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Understanding farmer production strategies in context of policies for adaptation to floods in Vietnam

Case study at two communes, An Giang province, Vietnam

Tran Van Hieu, An Giang University, An Giang province, Vietnam 2010

Department of Urban and Rural Development
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ABSTRACT

Adaptation has an important role in reducing the livelihood impacts of climate change, floods and other risks. However, the analysis of adaptation needs to be integrated with other factors. This study explores how the irrigation and dyke system affect the way of adaptation with flood of local people, as well as investigating the factors that influence changes in farmer's decision making on production structure, in order to adapt with floods. The study was carried out in two communes of Chau Phu and Cho Moi district of An Giang province; Binh Phu and Kien An communes, through using PRA tools in group discussion and in-depth interview. The results show that adaptation to floods is related to many factors, such as government policy, natural conditions, and climate condition, market price of agriculture products and household conditions, which were considered in the analysis of adaptation. Adaptation is one part of the household's decision making on production structure, and it varies for different groups of local peoples with different conditions.

Key words: Adaptation, floods, decision making, production structure, livelihood strategies

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LIST OF ABBREVIATIONS

FAO	Food and Agriculture Organization
VND	Vietnamese dong (19,000 VND = 1 USD in 2010)
MRD	Mekong River Delta
GDP	Gross Domestic Product
ADARD	An Giang Department of Rural Development
PRA	Participatory Rural Appraisal
GSOV	General Statistics Office Vietnam

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CHAPTER I. INTRODUCTION

The Mekong Delta is a key fishery and agricultural production zone located on the southern coast of Vietnam. The Delta supports 17.6 million people and accounting for 20.6 per cent of the country's population (GSOV, 2008). Most people live in the rural areas (80 per cent) and rely on the agricultural sector (GSOV, 2008). The Delta includes 3.9 million hectares (ha) currently under cultivation (GSOV, 2008), which account for 2 million ha of irrigated paddy fields, that are extremely important to the Vietnamese agricultural economy. However, agriculture production is facing increasing challenges from weather- and climate variability. This challenge means more pressure on the government to develop appropriate policies to enhance adaptability of farmers. Therefore, it is necessary to integrate both "top-down" and "bottom-up" in approach and process (Wall & Smit, 2005). Through assessing impacts of policies and examining adaptability of local people and the factors that enhance or discourage it, adaptation and vulnerability can give feedback to the policy development.

The annual flooding of the Delta is both an obstacle and a resource to agricultural and rural development. Nearly a half of the Delta's total area is continuously inundated for between four and six months from August to November in the flood season (Weichselgartner, 2004). According to (Dao Cong Tien, 2001), the normal floods in the Mekong Delta leads to an inundation of around six months. The big floods, in which the floods come later or earlier than normal, or when the level of flooding is higher than normal, often leads to damage and loss of human life and property of local people. For example, there were 407 and 217 people killed and 2.2 and 2.1 billion VND lost in the floods in 1994 and 1996 respectively. In addition to the human loss, 173,606 houses were destroyed by the flood in 1997. Especially, the historic flood in 2000 caused the entire loss of 56,000 ha of rice, and 251,341 ha of rice were subjected to a reduced yield. The damage of the flood in the year 2000 was estimated up to 4 billion VND. These costs of floods are a burden for both the government and the local people of the Mekong Delta region. Thus, the regional economic development must take flood issues into consideration for the sustainable development in the long term.

Despite these costs, floods in the Mekong Delta have also traditionally been known to bring some benefits. These benefits contribute significantly to sustainable agricultural development in the region. Firstly, floods provide fresh water fish, other aquatic animals and aquatic vegetables for rural livelihoods. It is estimated that the average fishery capture in the Delta is about 500 kg per household per year, which provide significant protein source for the local people. Secondly, floods deposit 150 million tons of sediment on paddy fields in every flood season (Dao Cong Tien, 2001). This helps to replenish the soil and maintain soil fertility for rice cultivation. Evidence shows that after every flood season, local rice farmers not only gain higher yields but also need to use less fertilizer because of the nutrient mud from sediment. Furthermore, floods have important biological functions; for example, floods help to recharge groundwater and clean farming residuals, and maintain biodiversity (Vo Tong Anh, 2002) These benefits contribute to the rural economy and the improvement of rural livelihoods.

Agricultural production in Mekong Delta has been developed to high productivity and with rapid economic growth. However, intensified agriculture and large scale water control structures have challenged the environmental sustainability in the area. It means that people use a lot of chemicals in agricultural production and full dyke system development for water control. The measures are closing off the Mekong Delta to floods, in order to make farming systems less dependent on natural conditions and to expand multiple cropping to former flood-prone areas. According to Käkonen (2008) recent development plans have included a strong belief in human mastery over nature and the water of Mekong Delta. These development efforts, while successful in some dimensions, have also contributed to creation of new risks, especially for the poorest group of people. He suggests that a sustainable development strategy in the future requires an examination of more adaptive measures in relation to the changing water flows of Mekong Delta (Käkönen, 2008).

Climate change will mean additional challenges in the future when people may be confronted with more severe damage caused by disasters such as tropical storms, floods, inundation, drought, salt water intrusion. It is likely to adversely affect agricultural production in Mekong Delta (Nguyen Huu Ninh, 2007). Moreover, the Mekong Delta is considered as one of the regions that will be worst effected by sea level rise. An Giang is one of the thirteen provinces located in the upstream area of the Mekong Delta that will be not only influenced by annual flooding but will also be affected by sea level rise in the future (Carew-Reid, 2008).

The government has promoted adaptation strategies to mitigate impacts of floods in the 'living with floods policy' in An Giang province (Decide number 1548/2001/QĐ-TTg) such as programs to exploit the benefits of the floods and the construction of dyke systems. For the dyke systems that have been finished more than ten years ago, the results have not only brought benefits but also have many disadvantages such as negative impact on the environment, degradation of the quality of the soil and water inside the dyke area. With the continued cropping and the absence of the annual floods the land is deprived of the deposit of alluvium (sediment and organic matter), which leads to that toxins cannot be released and transported away (Nha *et al.*, 2004). Moreover, one more critical discussion of benefits and cost and environment and socioeconomic impacts of the high dike have taken off. The study of Howie (2005) showed that after a few years, the total yield from three crops within the dike areas was less than the total yield from two crops outside of the dyke, because of the reduced soil fertility. It was also emphasized that increasing use of agrochemical led to harm for the environment, especially in terms of water quality (Howie, 2005). According to Kien (2008) mentioned that dyke development in Vietnam's MRD lead to two-sided effects in the delta including on one hand, the Mekong alluvium-rich waters bring many benefits to the area, such as soil fertility and agricultural and aquaculture productivity. On the other hand, the delta has been exposed to permanent threat of water disaster from the increased frequency of high floods in the wet season and water scarcity and saline intrusion in the dry season, as a result of potential rising in sea level from climate change. It is also suggested that local people have adapted the flood based farming and the services from the program of 'exploiting benefits of floods'. Along with the complications of climate change as well as

with the type of adaptation to floods with dyke systems, means that the Mekong Delta general and An Giang province is a vulnerable region. There is a high risk of poverty due to climate changes such as long floods, temperature rise, more disease, etc (Watkins, 2008).

An Giang province faces flood annually, which has negative and positive impacts on livelihood of local people. In order to reduce the negative impacts and damage by flood on local people, An Giang province has conducted policy of building irrigation system and dyke system. It led to changes of production structure, changing production conditions in different ways for different groups of farmers. This study will look closer at each period of the process of building irrigation and dyke system, and discuss farmer responses to the risks and opportunities that emerge. There are many studies conducted on the impacts of dyke systems on livelihood of local people but not so much research on how these adaptive strategies of province government affect the production strategies of farmers. This study will explore the role of different factors in influencing farmer's decision making on production, within the context of government policies for adaptation to floods. How does the dyke system and other factors such as natural conditions, climate conditions, market price of agricultural products and household condition in term of financial, physical and human capitals, influence farmer production decisions.

The general objective of this study is to understand the changes of farmer's production structure, including strategies of intensification, with a focus on adaptation to floods over time, corresponding to the process of construction of irrigation and dyke systems through provincial government policy. The objective is also to study the opportunities and risks involved in different of ways of production and adaptation. Based on the main objective, the main research question is formulated as follows:

How have the production strategies, and adaptive ways of local people in relation to the floods, changed over time, and what are the factors affecting farmer production decisions?
The specific research questions are as follows;

1) How does the change of production structure of farmers relate to adaptation with floods over time?
2) What are the factors affecting the decision making on production structure of different farmer groups with different conditions?
3) What are the opportunities and risks involved in the different production structure of different farmer groups?
4) What are the strategies to improve their livelihood?

The thesis includes seven chapters. After presenting the introduction and objectives in Chapter 1 and the brief of background in Chapter 2, it provides a review of flooding situation and adaptation to floods in Chapter 3 and Chapter 4 express conceptual definition and framework and Chapter 5 presents research methodology. Chapter 6 presents findings and discussion on changing of adaptation and factors influencing

farmer's decision to adapt to floods and the strategies of different group of farmers. Finally, Chapter 7 is a summary and conclusion.

CHAPTER II. BACKGROUND OF STUDY

2.1. Background of socio-economic situation in study site

An Giang Province covers a land area of 3,536 square kilometers and is among thirteen provinces located in the upstream area of the Mekong Delta. The Province, with a population of 2.25 million people (the population density is 631 people per km^2), is a leading agricultural production area in the Mekong Delta and Vietnam, especially rice production. The total cultivated land area is 581,436 hectares, of which 520,322 hectares is used for rice production, producing about 3.2 million tons of rice annually (An Giang Statistic 2007). In 2008, the total amount of rice exported reached approximately 0.5 million tons (An Giang Industrial and Trading Department 2008). The Province's Gross Domestic Product (GDP) is comprised of agriculture and forestry (35.47 percent), industry and construction (52.29 percent) and trading and services (12.34 percent). Average economic growth is 8.7 percent and GDP per capita was US$874 in 2008 (An Giang Department of Tourism and Trading 2008).

