% in An Thạnh and 90% in Thạnh Hải) have recognized signs of climate change in their localities in recent years, that is, volatile weather, longer sunny hours, and unusual rain and hurricane, etc. Some others say that global warming and sea level rise are also signs of climate change (Table 1).

- Trends and causes of climate change:

Roughly 82.5% of respondents respond that the present-day weather, as compared to that of a decade ago, is worse and more unusual. The coastal marine resources (mainly that in Thạnh Hải Commune), as remarked by 80% of respondents, show a downward trend; and the sea embankment system (mainly in Thạnh Hải Commune) has quickly deteriorated due to the fact that this system is composed of a naturally-made bank of earth and sand beaches and they have recently been eroded by waves, causing seawater to flow onto fields and accordingly exacerbating the local agricultural production. The road network of the two communes has been

Table 1: Sources of information and signs concerning climate change (as %)

Description	An Thạnh	Thạnh Hải	Mean
Sources of information concerning climate change			
1. Television/radio	95.0	80.0	87.5
2. Newspapers, magazines	10.0	0.0	5.0
3. Meetings	15.0	0.0	7.5
4. Training courses	10.0	0.0	5.0
5. Internet	5.0	0.0	2.5
6. Personal experience	20.0	30.0	25.0
Recognize signs of climate change?			
No	15.0	5.0	10.0
Yes	75.0	90.0	82.5
No ideas	10.0	5.0	7.5

Source: The author's survey in 2011

Table 2: Trends of climate change (as %)

Factors of climate change and infrastructure	Compared to a decade ago		
	Worse	Normal	Better
- Weather in general	82.5	12.5	5.0
- Coastal marine resources	80.0	20.0	-
- Hydraulic system and sea walls	40.0	55.0	5.0
- Road network	2.5	7.5	90.0
- Fresh water resource	40.0	35.0	25.0
	Decrease	Normal	Increase
- Temperature	7.5	25.0	67.5
- Number of rainy days, rainfall and flash flood	57.5	5.0	37.5
- Number of sunny days, heat and drought	10.0	90.0	-
- Gale, hurricanes, storms	2.5	17.5	80.0
- Sea level, tidal level, flows of seawater and waves	2.5	22.5	75.0
- River level and river flow	5.0	7.5	87.5
- Salt water intrusion	2.5	27.5	70.0

Source: The author's survey in 2011

upgraded, and thereby facilitating the production of local people. Regarding the fresh water resource, 40% of respondents state that the shortage of fresh water is widespread. Although there are six months of fresh water, it is polluted and cannot be used frequently (Table 2).

- The local people's evaluation on effects of climate change on agricultural production:

Effects of climate change on agricultural production are split into three levels namely adverse effects (1), neutral effects (2), and beneficial effects (3). Table 3 shows that most effects of climate change are adverse to the agricultural production. As some local people put it, factors of climate change (i.e. weather in general, temperature in general, number of rainy days, rainfall, number of sunny days, heat and drought, etc.) adversely impinge on rice/vegetable crops and aquaculture rather than fishing. Regarding sea level rise (mainly in Thạnh Hải) and river level, aquaculture is terribly menaced due to the fact that a large number of aquatic plants and organisms can be lost when ponds are flooded. Hurricane, gale, storm and salt water intrusion have adverse effects on crop farming because, as some respondents put it, gales and

hurricanes can push salt water far onto inlands where crops are grown. Yet, salt water intrusion improves aquaculture of marine and brackish products.

Thạnh Hải are higher than that in An Thạnh due to the fact that Thạnh Hải, a coastal commune, suffers both unpredictable changes in weather and river and sea level rises and tides,

Table 3: Factors of climate change affecting agricultural production

Factors of climate change and infrastructure	Rice/ Vegetables	Aquaculture	Fishing
Fluctuations in weather in general (i.e. temperature, sunshine, rain, gale, storm, etc.)	1.44	1.45	1.60
Fluctuations in temperature in general	1.68	1.55	2.00
Number of rainy days, rainfall, flash flood	2.50	1.21	1.20
Number of sunny days, heat, drought	1.59	1.76	2.40
Gale, hurricane, storm	1.26	1.64	1.20
Sea level, tidal level, seawater flow and waves	1.79	1.58	2.00
River level, river flows	1.88	1.52	2.00
Salt water intrusion	1.06	2.18	2.00

Source: The author's survey in 2011

Table 4: Effects of climate change on each field of agricultural production

Business	An Thạnh		Thạnh Hải		Mean	
	N	Mean	N	Mean	N	Mean
Rice/Vegetable	17	4.00	17	4.06	34	4.09
Aquaculture	19	4.11	14	3.64	33	3.91
Shrimps, crabs	19	4.11	6	4.17	25	4.12
Shellfish	-	-	8	3.25	8	3.25
Fishing	-	-	5	3.00	5	3.00

Source: The author's survey in 2011

- Evaluate effects of climate change on agriculture:

An Thạnh and Thạnh Hải respondents' evaluations of climate change impacts on agricultural production are given the following scores: (0) none, (1) very slightly, (2) slightly, (3) mildly, (4) profoundly, and (5) very profoundly.

