



ADAPTATION TO SALINITY INTRUSION FOR RICE FARMING HOUSEHOLD IN THE VIETNAMESE MEKONG DELTA

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ABSTRACT

Agriculture has considerably been affected due to the increased salinity in recent years in the Vietnamese Mekong Delta (VMD). The saline intrusion has increasingly caused problems to irrigation management, making it impossible to sustain the desired crop productivity. Rice farming are actually the most vulnerable as they have limited adaptive capacities and are more dependent on water for food production and other economic activities. This paper aims to understand how rice farming households responded to impacts of saline intrusion in the VMD, focusing the adaptive capacity and adaptation to saline intrusion at household level.

The study showed that most rice farming households perceived the impacts of saline intrusion on their production activities, but only a few households prepared for adaptation options. Their decisions were not based on long-term saline intrusion impacts because households made decisions and changed farming practices due to economic factors and government policy support. The environment factors such as saline intrusion always came after economic and government policy factors. Government policy strongly affected production conditions of rice farming households through building irrigation, dyke and sluice gate systems. It means that change of production activities of rice farming households much more depended on government programs and development goals. Thus, households have fewer choices of production diversification away from rice farming.

Keywords: *Vietnamese Mekong Delta, adaptation, salinity intrusion, rice farming.*

1. INTRODUCTION

The salinity from 1ppt to 4ppt encroached up to 70 km into the VMD (Tri, 2016). Nearly two million ha of rice land has been affected by saline intrusion, threatening the national food security and affecting millions of local people (Hanh & Furukawa, 2007). Agriculture, natural fisheries, and aquaculture are at risk (Tri, 2016). This ongoing trend has significant impacts on millions of people who are very poor and live primarily on agricultural production. They have limited options to turn to other sources of income (Wassmann et al., 2004).

Total natural area of the delta takes account up to 3.9 million hectares (ha), of which about 65% of the land (2.6 million ha) is devoted to agriculture (Ha et al., 2013). The region contributes more than 70% of rice products to the total foreign export (Hoanh et al., 2014). The rice production is not



only for domestic consumption, but also for export. Agricultural sector is providing food for nearly 18 million people and contributes to over 90% of rice export (Thanh et al., 2009).

Agriculture remains one of the most important sectors in Vietnam, contributing 24% to the annual Gross Domestic Product (GDP), 30% to the total export value and employing about 60% of the population (Hoanh et al., 2014). In the Vietnamese Mekong Delta (VMD), this sector employs about 76% of the local population (Lensink and Nam, 2008). The VMD contributes 45.8% to national agricultural food production, 50.5% of total paddy production each year. However, nearly 4 million ha of agricultural land and the population of 18 million living primarily on agricultural production are suffering from the consequences of sea level rise (Carew-Reid, 2008; IUCN-Vietnam, 2010).

Agriculture has considerably been affected due to the increased salinity in recent years. The saline intrusion has increasingly caused problems to irrigation management, making it impossible to sustain the desired crop productivity (Kirby and Mainuddin, 2009). The prevalence of salinity has implications to local poor communities while the effective water management mechanism and existing pro-poor policies sufficiently do not meet their livelihood supporting demands (Tri, 2016). They are actually the most vulnerable as they have limited adaptive capacities and are more dependent on water for food production and other economic activities.

Consequences of saline intrusion are not only increasing pressure to people's livelihoods, but also leading to unstable food security. People's livelihoods are based on water resources of the Mekong River. Saline intrusion has significant effects on the integrity of ecological systems in the Mekong Region, including aquatic species, water resources, and livelihoods of millions of inhabitants dependent on agriculture production.

This paper aims to understand how rice farming households responded to impacts of saline intrusion in the VMD, focusing the adaptive capacity and adaptation to saline intrusion, at household level.

2. METHOD OF STUDY

a. Study Areas

In this study, we selected the study areas located in the saline intrusion zones of the VMD. Thanh Phu commune of Ben Tre province and Dai Ngai commune of Soc Trang province were selected. Affected by saline intrusion, local inhabitants resort to agriculture activities (e.g., rice farming) as the primary livelihoods (Käkönen, 2008; Ha et al., 2018; Renauld et al., 2015). However, in dyke-protected areas, rice-based agricultural systems remain dominant (Renauld et al., 2015). It is evident that the diversity of livelihoods in these agro-ecological areas constitute the important aspects of the rural delta, illustrating how rice farming has evolved and disseminated.

b. Methods for Data Collection and Analysis

In this study, we utilized qualitative data gathered from focus group discussions (FGDs) and in-depth interviews to examine how rice farming has emerged and developed across the study areas



(Table 1). The main topics under the study concern how farming households got involved in learning practices and how these processes led to the emergence and dissemination of farming innovations that benefit farmers' livelihoods.