2.2. The situation of flooding in Mekong Delta before the dykes system

The Mekong Delta is typically associated with its hydrology, which is defined by local rainfall, the river's discharge and the tidal fluctuations, all of which affect the local water regime. The Mekong Delta has 1.2 to 1.9 million hectares of land subject to annual flooding (Nguyen Huu Ninh, 2007). Unlike the Red River Delta in the North, floods in the Mekong Delta increases at a relatively slow rate, due to the effects of Tonle Sap Lake in Cambodia which acts as a buffer upstream. Floods occur within the Tien and Hau Rivers, considered as the two biggest branches of the Mekong River by local people, both of which are linked by a complex system of natural and man-made canals, creating a complex water regime. The annual inundation begins in July or August, and can last until November or December, and even January in poorly drained areas. In addition, the discharge of the Mekong River exhibits strong seasonal variations in response to rainfall. During the peak of the flood season, approximately two-thirds of the Mekong Delta is affected by over bank flooding, of which about one-third experiences inundation exceeding one meter in depth (Tinh, 2005). Flood-prone areas in the Mekong Delta are home to 8.5 million people, of whom 17 percent live in urban and 83 percent live in rural areas. Approximately 2.5 million people in this inundation area live in deep floodwater zones (up to three meters), three million people live in medium flood zones (up to 1.5 meters), and the rest live in low flood zones (below one meter) (Nguyen Huu Ninh, 2007).

In the past many years, flooding and inundation have had the greatest impact on agricultural production and human lives in the Mekong Delta. The damage caused by the annual floods depends upon the nature of the flooding. The most serious flooding area is in the upper Mekong Delta, such as some parts of An Giang and Dong Thap Provinces, where the mean inundation depth and duration may reach four meters and six months

respectively (Tinh, 2005). This can be a danger to human life and property, as well as to irrigation and public infrastructure. The damage caused by the floods is considered to have negative effects on economic development, since infrastructure such as roads, houses, embankments and canals are underwater see (table 1). Moreover, floods of long duration have severe social impacts during the flooding season itself. Before the development of the dyke system, the farming systems for flooding areas were mainly floating rice. In the flooded condition the floating rice can deal with the very deep level (up to 3 meters) and fast increase of flooding water in the raining season (Nguyen Ngoc De, 2006).

Table 1: Estimated damage from flooding in the Mekong Delta

The Mekong Delta	Unit	1996	2000	2001	2002
1. Estimated total	VND (Billions)	2,182	4,597.3	1,456	256.8
2. Agricultural Production	VND (Billions)	1,036	948.5	372.5	216.1
- Reduced Rice Productivity	Ha	92,984	198,328	33,036	15,777
- Rice Loss	Ha	30,869	57,714	8,955	365
- Seriously Damaged Orchard	Ha	1,161	4,613	4,958	1,049
- Damaged Industrial Plant and Upland Crop Damaged	Ha	76,396	63,560	32,785	32,142

Source: ADARD 2003

2.3. Adaptation to floods through August dyke system

Adaptation of local people to severe flooding in Mekong Delta has long historical roots along with the concept "living with floods", which has been the major strategy to reduce negative impacts of flooding. It is interesting to know that 'living with floods' has been practiced by local people in some parts of Mekong Delta for a long time before the concept was used for the strategy of the government for adaptation to annual flooding. Especially, the development of dyke program in An Giang province has been based on the experience of 'living with floods' of local people. These adaptation ways were implemented by local people such as shifting crop calendars, planting deepwater rice, evacuation to higher ground during flooding season and building small-scale bordering embankment to protect crops, as well as making a living by catching fish and snails and colleting wild vegetables (Tinh 2003).

In response to floods, local governments and farmers have constructed and maintained the dyke systems surrounding their agricultural fields, in an attempt to control the floods and protect crops. Embankments have also been consolidated and constructed in order to

prevent early August flooding of the summer crops that is called August dyke protection. This type of embankment is demolished after the harvest to welcome the flood water and to decontaminate and fertilize the fields. Thanks to the dyke and embankment system, two or three crops are cultivated annually in many places in the Mekong Delta. There are approximately 1,000 square kilometers of three-crop rice farms, 10,000 square kilometers of two-crop and 1,300 square kilometers of single-crop farms. Dyke construction has been implemented across many sub-regions. It means that the August dyke systems were built in several small areas in Mekong Delta.

The dike system not only protects crops from floods but also plays a vital role in agricultural intensification. It was showed that, in An Giang province, the August dyke areas were the largest in 1999 with more than 200,000 hectares. It was gradually reduced and replaced by full dyke areas (Figure1). The government policies have had adaptation strategies towards reducing the costs of floods through dyke system and resident clusters development. Through these policies, the dyke constructions have been installed throughout the Delta by local governments and farmers called a temporary 'August dyke', which is used to protect the summer rice crop from floods in August and to allow floodwaters into the paddy fields afterwards. (Hoi, 2005).

2.4. Adaptation to floods through the full dyke systems

In recent years, the Central Government has designated the Mekong Delta as a prime area for expanding the production of food, export commodities and consumer goods in the Mekong Delta, causing a further increase in the area of cultivatable land in the floodplains by allowing agricultural production during the flooding season. Significant investment is being made not only in terms of rehabilitation and modernization (World Bank 2004, cited in Molle 2007), but also in "further crop diversification and increases in productivity which require modern hydraulic infrastructure and more efficient delivery of irrigation and drainage services" (Tiep 2002, cited in Molle 2007). According to Molle the expected increases of up to 50 percent in rice production, reaching 16 million tons by 2015, will have to come from improved varieties, increased chemical inputs and the most important factor: increased paddy land with double and triple-rice cropping capability through the construction of dike systems throughout the Mekong Delta.

Though the August dyke systems had been constructed the annual flood season often caused serious damages to property and human life, especially in, the huge floods in 2000. In order to reduce losses the adaptation strategies of the government (Decide number 1548/2001/QĐ-TTg), included the investment in a full dyke system. This is a permanent 'high dyke' system to control floods completely, thus protecting local property and allowing the growth of an additional rice crop during the flood season. However, the full dyke system has been based on August dyke system for construction. At present there are 111,167 ha of August dyke and 87,909 ha of high dyke areas. But the area of August dyke is decreasing while the high dyke area will be gradually increased year by year (An Giang department of Construction, 2009) as shown in figure:

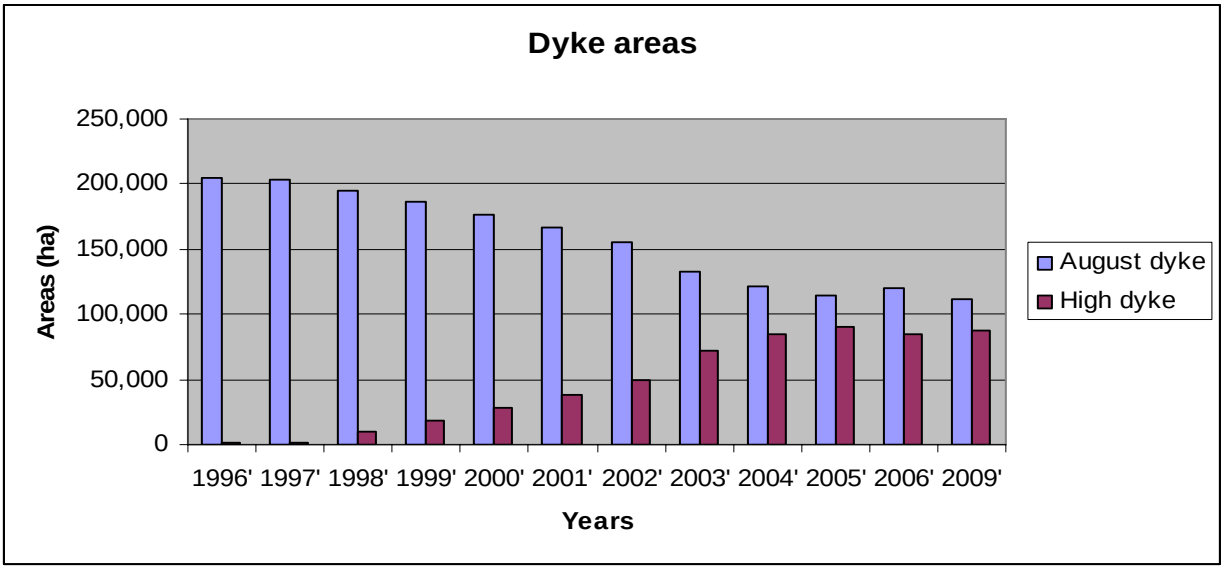


Figure 2.1: Dyke areas in An Giang province
Source: An Giang construction department in 2009

The construction of dykes has resulted in economic improvement in the Delta. The benefits of full dykes, for example, include saving the second rice crop from flood damage and the increasing rice production by additional rice crop during the flood season. For example, 87,909 ha out of 246,821 ha of agricultural lands of the An Giang province grew the third rice crop in the high dyke areas. As a result, 393,931 tons of rice were produced annually which were estimated at a value of VND 1,043 billion in 2004 (ADARD, 2004). This benefit has boosted the economic growth of the province in recent years.

In order to deal with the increased demand for rice production as well as to create employment during the flood period, the government of An Giang Province has been encouraged by both local authorities and farmers, to move toward a strategy of absolute control of the flood through the construction of full dike system. Therefore, full dike system was constructed in many sub-region of An Giang. By 2009, 12,435 hectares of the whole of Chau Phu district were protected from annual flooding by either full dyke or August dyke. An Gaing province had a total of 87,909 hectares (fifteen percent of the cultivated land surface) (ADARD, 2009) completely protected by full dike systems. Most of these areas can be found in Thoai Son (104 sub-regions). However, In Chau Phu, dyke system started later than other regions in An Giang. In Binh Phu there is also a full dyke but it was built later than in Kien An commune of Cho Moi district. In a small area of Binh Phu commune, where elevation is relatively high and full flow-control systems are available, rice is cropped thrice per year. In this area, dykes are higher than normal peak flood levels and the second wet-season rice crop is completely protected from the flooding.