Table 4 shows that the crop growing is extremely vulnerable to climate change (mean=4.09). Aquaculture is ranked second with the mean of 3.64.

The effects of climate change on crop growing (rice/vegetable) and aquaculture (shrimps, crabs and fish raising) in both communes are very profound with the respective means of 4.00 and 4.11 in An Thạnh, and 4.06 and 4.17 in Thạnh Hải. Apparently, effects of climate change in

and etc. As some local dwellers put it, at high tide, seawater flows onto fields and shrimp/crab farms, causing a great loss to farmers.

It is also evaluated that shellfish farming is affected by climate change at score level 3 and 4 (mean=3.38) while effects on fishing are at level 3 (mean=3.00).

- Changes in factors of agricultural production caused by effects of climate change:

Evaluations of respondents regarding how climate change impacts on agricultural production consist of the following levels: (1) sharply decrease, (2) slightly decease, (3) unchanged, (4) slightly increase, and (5) sharply increase.

Analyses show downward trends in the number of farmers engaging in aquaculture due to

the gradually-shrunk area of aquaculture. The number of crops in agricultural production does not change, yet the time of production depends heavily on the soon or late intrusion of salt water and rainy season.

In recent years, intensive cultivation in crop growing and aquaculture has risen and so has the overuse of pesticides. Yet, the use of pesticides only increases slightly because models of extensive cultivation are more preferable in the region. Moreover, rice farming lasts only six months and the remaining months are mainly for aquaculture; therefore, the use of pesticides is often constrained in order not to do harm to aquaculture.

The utilization of fresh water in crop growing and aquaculture shows an onward trend; yet, it is much less in aquaculture due to the fact that farmers would like to minimize risks from fresh water which has been heavily polluted. It is merely in case of intense drought that they are obliged to use fresh water to reduce the salinity of brackish ponds in which they raise shrimps, crabs, and shellfish, etc.

Furthermore, the quality of aquatic products shows a downward tendency and becomes a worrisome problem. Climate change has bedeviled both crop growing and aquaculture, causing diseases for both plants and animals. Although pesticide uses have been increased, the rate of dead plants and animals still increases.

4. Recommendations and policy implications

a. For the fresh water resource:

In the context of climate change, ensuring the fresh water resource for daily life and production is a matter of great importance and urgency. To achieve that, it is necessary to:

- Construct more water treatment factories
- Bring fresh water to rural areas
- Construct and upgrade dyke systems in Thạnh Hải and levee systems in An Thạnh
- Make plan to control and protect underground and surface water

b. For agricultural production:

- Crop growing:

+ Construct and upgrade exterior levee systems to protect fields

+ Investigate problems and proactively define potential problems in agricultural production to tackle them promptly

+ Construct and upgrade ditches and pumping stations at service of irrigation; and simultaneously upgrade road networks and hydraulic systems

Table 5: Changes in factors of agricultural production due to climate change

Production factors	Rice/ Vegetable	Aquaculture	Fishing
Number of labor involved or number of working days	3.03	2.91	3.20
Farming area or workload	2.82	2.73	4.00
Density of seeds/breeds	3.91	4.15	-
Number of crops	3.00	3.00	2.20
Use of fresh water per hectare or per animal	3.56	3.27	-
Diseases on plants and animals	4.62	4.00	-
Use of pesticides and chemicals	4.12	4.03	-
Term of breeding and size of products	3.09	3.12	-
Survival rate	2.35	1.79	-
Productivity	3.29	2.27	2.20
Production cost	4.35	4.36	3.40
Product quality	3.12	2.76	2.60
Market	4.00	4.27	3.60

Source: The author's survey in 2011

+ Propagate benefits of forest protection (i.e. constraining floods, tornado, drought; and bettering underground water, air, temperature, etc.)