Table 6: Summary of FGDs and in-depth interviews for the study

Methods	Participants	Participant selection and data analysis	Data gathered
<i>Focus group discussions</i>	Six FGDs in the two communes	Selection of participants based on the participatory approach (King and Horrocks, 2010; Neuman, 2011) Thematic analysis (Neuman, 2011) assisted by NVivo	Situations of floods and saline intrusion, impacts of floods and saline intrusion on farming households' livelihoods, corresponding adaptation options and learning practices in dealing with environmental changes
<i>In-depth interviews</i>	24 interviews with government officials, environmental scientists, agricultural extension officials, and senior farmers	Purposive sampling and snowball sampling (Liamputtong, 2013) Thematic analysis (Neuman, 2011) assisted by NVivo	Local impacts of floods and saline intrusion on farming households' livelihoods and their respective adaptation responses Contribution of households' learning effects to local adaptation policy

Household participants recruited for FGDs in this study were based upon the participatory approach. In particular, we coordinated with local government officials to determine a set of criteria on which household samples for FGDs were based. Primary criteria to select FGD participants included their occupation, gender, age, and socio-economic characteristics. In this regard, participants were those who were directly engaged in farming activities (e.g., rice farmers). In total, six FGDs in the saline intrusion zones were respectively undertaken.

This study involved the application of purposive sampling and snowball sampling methods to approach key informants (Liamputtong, 2013). Key informants included local government officials (communal, district, provincial), environmental scientists, agricultural extension officials, and senior farmers who have in-depth understanding of situations of saline intrusion and their impacts on farming households' livelihoods, households' adaptation responses, and the contribution of their learning effects to local adaptation policies. Overall, thirty-three interviews with key informants in the flooding and twenty four in the saline intrusion zones were undertaken.

The data analysis strategy involved the application of thematic analysis assisted by Nvivo software, which supports the identification of themes emerged from the data. In this regard, the analysis was inductively implemented, following Neuman's (2011) approach (e.g., open coding, axial coding and selective coding). These exploratory techniques consequently achieved several key themes,



including the role of farming households in learning practices, farmers' experimental and experiential knowledge and its construction process into innovations, and the diffusion of farming innovations across geographical scales. In addition to primary data sources collected during the fieldworks, this study employed a large body of literature (e.g., policy documents, scientific reports, etc.) relevant to rural adaptation policies and practices.

3. RESULTS AND DISCUSSION

a. Dyke-driven transformation of rural landscapes

The VMD has undergone the remarkable change as the result of building dykes and irrigation schemes spanning in downstream of VMD (salinity) areas. Literally speaking, this process involves the transformation of physical landscapes (Tran and James, 2017) and ensuing socio-environmental impacts. Besides the side-effects of hydraulic systems, incremental impacts of climate change (e.g., droughts) and ongoing hydropower development dynamics have added greater pressures to regional hydrological regimes (Le et al., 2007; Kuenzer et al., 2013). The disconnection of the delta's physical landscapes is largely driven by dissimilar water control and irrigation systems. This fragmentation is attributed to specific socio-economic development policies prioritized by local governments. In the coastal area, the provincial government had built dyke and sluice gate systems for storing freshwater and controlling the salinity before pumped into the production areas. With this initiative, freshwater was pumped into canals system and small ponds which a canvas is stretched at the farming areas. Supported by this method, freshwater could be stored and used for crop irrigation during hot days or in case of water shortage. This way was very effective in case of water shortage during hot days. However, this was only a temporal measure since the volume of stored water needed in the pond was not always available. These solution had actively transformed seasonal calendar, types of crop and crop varieties in coastal area. Famers grew the rice seed early to ensure that they could harvest before the saltwater infiltrated into canal systems. This transformation helped them reduce economic loss as compared to the original model. Importantly, the crop transformation contributes to diversifying the local agriculture production activities that bring more income for local associated households.

b. Shift of livelihood patterns as adaptation

Rice farming is the main source of livelihoods of the majority of farming households in the VMD. Table 2 presents different typologies of adaptation undertaken by farming households to better respond to emergent environmental conditions in saline intrusion areas. Perceiving accelerating impacts of saline intrusion, farming households in the coastal communes have transformed their livelihood practices. They replaced rice with sugarcanes which grow well in salinity-affected soils. Qualitative analysis of FGDs in coastal provinces suggested that most farming households reduced to single rice crop per year because the salinity duration is getting longer. Growing rice in high elevation areas was one of key approaches that assisted rice farmers in dealing with salinity effects. Results from in-depth interviews with key informants revealed that fish farmers adjusted schedules



to release fish. They commonly selected fingerlings of large sizes which could better adapt in the salinity condition. Off-farm activities were the predominant adaptation option that enabled farming households to increase income during saline intrusion periods. These activities included collecting scraps, petty trading, bricklaying and carpentry. This is consistent with Ovwigho’s (2014) view that off-farm activities provide a continuous stream of income to cater for exigencies of life.