Dike systems have been built in many sub-regions to regulate floodwater flows from the Mekong River system. Most of prone-flood areas in An Giang are now protected by dike systems. The adaptation strategies to floods inside the dykes have therefore changed

significantly since the permanent dike systems have been built. This is because after building the dyke systems the flood water is prevented to go into the fields and the farmer can cultivate all year around. However, it has contributed to the creation of new risks for the people in Kien An commune, as will be discussed in chapter 6. According to farmers in Binh Phu, the permanent dike system will be expanded also in their commune in the coming year. As the fieldwork shows, this is still under debate.

CHAPTER III. REVIEW OF LITERATURE

3.1. Climate change in the world and flooding situation in Mekong Delta

3.1.1. Adaptation to flooding and climate change in the world

Climate change will have a significant impact on the livelihoods of the rural poor in developing countries. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicts that climate change is likely to have a significant effect on agricultural production in many countries. Adaptation takes place at both the micro- and macro-levels: Farmers introduce practices at the local level, and the main factors influencing their diffusion are seasonal climatic variations, the agricultural production system, and other socioeconomic factors. The government, NGOs, or private companies introduce practices nationally, and long-term changes in climate, markets, and other conditions influence their establishment (Nhemachena & Hassan, 2007).

A case study in Bangladesh (Anmi Mitin, 2009) shows that, in order to adapt to climate change the government continuously seek for long term measures with dyke construction for defence against the rising sea level and flooding .Another case study of climate changes and flooding in Bangladesh considers the relationship between risk due to flooding, and the vulnerability and poverty in one of the most flood prone parts of the country. The study showed that the effects of preventive and adaptive strategies reduce impact of flooding. However, this research did not deeply study the impacts or the adaptation strategies of flooding and the methods used in research, were mostly quantitative methods (Brouwer *et al.*, 2007).

According to (Smit & Skinner, 2002) there are many options to adapt with climate changes. They emphasize that, for adaptation of agriculture to climate change, there is a need to better consider the relationship between the farm-level adaptation and the government decision-making process (Gallopín, 2006). According to the report of the (IPCC, 2007) the impact of climate changes on agriculture, forestry, fisheries, water resources, human health and human settlements in development countries is substantial. Especially, agriculture is very sensitive to climate change. Several typologies of adaptation in agriculture comprise the change of seasonal calendar in agriculture production, choosing seed, improve irrigation system, technical for management and adjustment input and improve the weather forecast (Burton & Lim).

A study conducted in Mexico (Eakin, 2005) argues that institutional change such as economic restructuring influences the adaptive capacity of farmers and plays a more important role in determining farmer livelihood strategies than climate risk. The article mentioned about people's livelihood strategies from a climate risk perspective, which also takes other economic and institutional perspectives into account. (Deressa *et al.*, 2009) show that the people who adapt to climate change use different strategies including planting tree, soil conservation, use different crop varieties, change planting date and irrigation. On the other hand, some farmers did not adapt due to reasons such as lack of information, lack of money, shortage of labor, shortage of land and poor irrigation

systems. However, (Anmi Mitin, 2009) has mentioned many strategies to adapt with climate change and with several reasons, in some Asian countries, as shown in table 2. The emphasis is on the adaptation of non-monetary inputs like timely sowing, maintaining optimum plant population, timely irrigation, efficient use of organic inputs, plant protection measure and timely harvesting of crop.

Table 2: Adaptation strategies to climate change. Source: Anmi Mitin (2009)

Strategies	Reason / Problem
Change varieties (High yield variety, Strong stem variety, Disease resistant, Drought tolerant, etc)	Non saline
Change cultivation area	Infertility, salinity
Diversify	Expand sources of income, soil or water management
Crop rotation	To improve soil fertility, to suit climatic conditions (seasonal weather)
Systemize irrigation (water ponds)	Improve water management and supply to low - land rice fields.
Drainage	Mitigate flooding problems
Aerobic cultivation	Drought, poor irrigation
Alternate wet and dry system	Increase income potential, take advantage of seasonal weather
Rice intensification (SRI)	To reduce production cost, minimize environmental damage, increase productivity.
Farming techniques	Increase efficiency, productivity
Equipment or Mechanization	Labor-constraint
Inputs (fertilizers, pesticides)	To enhance yields
Farm animals	Reduce cost of production, organic soil management,
Tree planting (buffer zone, rooting)	To mitigate climatic impact, to stabilize soil
Change planting and harvesting dates (crop management)	To reduce socio-economic impacts due to climatic variability, taking advantage of conducive growing conditions.

3.1.2. Adaptation to climate change and flooding situation in Vietnam and Mekong Delta

The major problems that the Mekong River Delta is facing include the increasing frequency and magnitude of flooding, sea water intrusion with high tide, contaminated soil, sea level rise, seasonal tropical storms. Annual flooding season occurs in Mekong River Delta in five months from July to November. Floods occur from lower part of the delta, attributable to Tien River and Hau River, which are linked by a complex system of natural and man-made canals, creating a complicated hydraulic regime. Floods also occur from the upper part of the delta, carrying much poorer nutrient sediment water. The water level in inundation area reaches 1 to 3 meters. Flooding area in Mekong River Delta is home to 8.5 million people, of which 17 percent urban and 83 percent rural. 2.5 million people in this flooding area live in deep flood water area (up to 3 meters) while 3 million people in medium flooding (up to 1.5 meters) (Nguyen Huu Ninh, 2007).

In recent studies, one of the negative impacts of climate change is the sea level rise. Vietnam is considered as one of the developing countries that will be worst affected by sea level rise in the world. The sea level rise may have significant effects to many sectors, especially on livelihood security of local rural people (Carew-Reid, 2008). Asia has increased exposure to extreme events, including typhoons, tropical storms, floods, landslides and other serious disasters. Strategies to mitigate vulnerabilities to the impacts of climate change and to develop adaptation strategies include increase of income level, educational and technical skills, disaster preparedness and management. (Parry *et al.*, 2007).

Recent studies have been done on the impacts of flooding and dykes, but most of them tend to focus on aspects of environmental degradation, ecological impacts, the decline of rice yield, and the economic costs and benefits of the dyke programs. For example, (Thang Nam Do, 2007) who investigated impact of dykes on wetland value in Mekong Delta, shows that the development of a dykes system in Mekong Delta has resulted in wetland degradation. He also estimates the impact of changes in the dyke on rice value and biodiversity value through the use of modeling.

In a study by (Nguyen Hieu Trung, 2007) on multi-level adaptation to floods and the governance of risks in the Mekong Delta, he shows that the government at different levels have taken many measures to reduce the flood damages and improve the local livelihoods in the flood areas. The measures can be structural or non structural, the structural measure mainly implemented by national and provincial levels such as dyke protection systems. On the other hand, the non structural measures are conducted at local level such as programs for taking advantages of the flood season and exploiting aquaculture. There is, however, less research on the changes over time of the measures of adaptation and production strategies in relation to the changing conditions.

According to (Nha *et al.*, 2004), in a case study on socio-economic and environmental factors in dyke areas in the Mekong delta, the positive impacts include the floods bringing sediment to the rice fields. They make the soil more fertile and improve soil quality. In the report they analyze the damage brought by dykes and focus mainly on rice.

The report has not analyzed how the people respond to or deal with these harmful aspects, such as how reduced soil fertility may reduce production productivity and profits.

Also (Käkönen, 2008) has a crucial discussion of benefits and costs, as well as environmental and socio-economic impact of the high dykes. He refers to many studies which show that after a few years, the total yield from three crops within the dyke areas was less than the total yield from two crops outside, because of the reduced soil fertility. Especially, the water environment became more polluted due to using more chemicals in agriculture production. Also in this case the article did not discuss how farmer respond or and deal with that issue, which leads me to see the need to explore further the issue of how farmer production decisions are influenced by these changing conditions.

The study of Miller (2003) used a qualitative approach to analyze the perceptions and responses to risk in a research that was applied for different scales in the context of flooding in the Mekong Delta. She used general indicators to measure the risks and impacts. In addition, Miller conducted in-depth interviews to interpret many cases that were affected. She argues that the dominant risk strategy of the State in relation to floods and salinity intrusion has resulted in the re-distribution and creation of new risks socially, spatially and at multiple scales. At the same time, the traditional risk strategies have been challenged, for instance through the degradation of common property resources. Many of the impacts of the engineering-based approach have their origin in economic, social and political processes operating beyond the local scale, influencing those dependent on the land and water resources of the Mekong (Miller, 2003).

3.2. Decision on adaptation to climate changes in agricultural sector

Agriculture adaptation is complex processes include many dimensions, scales and levels. (Bryant *et al.*, 2000) identify four main components of adaptation such as the characteristics of the stress, characteristics of system including the cultural, economic, political, institutional and biophysical environment, multiple-scales and adaptive response. In my case the focus will be on the components relating to climate signals, factors influencing economic conditions and government policy.

Farmers' decision whether to adapt to climate change or not, is not simplistic (Adger & Arnell, 2005) because it depend on both climatic stimuli as well on other issues, such as their personal, economic and policy motivations. If farmers recognize changes in rainfall, they do not necessarily refer to climate change, because in their view, the current changes in rainfall can be part of the natural climatic variability. Further, awareness of climate change does not directly mean that farmers will adapt to climate changes. On the other hand, farmers can undertake adaptations to climate change, even when the farmer is not aware of climate change as those adaptations are in response to other stimuli. (Bryant *et al.*, 2000) suggest that economic incentives are the most important to initiate adaptation strategies, and it is hence more important to know how farmers adapt to changes in their environment rather than whether it is due to the climate change. Adaptation occurs at different scales and involves different actors (Adger et al., 2005). However, this study

only takes into account on-farm responses and the decision making process by the farmers. Thus, more insight in the adaptation process would be gained if the different actors on the different scales would be included the research in a future perspective.