- Aquaculture:

+ Study and develop new breeds that can adapt to climate change

+ Import and develop commercial breeds which have high economic value and can adapt to the high temperature; increase the depth of ponds so as to reduce adverse effects of high temperature and quick vaporization

+ Enhance ability to research and develop new breeds and strains

+ Improve road networks, hydraulic systems, and dykes so as to guarantee fresh water for production

+ Study and predict the journey of shoals of fish and changes in fishing grounds

c. Application of sciences and technologies to production:

- Develop new types of rice, vegetables, and aquatic plants and animals which can adapt to unusual weather and diseases

- Study and apply new farming techniques into production (especially in aquaculture) which can help prevent bad effects on the environment

- Propagate and disseminate new production techniques and ways to recognize unfavorable signs of climate change; enable technicians and local people to have wide knowledge of new breeds and be able to apply into their production

d. Dissemination of information and ability to adapt to climate change:

- Promote the propagation and education of climate change

- Offer after-school courses in climate change, its adverse effects and adaptation to such effects

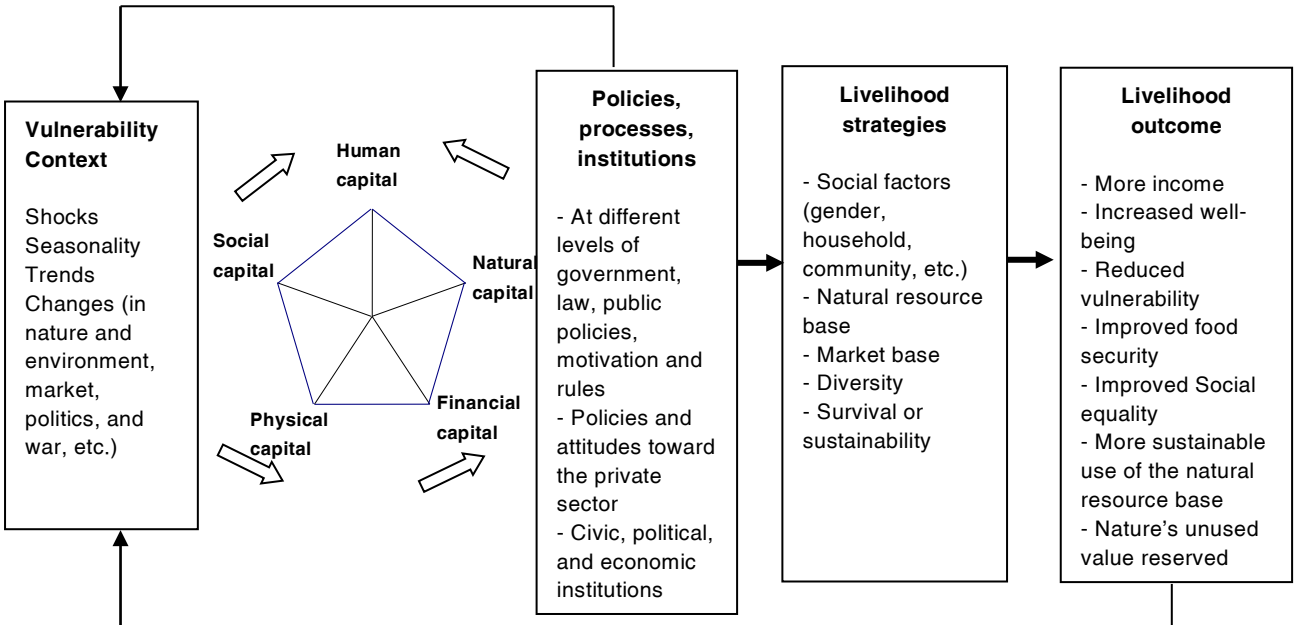
- Distribute knowledge of climate change and sustainable development as well as some solutions to this issue through mass media

- Hold conferences, seminars, training courses regarding climate change and how to reduce such effects and adapt to climate change for the sake of local bureaucrats

5. Conclusion and recommendations

a. Conclusion:

The research results show that local dwellers are able to access abundant sources of information concerning climate change (especially through television and radio), and they also recognize the fact that climate change is derived from human activities.



Sustainable livelihoods framework (DFID, 2003)

Climate change profoundly affects rice/vegetable production and aquaculture – two businesses that require priority in time to come. Due to the fact that most people in the surveyed districts live on agriculture and aquaculture, it is very difficult for them to change to another occupation. However, in order to facilitate the sustainable development and adapt to climate change, it is a must to develop new breeds which can adapt to the local conditions.

b. Recommendations:

In order to restrict adverse effects of climate change, it is necessary to:

- Improve human resource for all fields,
- Regularly hold training courses in new production techniques to enhance local people's competence in using new technologies,
- Attach agricultural and aquacultural extension programs to transfer of information and solutions to climate change,
- Research, pilot, and transfer new breeds and effective production paradigms which suits the context of climate change; and simultaneously provide a stable market for farm products as well as occupations for farmers,
- Improve the weather forecast and observation of natural disasters to help local authorities and farmers punctually work out effective measures to protect themselves and their business activities,
- Amend and modify regulations on zoning at service of local socioeconomic development and high adaptability to climate change■

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