Table 2: Adaptation practices across the study areas

Shift models	Saline intrusion areas
<i>Land use change</i>	Reduction to single rice crop; Growing rice in high elevation areas
<i>Cropping patterns</i>	Growing salinity-tolerant plants (e.g., sugarcane ...); Adjusting time for growing fish and rice; Shortening crops; Shifting rice and fishing farming to shrimp farming; Leaving farmlands abandoned
<i>Employment</i>	Off-farm activities (e.g., petty trading...); Migration to urban areas

Socio-economic constraints faced by poor farmers during the adaptation processes were observed. They are the most vulnerable group since they are not capable of mobilizing sufficient resources (e.g., financial capital) to get out of difficulties. It is evident that they failed to gain sufficient access to necessary resources (e.g., land, financial capital) to maintain their traditional livelihoods. Instead, they increasingly depend on local landowners for seasonal employment (e.g., building bunds, weeding, or spraying pesticides), which often provides low income (Tran and James, 2017). Empirical findings in saline intrusion zones suggested that most poor households increasingly depend on migration as the main means of survival.

c. Adaptation options for rice farming households to saline intrusion at household level

Farming households made decision depended on the salinity level. Rice farmers mainly relied on two or three crops per year of rice monoculture. Different vulnerability led to different options of adaptation (Table 3).

Table 3: Adaptation options of rice farming households to saline intrusion

Salinity level	Vulnerability	Adaptation options
<i>0-1ppt</i>	Low salinity effects	Changing part of farming practices
<i>> 1-1.5ppt</i>	Salinity affected; Soil and water quality reduced; potentially salt-contaminated land	Changing part of farming practices, crop patterns, seasonal calendar; Develop/apply integrated production model
<i>> 1.5-2ppt</i>	Salinity strongly affected, salt-contaminated land; Loss of productivity, yield; Less rainfall, increase of temperature, drought, freshwater shortage	Change all farming practices/cropping patterns; Apply tolerant rice varieties, use short-term rice varieties; Apply new production model (sugarcane, shrimp)
<i>> 2-3ppt</i>	Salinity severely affect; Damage of productivity, yield; Less	Reduce rice crop; Completely change production model, turn to



	rainfall, increase of temperature, drought, freshwater shortage, high tide; Not enough freshwater for irrigation	shrimp or brackish water fishes; Migration/seek for new jobs
> 3-4ppt	Salted, completely change fresh water ecosystem	Develop saltwater farming system (shrimp, crab); Non-cultivation, no more freshwater farming system; Non-farm activities

Rice farming households had different ways to deal with saline intrusion. Rice farming group changed part of farming practices at very low salinity. They changed seasonal calendar, cropping patterns and applied integrated production model at low salinity. New production model (sugarcane, shrimp) and salt-tolerant rice varieties were applied at moderate salinity. Brackish fish farming and shrimp farming were developed at high and very high salinity in order to replace rice farming. Non-cultivation (no more freshwater farming system) and off-farm activities were the last adaptation options.

d. Adaptation options for rice farming households to saline intrusion at provincial level

Rice farming households had the opportunity to continue their production activities under the interest of government investment into the planning stage of agriculture production, especially irrigation, dyke and sluice gate systems which mitigated the impacts of saline intrusion on production activities. Provinces had supported many policies and projections in order to deal with saline intrusion. Nevertheless, according to surveyed households, the government policies and projections had two-sided effects on rice and fish farming households. The policies and projections focused on the efficiency of production activities, including stability of productivity and sustainable livelihood, but less on adaptive capacity. Leaders of provinces confirmed that saline intrusion adaptation must ensure provincial development goals, focusing on the strength and adaptability. The adaptation options recommended by provinces were as follows.

- i. In the areas facing with severe freshwater shortage: Provinces should adjust production activities to adapt to saltwater ecosystems. Shrimp and brackish fish species should be encouraged as main cropping systems in these region.
- ii. In the areas facing with salinity-effected freshwater in dry season: Provinces should apply integrated production models or modify seasonal calendar to one rice or fish crop in freshwater months-one brackish fish or shrimp crop in saline intrusion duration.
- iii. In the areas where freshwater was slightly affected by saline intrusion: Provinces should encourage households to continue their production activities normally. However, the improvement of farming practices and the development of salt-tolerant rice varieties and fish species should be developed as adaptation options under future saline intrusion impacts.



4. CONCLUSION AND RECOMMENDATION

The successful adaptation options did not involve all households and stakeholders. However, the adaptation options showed the expectation of rice and fish farming households which provided useful information for policy makers. Based on the research findings, there were many factors affecting household's decisions responding to different levels of vulnerability to saline intrusion. In order to develop adaptation policies and strategy options, rice and fish farming households should be involved in balance of economic, social and environmental aspects, especially household's adaptive capacity and government policy supports.

The adaptation options at regional/national level should consider regional links and transfer of adaptation experience of saline intrusion between downstream and upstream in order to supervise the implementations of saline intrusion prevention and mitigation in the context of future saline intrusion. Upstream provinces of the Mekong Delta should play a role as focal agencies for trainings and guiding adaptation options. Adaptation options at regional/national level should combine adaptation trainings with upgrading saline intrusion information in order to increase awareness and preparedness at the regional level when saline intrusion truly impacted.

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