The study of (Bryan *et al.*, 2009) showed that, most of the common adaptations strategies include the use of different crops or crop varieties, planting trees, soil conservation, changing planting dates, and irrigation. Constraints for adaptation include lack of access to credit and access to land. In analyzing the factors influencing the household's decision to adapt to climate change comprise wealth, and access to extension, credit, and climate information in Ethiopia, and access to fertile land and credit in South Africa. It is clear that economic factors have great influence on adaptation to climate change. My study focuses on the factors influencing household's decision, in which considerations to how to adapt to floods are strongly intertwined with economic factors. While other studies identify the factors that affect their choice of method, and the barriers to adaptation, which include lack of information on adaptation methods and financial constraints (Deressa *et al.*, 2009).

There are many studies on the factors those influence farmers' decision to adapt to climate changes at the farm level. (Vogel & O Brien, 2006) and (James Hansen 2004) identify factors influencing the decision making process through examining farmer's perception. Several studies find that the factors uptake adaptation measures are farming experience, socio-economic position, access to resources, credit and extension services (Maddison, 2007) and (Ziervogel *et al.*, 2006).

Determinants of African farmers' strategies for adapting to climate change through the multinomial choice analysis showed that, the larger farm sizes were found to encourage the use of multiple cropping and integration of a livestock component, especially under dry land conditions. Large farm sizes allow farmers to diversify their crop and livestock options and help spread the risks of loss associated with changes in climate. This suggests that availability of labor may be a critical factor constraining the switch away from the risky mono-cropping systems. This study demonstrates the importance of government policies and strategic investment plans that support improved access to climate forecasting, research into the development of and information about appropriate farm-level climate adaptation technologies, access to credit, farmer education and market development, especially in areas where dry land farming currently predominates (Hassan & Nhemachena, 2008).

CHAPTER IV. THEORETICAL FRAMEWORK AND CONCEPTS

4.1. Adaptation concepts

According to IPCC (2001) "adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation". UNDP on the other hand defines adaptation as a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented" (UNDP, 2005). (Smit, 2001) uses a similar definition as IPCC, which I see as most suited to use in this thesis: 'Adaptation is defined as adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts.' Adjustments are often made at the scale of the impacted systems, and have the ability to mitigate the negative impacts of climatic stimuli (Klein, 2003). Although there are many different adaptation possibilities, the process of adaptation or how actors decide on a certain adaptation strategy is not yet well understood (Adger *et al.*, 2003); Smit & Skinner, 2002; (Smit *et al.*, 1999) have developed a theory that describe adaptations and argue that it cannot be isolated from the many stimuli and processes that influence the eventual decision making.

Adaptation to non-climatic stimuli also influences adaptation to climate change. This may increase the risk of mal-adaptation and thus reduce the resilience of a system to subsequence changes in climatic condition (Adger *et al.*, 2005). There is especially a risk of mal-adaptation at locations where short term trend from cyclical changes are at reverse of the long-term climate change. Correspondingly, the term "maladaptation" has been used to depict the extent to which adaptation fails (Klein & Maciver, 1999). Maladaptation include avoidant reactions (denial of the threat, wishful thinking, fatalism) and "wrong" adaptations that unintentionally increase the damage done through climate change (Burton, 1996 quoted in (Grothmann & Patt, 2005).

The effectiveness of responses (i.e. moderating the adverse impacts caused by changing climate or exploiting beneficial opportunities) depends on the type of adaptation (Thomas & Twyman, 2005). It is also recognized that adaptation for an individual or group may increase vulnerability of others, therefore adaptation cannot be a target-based solution and needs to be integrated into development activities for all (Barnett *et al.*, 2008).

4.2. My theoretical framework

In my context I looked at adaptation of local people in different time periods, on the perceptions of local people on adaptation to floods, and on government policies and local decisions. The focus is on the factors influencing household production decisions and how this relates to adaptation with floods. I look at situations of tensions between the adaptation to floods by dike construction, and the adaptation to the difficulties caused by the dikes.

Farmer's production decision-making is based on many factors, such as their available resources including land holdings, labor force, capital and physical and economical conditions, etc. as well as other external dependent factors such as agricultural product market price fluctuation. Adaptation to floods appears to be one of the important factors that affect their production decisions. In the research process, I use the concept of adaptation for activities that the farmers do to reduce risk and take advantage of opportunities under different conditions. I look at adaptation in different time periods, on the perceptions of local people on adaptation to floods, and on government policies and local decisions. The focus is on the factors influencing household production decisions and how this relates to adaptation with floods. Farmer production decisions are made both with the perspective to adapt to the floods themselves, but also to adapt to the government policies on adaptation. I recognize that the farmers need to cope with many risks and it is important to look at the responses to these different kind of risks at the same time.

CHAPTER V. RESEARCH METHODOLOGY

5.1. Research site

An Giang province is one of the upstream provinces that is most heavily flooded in the Mekong Delta. It lies at the head of the Mekong basin between the two branches of the Mekong River. It borders on Dong Thap, Can Tho, Kien Giang province and with Cambodia. Annual flood season in An Giang brings fresh water, alluvium and a lot of fishes and shrimps, and because of these suitable natural conditions, agriculture in An Giang province have developed well in the Mekong Delta. An Giang have different ecological regions including upland, low land and island area.

5.2. Selection of the studied commune

The study was conducted in Binh Phu commune of Chau Phu district and Kien An commune of Cho Moi district. They were selected to represent different geographical and social-economic conditions and have both been severely affected by annual floods. They also represent different forms of adaptation to flooding. Kien An is the first commune to complete the permanent dike program to adapt to annual flooding more than ten years ago, which has shown impacts on the farming system and livelihoods. It is representative for island areas. The dike construction in Binh Phu has just been built in recent years, so there is not yet a shown impact of the dike systems. It belongs to the lowland areas. Especially, Binh Phu commune was chosen for the study because people are in process of deciding whether to expand full dyke for it or not. The leader of the commune said that the commune will be expanding full dyke in the whole commune, but this process was stopped due to some local disagreement to build full dyke.

In order to understand the difference in impact of floods and adaptation ways as well as impact of climate changes between each region, the study tries to cover two different areas in the selection of study sites. The main focus is on the low area, while the island area is discussed for comparisons. The qualitative study has been done in my thesis. This is because using questionnaire survey produces different type of information as compared to in-depth interview and discussion. The latter focuses on the household story with open questions and follow up with more detailed question to clarify and elaborate. The purpose is to understand the changing process of adaptation from no dyke to August dyke and full dyke.

5.3. Research process

The study included interviews and group discussions conducted in two communes mentioned above. In order to investigate the adaptation and local responses to floods, change of production structure, several kinds of data and information needed to be collected as methodologies had to be used.

Firstly, the method of Participatory Rural Appraisal (PRA) was conducted with different groups of different kinds of households for understanding general information. Some tools of PRA were implemented: Timeline was used to record the changes over a period of time regarding how the floods have changed, as well as adaptation strategies and main events. Seasonal calendar was

used to relate agricultural production activities to income, employment, flooding etc over time; Mapping was used to understand the changes in use of natural resources and the development of farming systems in the community over time. However, in implementing process, I had some difficulty in following up different information of different kind of people. Especially, there may be some biases in the information from villagers, due to that interviews were held with participation of the commune staff and the village leader.

Secondly, with the first step for general understanding, I had chosen some key households with long experience for in-depth interview, making the individual story to understand deeply the change process of adaptation and livelihoods.

Thirdly, thanks to the first and second steps, I chose specific groups that have changed their farming systems and adaptation strategies to floods as well as some households belonging to this group for group discussion and in-depth interview. Such groups included farmers who had changed from two rice crops to rice-shrimp farming, a group which had changed from two rice crops to three rice crops in full dyke areas in the Binh Phu commune, and a group that changed to having vegetables from having three rice crops in Kien An commune. This step gave additional information about farming activities, adaptation strategies changes as well as some factors influencing household's decision to adapt to floods. However, it did not identify the order of importance of the factors influencing to household's decision. This also varied depending on different groups. So the final step was to conduct group discussions with ranking tools to find out what are the important factors for each group.

5.4. Data collection

5.4.1. Primary data

This type of data was conducted from the duration of fieldwork through various data-gathering methods. Both qualitative and quantitative data comprise information on the impacts of dyke program and floods changes, social-economic households, local livelihood activities, local experiences and knowledge on their traditional farming systems, their adaptive strategy to reduce flood damage, the attitudes of different groups of farmers to dike construction, and their adaptive strategy to cope with the changes after the dyke construction and flood risk changes.

5.4.2. Secondary data

Secondary data includes the various published and unpublished documents from government agencies, research institutes and universities in the Mekong Delta and Vietnam. Historical documents concerning with the history of the village, land use, farming system and water management from the annual reports. Besides, official records will be collected. The statistical data about area, population, religion, farmers' income, and agricultural products, livelihood activities so on before and after the dyke construction were also collected.

5.4.3. Method of data collection

Group discussion include 10 groups of farmers in two communes with several kind of groups, composed depending on scale and type of production, and their type of dyke protection.

Some PRA tools were conducted, such as timeline, with critical determined points related to the most important extreme event, were used to understand how people cope with and adapt by changing production structure; seasonal calendar for recording the change of farming activities

calendar by the time, mapping was used to determine the change of distribution of natural resources, residents, production structure in respect to adaptation over time and ranking. This method aims at discovering conception and expectation of different groups of farmers about the dike program, the adaptive strategies of different groups of farmers to cope with new condition. It was also conducted in general groups and specific groups.

In-depth interview: The interview was supplementary to the group discussion. Selected household did not follow statistics samples but basing on the categories of households represented in the commune, such as different household economic ranking (poor, mediums better-off), landholding households (landless, little land, more land) and households with different farming system. I also interview key informants who have specialized knowledge on identified issues to get more comprehensive understanding about the context of the village. The information relates to history of village and traditional customs.

CHAPTER VI. FINDING AND DISCUSSION

6.1. Livelihood condition in the study site over time

6.1.1. Livelihood condition in Binh Phu commune

6.1.1.1. The characteristics in Binh Phu commune

Chau Phu district is located in the low land of An Giang Province. It has around 254,480 inhabitants, and 54,490 households. The district is not highly populated, with a population density of about 564 persons per square kilometer, similar to the provincial average figure of 625 persons per square kilometer. The poverty rate is estimated to be 7.3 percent, lower than the provincial average rate of 13 percent. It has 12 low land communes and one district center (Chau Phu District Department of Statistic 2008).

Table 3: Major characteristics in Binh Phu commune, Chau Phu district

Parameters	Chau Phu District	Binh Phu commune
Land Use Pattern		
Natural Land (ha)	45,100	4,793
Agricultural Land (ha)	40,169	4,507
• Rice (ha)	38,591	4,477
• Dry land crops (ha)	703	21
• Aquaculture (ha)	455	54,8
Socio-Economic Background		
Households (HHs)	54,490	1,909
Poverty Rates (%)	7.3	8.9
Population Density (persons/km^2)	564	181

Source: Chau Phu District and Binh Phu commune statistics, 2008

6.1.1.2. Changing production activities over time in Binh Phu commune

Binh Phu is a rural remote commune of Chau Phu district, An Giang province in Mekong Delta. It is located about 30 kilometers far from the center of An Giang province. The natural area of commune is 4,793 hectare, of which agriculture land is 4,507 hectare and non-agriculture land is 286 hectares. The population is 8,683 people with 1,909 households of which 169 are poor. Binh Phu commune terrain is lower than other communes of Chau Phu district, so most of agriculture production land is often flooded from 4 to 6 months in the flood season except in the permanent dike areas. The commune often suffers heavy damage in terms of agriculture, human, housing and infrastructure because of the annual floods. Rice cultivation has been the traditional farming

in Binh Phu commune for many years. Rice production is also the main farming activity in the study sites. Before 1985, the farmers grew only one rice crop per year to adapt with flood condition and one dry vegetable crop in dry season. Local livelihoods, at that time, depended more on floating rice production during six months and fishing in floods season. However, the yield of rice was low, about 1.5 to 2 tons per hectare per crop, which was just enough for food security. After they harvested the floating rice, they could start growing vegetable crops. Since the 1980s the government has invested heavily in the intensification of rice production with irrigation and drainage and new seed varieties. This has enabled the farmers to grow two rice crops per year so that the farmers have enough rice for consumption yearly and they also have surplus to sell. In addition, they also get fishing in flood season. However, rice production was sometimes affected by the annual floods, depending on level and inundation time. It means that when the floods come early the second crop will be affected by floods.

By 1996 the August dike system was developed to protect and ensure that the second rice crop can be harvested without being damaged by early floods. With August control dykes, most of the rice land is cropped twice a year. The dykes are lower than normal peak flood levels and are used to prevent the wet-season rice crop from being damaged by the early flood season only. Subsequently, sluice-gates are opened to allow flood water to come into the rice fields after harvesting the rice crop.

By 2000, the government deployed a program (The project '31' for exploiting the benefits from flooding season) (ADARD, 2004) to take advantage of the floods and create jobs for people in the floods season with the development of production such as raising shrimps, fish, eels and vegetable farming. These were just for some people who have land close to canals with natural condition and capacity for this program. On the other hand, most people can not apply this program because the farmers lack of techniques and capital for raising fish and shrimp in their situation.

In 2006 construction of a full dike system started on a small area within 360 hectares (leader of Binh Phu commune). In this area, the farmers can grow three rice crops per year so that the yields continued to increase and they did not worry about flooding. However, the farmers are now facing low price of rice and high price of inputs. Therefore, there is no profitability in rice production. Binh Phu has two kinds of adaptation, which include August dike and full dike systems. There are local discussion regarding whether to complete the full dike systems in the coming years or not (group discussion).

Table 4: Changing activities over time in Binh Phu commune

Period	Major events	Crop pattern and activities	Household participate (%)
1950s - 1985	Reclaim land	• Floating rice crop per year	100
		• Vegetable crop per year	85
		• Fishing in flooding season	90
1985-1990	Developing irrigation and drainage systems	• Double rice crops per year	100
		• Fishing in flooding season	90
1996	Starting to construct the	• Double rice crops per year	90

	August dike system	• Fishing in flooding season • Shrimp-rice farming • Rising fishes • Rising eels	85 10 20 10
2006	Starting to construct the permanent dike system in small area which provides absolute flood-control	• Three rice crops per year in permanent dike areas	20
2000 up to now	August and permanent dike system	• Double rice crops per year • Fishing in flooding season • Shrimp-rice farming • Rising fishes • Rising eels • Three rice crops per year in permanent dike areas	80 10 10 10 10 20

Source: General group discussion on October 10th 2009

6.1.1.3. The production activities in floods season

The floods do not always have negative consequences. The peaceful floods supply fresh water for irrigation and domestic usage, increase fishing resources, improves navigation for transport, introduces natural fertilizer, flush-out contaminated water caused by sulphate soils, and transport salt water towards the East Sea. Although the annual water event is perceived to bring fish and fertile sediments, to flush farm residuals and kill insects, it also interrupts rural livelihood activities due to floodwater incursion into livelihood activities. The livelihood of rural population comprises of housing, agricultural crops, means of transportation and exploiting natural resources from the floodplain. Besides the significant acknowledged benefits of the floods, the extreme water event often destroys public infrastructures, agricultural crops, fishponds, livestock and cattle grounds, houses, and rural livelihood activities. It also cause health risks (death, injuries and morbidity) and force rural poor people to seasonally evacuate (for temporarily seeking new livelihoods or survival evacuation during floods), and those often need urgent relief from different sources. In contrast, rice farmers perceived that they gain a higher yield after the high flood years thanks to the fertile sediment deposited by the floodwaters (Tien, 2001). This type of floodwater also provides nutrition for fish and crops. Especially, they improve income of local people who take part in production activities in flood season. The table 5 illustrates theses activities and net income of total farmer households who took part in flood season in An Giang province.

Table 5: Production activities in flood season 2002/2003 in An Giang province

No.	Activities	Number of Participating Households (HHs)	Net Income (VND/month)
1	Fish processing: drying fish, fermenting fish	460	450,000-600,000
2	Embroidering and weaving textile	3,370	300,000-600,000
3	Sinker and fish hook production	2,057	300,000-450,000
4	Boat and paddle making	2,243	600,000-1,200,000
5	Catching golden snails	4,025	150,000-200,000
6	Leveling land	1,424	300,000-500,000
7	Harvesting, drying water hyacinth stalks for handicraft making	1,000	150,000-200,000
8	Fishing	12,000	150,000-200,000
	Total	**25,832 HHs**	

Source: ADARD 2003

In the beginning of 2001 some adaptation program were developed by the province level government and have been successful implemented in some areas of An Giang province such as the project '31' 'to exploit the benefits of the floods program' (ADARD, 2003) to develop the farming system or create jobs for local people in the flood season. The activities of production during flood season in Binh Phu are as follows:

Table 6: Production activities in flood season 2008 in Binh Phu commune

No.	Activities	Number of Participating Households (HHs)	(%)
1	Shrimp-rice farming	20	2
2	Third of rice crop	250	27
3	Fishing, golden snail	300	33
4	Rising fishes in the next enclosure in the river	150	16
5	Rising eels	200	22
	Total	**920**	100

Source: The social-economic annually reported of Binh Phu commune 2009

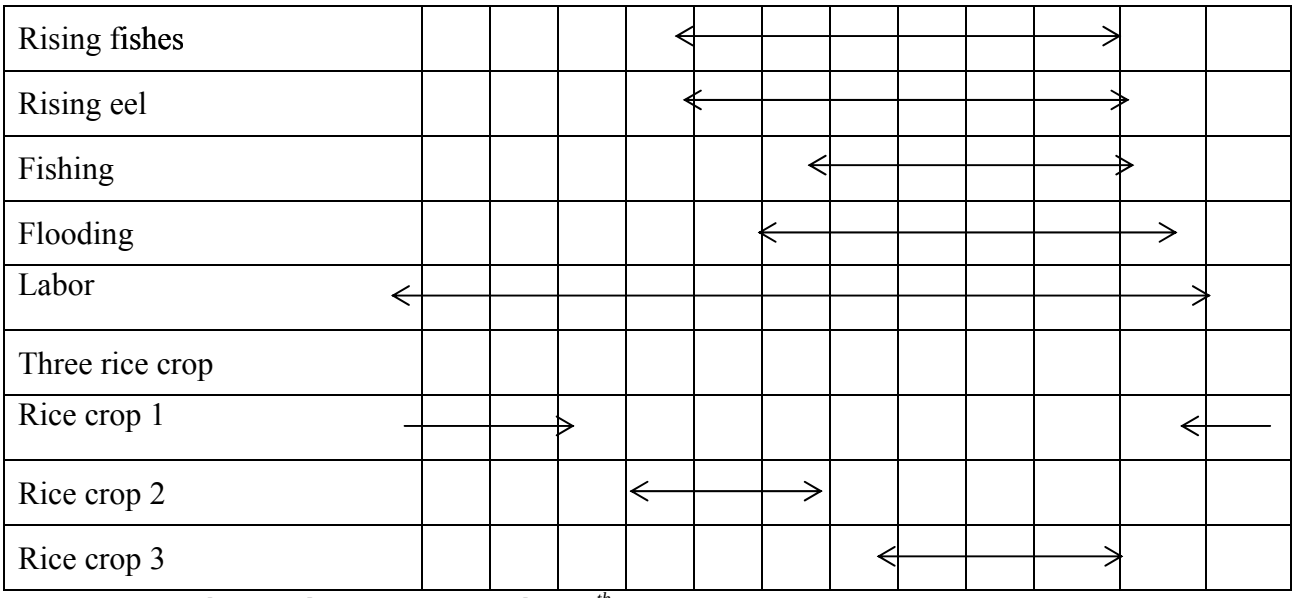
The adaptation process of farmers and the government has been changed over time. Annual flooding is an integral part of the nature of the Mekong River systems. Floods bring benefits to humans. However, severe floods might cause tremendous damage to people's lives through destructive impacts on infrastructure, agriculture production and disturbance to livelihood activities of inhabitants living in flood-prone areas. Normally, monsoonal flooding starts in July when flood water comes into the rice fields, reaches its peak level in mid-September and starts to recede by late October. During July and October, flood water levels rise from 1 to 5 cm daily. Flood dynamics, however, depend highly upon river discharges from upstream, local rainfall and the tidal effects from the estuary. According to the report of flood events in recent history in Binh Phu commune, there were six big floods between 1978 and 2008 (1978, 1990, 1991, 1993, 1996, 2000 and 2001), floods came earlier and reached their peak levels in September. The report of (Nguyen Huu Ninh, 2007) also mentions this. There have not been any big flood since 2001 but they continue to adapt to floods through these activities in flood season mentioned above. Especial, the government has extended to expand full dyke areas for prevention and adaptation.

Farmers of Binh Phu commune have been adapting to flood impacts throughout history since they moved to the commune in the 1950s, and strategies for managing flood risks have evolved through time. Binh Phu commune, followed the concept of "living with floods" which used to be a major strategy for disaster mitigation in this region. This strategy is based on the understanding of the non preventive nature of floods in the Binh Phu commune. It included planting floating rice, building small scale bordering embankment to protect crop, construction of houses higher than the peak of the flood and evacuation to higher ground during the flood season. There are changes in adaptation strategy with floods over time that follow as the long historical adaptation of local people to severe flooding. This is similar with (Reis, 2007) has mentioned, that local people adapt to flood through specific technologies and production patterns, like the seasonal variation between rice cultivation and fisheries in the stream and flood plains.

At present, there are two ways of adaptation which are quite different. In the August dyke areas, the farmers have adapted to floods following some agriculture activities such as rice-shrimp farming and fisheries in flood season. It represent the strategy of both protection and making use of the floods; 'living with the floods'. On the order hand, in the full dyke areas it is very different. It is not 'living with floods' anymore but involves complete protection against floods.

Table 7: Calendar seasonal in Binh Phu commune

Months	1	2	3	4	5	6	7	8	9	10	11	12
Floating rice crop				←	—	—	—	—	—	→		
Vegetable crop	—	→										←
Double rice crop	—	→	←	—	—	→					←	—
Shrimp-rice farming			←	—	—	—	—	—	—	—	→	



Source: General group discussion on October 11th 2009

6.1.2 Livelihood conditions in Kien An commune

6.1.2.1. The characteristics in Kien An commune

Cho Moi district is located in the island areas of An Giang Province. The population is 359,576 people and there are 78,572 households. The district is highly populated, with a population density of about 1,005 people per square kilometer, much higher than the provincial average figure of 625 people per square kilometer. The poverty rate is estimated to be 8,6 percent, lower than the provincial average rate of 13 percent (Cho Moi District Department of Statistic 2008).

Table 8: Major Characteristics in Kien An commune, Choi Moi district

Parameters	Cho Moi District	Kien An Village
Land Use Pattern		
Natural Land (ha)	36,962	2,527
Agricultural Land (ha)	27,368	1,560
• Rice (ha)	21,292	757
• Dry land crops (ha)	3,257	725
• Orchards (ha)	2,819	55
• Aquaculture (ha)	328	17
Socio-Economic Background		
Households (HHs)	78,517	7,024
Poverty Rates (%)	8.66	5.3

Parameters	Cho Moi District	Kien An Village
Population Density (persons/km^2)	1,005	1,233

Source: Cho Moi District and Kien An commune statistics, 2008

6.1.2.2. Changing production activities over time in Kien An commune

Kien An commune belongs to Cho Moi district, An Giang province. It is located about 30 kilometers from the capital of An Giang province. The natural area of the commune is 2,527 hectares with 1,560 hectares of agriculture land including 757 hectares of rice cultivation, 725 hectares of vegetables, and 55 hectares for orchards and 17 hectare for aquaculture areas. Kien An commune has a population of 15,689 people in 7,024 households, of which approximately 70 percent rely on agriculture activities. It is one of the most densely populated communes of Cho Moi district. Before 1978, the people practiced mainly floating rice cultivation in flood season and one crop of vegetables in the dry season per year. In addition, they also had fishing in the flood season. In 1978 the government developed a trial permanent dike system within 25 hectares in the commune. As result, the people can cultivate rice and vegetables all the year round. Therefore, their livelihoods were improved in this period. By 1997, the whole commune was fully flood-protected with dikes, embankments and sluice-gate structures. Therefore, agricultural production activities are now well irrigated and are no longer affected by the annual monsoon floods. Agricultural irrigation is available year-round and relies on water from the Mekong River system. Previously most agricultural land was devoted to rice farming with three crops per year being common. Presently there are more secondary farming components, including dry land crops, vegetables and fruit trees. Since the flood-control structures were installed, agricultural production has become more intensive and commercialized. Farmers have shifted from double-rice to triple-rice cropping. They have also switched from rice to cash-crops. These are big changes in terms of adaptation to floods that has lead to virtually no exposure to floods in commune. However, around more than five years after the full dike system was built the people recognized that there were increasing crop diseases and the soil fertility was decreasing. One reason was that the government did not have a plan for the cultivation in this area. It means that the farmers have decided their production by themselves in term of what kind of crops that have been grown, with a high diversity of different crops. The commune cannot open the sluice gates for water to come into the fields in the floods season, because some farmers' crops and trees will be negatively affected.

Table 9: Changing activities over time in Kien An commune

Period	Major events	Crop pattern and activities	Household participate (%)
Before	Reclaim land	• Floating rice crop per year	95
		• Vegetable crop per year	90
		• Fishing in flooding season	90
1978	Starting to construct the August dike system	• Double rice crops per year	90
		• Vegetable crop per year	50
		• Fishing in flooding season	90
1995-1997	Completing permanent dike system in whole	• Three rice crops per year	75 20

	commune	• Two rice crops-one vegetable crop per year • Fruits	15
2000 up to now	Completing permanent dike system in whole commune	• Three rice crops per year • Three vegetable crops per year • Fruits	60 40 10

Source: General group discussion on October 13th 2009

Differences between Binh Phu and Kien An commune include that Kien An is the first commune to complete the dike program to adapt to annual flooding more than ten years ago, which has shown impacts on the farming system and livelihoods, while dike construction in Binh Phu was built 4 years ago, so that there is not yet a shown impact of the dike systems. Secondly, Binh Phu belongs to the lowland areas but Kien An is representative for island areas in the Mekong Delta. Thirdly, Binh Phu has more agriculture land than Kien An. The table 10 shows that the total agriculture land of Binh Phu is 4,507 hectares while Kien An has 1,560 hectares for agriculture production. However, the population of Kien An was 7,024 households, which is higher than Binh Phu, which has 1,909 households. In Binh Phu commune more dykes may be built but it has not been decided yet. Farmers worry about lack of sedimentation that follows the full dykes. At present people do not agree to build more dikes with economic reasons because the price of rice is so low. However, in Kien An of Cho Moi district people do not worry about floods, but they worry about high input costs, low market prices and the high use of chemicals in their production. They also worry about the increased insect attacks due to higher temperature and complex weather.

Table 10: Calendar seasonal in Kien An commune

Months	1	2	3	4	5	6	7	8	9	10	11	12
Before dyke construction												
Floating rice crop	←	—	→									→
Vegetable crop				←	—	→						
Double rice crop	←	—	→	←	—	→					←	—
Fishing						←	—	—	—	—	→	
Flooding						←	—	—	—	—	→	
After dyke construction												
Vegetable crops	←	—	—	—	—	—	—	—	—	—	—	→
Labors	←	—	—	—	—	—	—	—	—	—	—	→
Three rice crop												

Rice crop 1												
Rice crop 2												
Rice crop 3												

Source: General group discussion on October 10th 2009

6.2. The changes of adaptation to floods risks over time

Adaptation of local people has been strongly affected by the government decisions through building irrigation and drainage and dyke systems to help farmers prevent damage by floods and provide good conditions for them to live with the floods. In the different periods, farmers chose different ways of living with the floods in order to reduce impacts of flooding and suitable for new conditions, by changing of not only their production structure but also of physical and social aspects. In each period, the way of adaptation to flood of local people did not rely completely on irrigation and drainage systems, but also based on their perception, experience and historical of country. It is illustrated by looking at some main periods below.

6.2.1. The period of reclaiming land in the 1950s

Because of war and difficulties in getting access to the equipments and the techniques of agriculture production, the livelihoods of local people relied completely on natural conditions. They discovered some ways to get the most benefits from natural environments for their livelihoods. In this period, in agriculture activities, the farmers used to grow one floating rice crop based on flood water during six months and one dry land crop in dry season. According to Nguyen Ngoc De (2006) this agriculture production was not efficient and low income. The characteristic of this variety was tolerant and developed with flood condition. In addition, in order to reduce damage about human and property in flood season farmers have constructed the houses higher than the peak of flood and evacuated to higher ground during the flood season. Local people have common ways to adapt to floods in this period. It seemed to be the same way for all people to adapt to floods. In addition, the fish resources were an important daily food in floods season. It was illustrated by the box1.

Box 1: People who were the first to reclaim land for settlement and living in the commune in 1955

Mr. Man is 63 year olds. His family was the first to reclaim land for settlement and living in the commune in 1955 with 3 ha of agriculture land. He said that, two years later many people came to that commune to reclaim land for living too. In the first time, he cultivate one floating rice crop during six months in the flood season and one watermelon or corn and cassavas crop in dry season. Most people living here must build their house higher than peak of flood water. Sometime his crop was destroyed by big floods. In addition, fish resources are one feed for his family in flood season. Interview on October 9th, 2009 in Binh Phu commune

6.2.2. The period of development irrigation and drainage system (1985-1990)

The construction of the canal systems in 1985 created more advantages to the production system of local people although they are still influenced by floods yearly. The farmer used the canal system to increase the numbers of crops produced in a year. This change leads to some change in the social relations among people in community in term of collective actions. Thanks to the development of irrigation systems, the dry land areas also have water in the dry season. Therefore, one floating rice crop is rapidly replaced by two irrigated rice crops per year with short-term varieties that could be harvested after three months. Moreover, the policy of economic liberalization "Doi Moi" and free market exchange also affected to develop many rice crops per year (Pingali & Xuan, 1992). However, sometimes the second rice (summer-autumn rice crop) in raining season was affected by early floods. In order to reduce the effects of flooding on second rice crop, farmers adjusted the seasonal calendar such as to sow the rice seed early to ensure that they can harvest before the flood come into their field. They change varieties to be suited with flood condition. In addition, livelihood also relied on the benefits of the resources from the flood season such as fish, snail etc.

6.2.3. The period of August dyke system (1996)

In 1996, August dyke was built in most areas in An Giang province. This created opportunities for farmers to improve their livelihood by diversifying their production activities and enhancing agriculture productivity. According to Dao Cong Tien (2001) mentioned that this period has been transform from living completely with floods to living with controlled floods. It has been achieved through development of infrastructure and farming system in the Mekong Delta such as two rice crops per year, shrimp, fish, vegetable and fruits. Therefore, the farmers received this event as a new chance for their life. Farmers changed their production activities structure to make use of the benefits of the flood season and the negative impacts of the floods on their livelihood were reduced. There were significant differences in decision making between different people in their production activities in this period. The August dyke systems have ensured that the farmers can harvest the second rice crop before the floods come. Most farmers in the commune still continue to grow double rice crop but they also change the variety of rice in order to increase quality and productivity. On the other hand, some farmers have converted from double rice crops to rice-shrimp farming to exploit the benefits from the floods season. The farmers who cultivate shrimp-rice farming think that raising fishes and shrimps in the rice fields in the flood season not only brings high income but also makes use of available labor and feed resources. In addition, the location of their land is near the river banks or canals, which is appropriate for raising shrimps and fish farming because it is easy to change the water out or in to the field. See the (box2 and box3)

Box 2: People who changed their production structure over time

Mr L is 50 year old. He has been living for a long time in Binh Phu commune. In early days his family relied on one floating rice crop and one watermelon crop production activities within 1 hectare. In 1995 he started growing two rice crops per year. Until 2002 he changed from double rice crop to shrimp-rice farming; follow the experience he learned from other farmer in other commune. The profit of shrimp is 7million VND/cong, which is higher than the profit of rice production, (which is 1million VND/cong). Moreover, shrimp farming can make use of the

available natural resources and labor in the flood season that can reduce the cost for shrimp farming activities. His land is near the canal, which is very appropriate for water getting out or in the field. Now, he knows that the government is going to build the full dike in next coming year, he hopes that the government changes their strategy so that he can continue to conduct shrimp-rice farming activities. Interview on 3rd January, 2010, Binh Phu commune.

Box 3: People who keep growing rice in their production

Mr U. is 45 year old. He has 7 congs of land for rice production. In the time before dyke was constructed, he cultivated similar with other farmers including one floating rice crop in flooding season and one vegetable crop in dry season. Since the irrigation and drainage systems were developed he has transformed to two rice crop per year up to now. He said that, he did not want to change from two rice crop to other crops because farmers living here have a long history of growing rice crops. It is easy for farmers to cultivate rice, with low investment and low risk. Moreover, if they stopped growing rice they would not know what the activities would be that could help their life. Interview on 4th January, 2010, Binh Phu commune.

6.2.4. The period of full dyke system (2006 up to now)

The life and production activities of local people have been safe and easy from 2006 until now, because of the completion of the full dyke system in areas. The income and production activities of farmers have changed in positive ways by taking advantages of the full dyke system in order to increase agriculture productivity and income generation. The change in farmers' activities to adapt with present condition of full dyke system follows the social-economy in modern society. It can be argued that as the local people's production is no more affected by flood, as before, the other reasons for production changes, such as agricultural products' market status become more important in farmer decision making. In this period, in Binh Phu commune, the agriculture production was only focused on three rice crop per year in the full dyke areas. According to some farmers who are growing three rice crops in this area, they want the full dike system because growing three rice crops per year creates jobs for local people and they become less exposed to flooding. However, they argue that full dike should not be built in the whole commune because if people grow more rice per year the price of rice will decrease even more. Farmers are also concerned that growing three rice crops per year is affecting soil quality (following the discussion of the 'three rice crops per year' group). At present, in Binh Phu commune there are two kinds of dykes, one is August dyke and the other is full dyke. In the August dyke areas it is common with two rice crops per year and rice-shrimp farming. These farmers are not interested in expanding the full dyke system to their areas (group discussion of rice-shrimp farmers).

In Kien An commune they have had a full dike systems for more than ten years. According to group of farmers growing vegetables they are facing soil fertility reduction. In order to deal with this issue, farmers must use more fertilizer materials in their production, rotation from rice crops to cash crops to make the soil become softer and use husk to improve their soil. This results in higher than normal production costs, which leads to low profit in agriculture production. They were also facing fluctuation of vegetables market prices. It seems that the farmers deal with a lot of uncertainty and unpredictable situations. As in (box 4) farmers also have some ways of coping with these problems such as they change between many kinds of vegetables every year.

In relation to this, Nha (2004) mentioned that it is because farmers grow three rice crops per year that the soil did not have time for rest, which leads to that soil quality and yield of rice reduces after a few years in the full dike areas.

Box 4: People who cultivate many kinds of vegetables

Mr H is one of many farmers who are growing vegetable in Kien An commune. He is 40 year old. He has 2 cong of onions, 0.5 cong of spices (rau thom) and 1 cong of a type of cabbage (cai ngot). He said that he must use husk to improve soil fertility before he starts growing this kind of vegetable. If he did not use husk the crop would fail even if he used more chemical fertilizer. In order to cope with market price, he always changes between many kind of vegetable every season, and it seems to be successful. Interview on 5th January, 2010, Kien An commune.

Although the full dyke systems was constructed in both the two communes Binh Phu and Kien An, but they have very different agricultural production structure. It was expressed that the natural condition of Binh Phu lowland area is mainly suitable for rice production while in Kien An island the land is suitable for both rice and vegetable production. Moreover, the average land area per household is bigger than in Kien An. They also lack of experience growing vegetables while farmers in Kien An have long time experience for growing vegetables. In Binh Phu, after building permanent dike systems, farmers have all grown only three rice crops per year. Some farmers who would like to change from rice production to other crops are not able to do so as they depend on the decision of the collective. In contrast, in Kien An commune, after building the dike systems they diversified their crops because Kien An commune is an island and farmers have long experience about cultivation of vegetables. Kien An farmers also have less land, with an average of about 3 to 4 cong per household as compared to Binh Phu where they have an average of 8 to 9 cong per household. This also influences production decisions. Kien An farmers often grow two rice crops and one dry crop per year. They also grow vegetable crops all the year around.

6.3. The factors influencing household's decisions to adapt to flood risks and other risks

Even with the same impact by floods the ways to adapt are different and depend on many factors. This study considers the ways local people change their production structure expressed as an adaptation to the effects of floods and this will be further discussed. Beside the impacts of the provincial government policy, the change of production activities of local people is also influenced by other factors and in different places including market price of agricultural products, household conditions in terms of financial, physical and human capitals. Because of being affected by these factors, farmers in Binh phu commune are categorized in the following two main production groups that comprise households, which have converted from two rice crop per year to rice-shrimp farming in the August dyke area, and the farmers who have three rice crops per year in full dyke area. In Kien An commune the two main production groups include the farmers who have three rice crops per year, and farmers who have vegetable crops all year around. This classification implies that the production structure of farmers has changed compare in the past, as a consequence of many factors, including the ways to adapt to floods. Why do some farmers choose to remain with the system of three rice crops per year, while others farmer do other ways? And why do some farmers keep a system of two rice crops per year, while some

other farmers change to rice-shrimp farming? The reasons will be explored as follows for each farmer group. The production groups were asked to rank the factors influencing their decision to change production.

6.3.1. Rice-shrimp farming group

Table 11: The factors influencing rice-shrimp farming production decision group in Binh Phu

Ranking of factors influencing farmer production decision	**Households**							**Total**
	1	***2***	***3***	***4***	***5***	***6***	***7***	
Suitable land	1	2	2	2	2	3	2	**14**
Land size	3	1	1	3	3	2	1	**14**
Financial capitals	2	5	3	4	1	4	3	**22**
Market price	4	4	4	1	5	1	4	**23**
Flood waters	5	3	5	5	4	5	5	**32**

Sources: group discussion on April 28, 2010 in Binh Phu commune

The characteristic of rice-shrimp farming group is that they have changed from previously having double rice crop only. They are still growing two rice crops per year, but in the second rice crop, is integrated with raising young shrimp in small scale. Then they expand shrimps in the whole area after harvesting the second rice crop and the floods water come into the fields. There are many factors influencing the way to change production structure of this group, as an adaptation to floods. Through group discussion, it is shown that the factor of flood water strongly affected their decision. It can be explained by that this model cannot be implemented without flood water. Moreover, the flood water provides a feed resource for shrimps, which leads to reduced cost for shrimp cultivation. The market price and financial capital also influenced their decision, because one needs more capital in order to conduct this model, and the price of shrimp is one factor determining the profit. Farmers who cultivated shrimp and fish said that, they raise fish and shrimps in the flood season because it not only brings high income but also because it makes use of available labor and feed resources during the flood season. It is suggested that the second most important factor, which influence household's adaptation decisions can be attributed mainly to economic purposes. However, the suitable land and land size factor is important condition for rice shrimp farming of households see (table 11) and (box 5).

Box 5: People who have been changed from rice crops to rice-shrimp farming

Mr D has agriculture production land with 15 cong of area. He started to cultivate shrimp-rice farming in 2001. The reason why he changed from rice crop to shrimp-rice production is economic purpose. He said that some people in other commune conduct this farming and it brought higher profit than rice crop. But he emphasizes that the requirement for the implementation of shrimp-rice farming is to invest more money and understand the technical.

This model is based on the flood season. Without flooding we cannot conduct. Moreover, he can use feed from the flood water for feeding shrimp, which can reduce the cost for investment. Interview on 3rd January, 2010, Binh Phu commune.

6.3.2. The group of three rice crop

Table 12: The factors influencing three rice crops production decision group in Binh Phu

Ranking of factors influencing farmer production decision	**Households**							**Total**
	1	***2***	***3***	***4***	***5***	***6***	***7***	
Labors	1	3	5	2	3	4	3	**21**
Land size	3	2	4	1	2	3	2	**17**
Financial capitals	2	1	1	3	1	1	1	**10**
Market price	4	5	2	5	5	5	4	**30**
Build full dyke	5	5	3	4	4	2	5	**28**

Sources: group discussion on April 28, 2010 Binh Phu commune

This group is growing three rice crops per year in full dyke area, which is a conversion from two rice crops before. It was expected that the dyke construction was important for the change from double rice crop to three rice crop, but the farmer did not think that the dyke factor was the most important, affecting on their change of production structure. Instead it was the market factor which was the most important for them to produce three rice crops. However, the farmers were continued growing rice crops although the price of rice was low because they did not have alternative for others. From the group discussion, it is interesting to discover that, the price of rice affected to their decision agrees to full dyke system. In group discussion some farmers said "they agree to expand the construction of the permanent dike system if the price of rice was higher", the price of rice determines whether to build the dikes or not. In addition, labors, land size and capitals also influence their decision. Especial, farmers who have agriculture land with three rice crop in full dyke areas they did not consider floods when they make production decision. Because of full dyke is indispensable for three rice production development. But after full dyke was built the farmer did not worry about flood anymore.

6.3.3. The group of three rice crops

Table 13: The factors influencing three rice crops production decision group in Kien An

Ranking of **factors influencing farmer production decision**	**Households**						**Total**
	1	***2***	***3***	***4***	***5***	***6***	
Suitable land	1	2	2	3	1	3	**12**
Land size	3	1	3	2	5	2	**16**

Financial capitals	2	6	1	4	4	1	**18**
Market price	4	4	5	5	3	5	**26**
Food security	6	5	6	6	2	4	**29**
Build full dyke	5	3	4	1	6	6	**25**

Sources: group discussion on April 29, 2010 Kien An commune

However, in Kien An commune, where they have a completed full dike system, the flooding was not a problem for them. Instead they considered food security in their production decision making as maintain their production. The reason shows that their land suitable for growing rice and most of people were growing rice. However, the market factor is also important to them. Although they do not consider the full dyke factor in their decisions today, they do not deny the fact that the dykes are important.

6.3.4. The group of vegetable crops all year around

Table 14: The factors influencing vegetable crops production decision group in Kien An

Ranking of **factors influencing farmer production**	**Households**							**Total**
	1	***2***	***3***	***4***	***5***	***6***	***7***	
Suitable land	3	1	1	4	1	2	2	**14**
Land size (small)	1	2	2	1	2	5	3	**16**
Financial capitals	2	3	3	2	5	3	1	**19**
Market price	5	6	4	6	4	4	6	**35**
Many crops per year	4	4	5	3	6	6	5	**33**
Build full dyke	6	5	6	5	3	1	4	**30**

Sources: Group discussion on April 29, 2010 Kien An commune

According to the group discussion of people who are not growing vegetables all the year around, but still have many kinds of vegetables, they said that since the building of the full dike system, people did not worry about the floods. So their decision regarding production is not related to adapting to flooding. Instead their decision on production is related to other factors. It is indicated that the market price strongly affects their decision. Furthermore, the full dyke system was also important to influence the change of their crops. Especially, in vegetable production, they can cultivate many crops or many kinds of vegetables per year, as they have short time production cycles. However, they also need capital for vegetable cultivation. Moreover, the suitable land and land size factors are one of the essential factors, because the soil in Kien An commune belongs to island area where is suitable for development of vegetables. Small land is easier for management and control than big land. I am surprised that the soil quality reduction is affecting their production but they did not mention it in the group discussion, see table 14 and (box 6).

Box 6: ***The main reason to change his crop is based on the market price of vegetable***

Mr.T is growing vegetables with 4 cong. In the past time, he cultivated only rice crops. Since, the full dike system was constructed he has changed from rice crop to vegetable crops. He has been using the husk to improve soil fertility every year and even each season. He said that he was using pesticides more than he used to in the past. He was using more if his crop gets disease. The main reason for him to change his crop is based on the market price of vegetable. He predicts what kind of vegetable will have a higher price in comparison with others, and he will follow this. Interview on 7th January, 2010, Kien An commune.

Through the analysis of the factors influencing household's decisions of different groups, it shows that beside the influence of the government factors, the household's decision to change their production is affected by important factors such as the market, for most of the different groups. In addition, the capital, land size and suitable land were also contributed to changing their production structure. However, it is clear that, there were significant differences between the two groups of August dyke and full dyke, regarding the flood factor and adaptation to floods. Although farmers cultivated three rice crops per year under the same conditions inside the full dyke areas, but the factors influencing their decision to remain with three rice crops per year or not were different between the areas. For example as farmers were concerned about the market for rice in Binh Phu commune, and in Kien An they considered food security as the most important for them. This is similar with (Bryant *et al.*, 2000) suggest that economic incentives factor are most important initiate for decision as well as adaptation strategies, and it is hence more important to know how farmers adapt to changes in their immediate environment rather than to the climate change. However, (Bryan *et al.*, 2009) mentioned different factors influencing the household's decision to adapt to climate change comprising wealth, and access to extension, credit, and climate information, in Ethiopia, and access to fertile land and credit in South Africa.

6.4. Adaptation and livelihood strategies of farmers to response to the flood risks and other risks

In the previous section it was discussed how many factors affect adaptation to floods and the impacts on production change over time was explored. Different adaptation ways led to different strategies on livelihood of farmers. The change of flood impacts over time and the establishment of irrigation and dyke systems, provided opportunities as well as risks for farmers. Different household groups have different strategies in order to make use of the opportunities and reduce the risks in the future for their production activities. The successful strategies do not involve all households, as they depend on what kind of activities the farmers follow and strong impacts by climate conditions. However, the strategies show the expectation of farmer, which provides useful information for policy makers.

6.4.1. Two rice crop group

Table 15: Strategies of two rice crop group

Risks	Opportunities
- Affected by flood - The weather, including rainfall and temperature - Market price of rice	- For some farmers to develop shrimps
Strategies (future policy building full dyke)	
Risks	**Opportunities**
- Intensification with three rice crops - Low sediment - Low fertility	- Developed three rice crops per year

Sources: Integrate group discussion and in-depth interview, 2010 Kien An commune

The livelihood of this group mainly relies on two rice crop per year and fishing activities in flood season. At present, in the discussion group of some farmers, who are growing rice crops in the August dike areas, they sometimes think that the flooding is a problem to them. Especially when the flooding season comes early, with high level water in their fields and drainage out of the field is low, which cause damage to their rice crops. If they have planted rice too late, the weather may cause difficulties for them with rains at the harvesting time. In order to reduce the effect to their crop, the farmers change the seasonal calendar for cultivation. They have also adapted to flooding by changing to short-term seed for rice production. Moreover, the market is one of the risks they face, and the farmers discuss whether to continue to focus on rice production or not, when the price is low. They said that, the rice production activities have been the history of the farmers for a long time, so it is easy to continue growing this crop. They are thinking that without rice production it is the same as facing difficulty. Another reason discussed is that their location of land is not appropriate for shrimp farming, which also involves higher investment and risks. Moreover, they compare that the shrimp and fish production activities require more technical knowledge than growing rice.

At present, the government has strategy to build full dyke in the whole of Binh Phu commune. This a good opportunity for them to develop three rice crops per year. However, the low price of rice affects their income generation. Some farmers said that even if the price of rice was low they would still continue to cultivate rice crop because growing rice was their main income. They did not have alternatives for replacing the rice crop, see (box7).

Box 7: Rice production were always facing difficulties with the raining

Mr N is 50 year old. He has 2.5 hectares of land for rice production including 1 hectare in the August dike area and 1.5 hectare in the full dike area. He said that the price of rice was low in 2005 so at that time he hired out his land for the third crop for others who have no agriculture land for production. He said that the crop2 and crop3 of rice were always facing difficulties with the raining, meaning that the rice crop was grown on raining season, which make low yield of rice. If the price of rice was low, together with higher cost for cultivation it led to low profitability in rice production. Interview on 5th January, 2010, Binh Phu commune.

6.4.2. Rice-shrimp farming group

Table 16: Strategies of rice-shrimp farming group in Binh Phu

Risks	Opportunities
- Affected by big floods - Affected by high temperature - Low market price of rice and shrimp - Water polluted - Development of full dyke areas	- Make use of natural resources - Employment during flood season
Strategies	
If the full dyke is constructed	**If the full dyke is not constructed**
- Develop three rice crops per year	- Continue to cultivate rice shrimp farming

Sources: Integrate group discussion and in-depth interview, 2010 Binh Phu commune

In general, this group of farmers changed from monoculture of rice to shrimps-rice farming and raising fish in flooding season. They develop shrimp-rice farming system to make use of available labor and natural resources in the flooding season. However, big floods also influenced their rice and shrimps. In addition, shrimp farming was affected by low market price, sometimes leading to lack of profit because this model has higher investment costs than rice. Especially, shrimp is very sensitive with water pollution due to chemicals used in rice production and high temperature. At present, the farmers know that the government is planning to build the full dike system in whole the commune. Therefore, farmers who cultivated shrimp-rice farming and fishes in flooding season will not invest any money for this production anymore, because the government may build the permanent dikes to protect rice production, and flood water cannot go into the fields anymore. Therefore, they cannot cultivate shrimp-rice farming in flooding season. This is a risk for them and is an opportunity to develop rice production. In their thinking, they are hoping that the government will change the strategies and refrain from building the permanent dike systems in this commune. However, according to the leader of commune, whether the plans to build full dike system or not depends on the number of farmers' agreement. According to the government decision, if more than 70 percent of farmers agree the planning will be implemented, and if the number of farmers' agreement is lower than 70 percent the dyke will not be built. It is more illustrated (in box 2).

6.4.3. Three rice crops per year group

Table 17: Strategies of three rice crops group in Binh Phu

Risks	Opportunities
- Rainfall and temperature changes - Low market price of rice - Water polluted - Soil quality reduce - More disease	- Increasing yields of rice - Many crop per year
Strategies	

- Develop three rice crops per year

Sources: Integrate group discussion and in-depth interview, 2010 Binh Phu commune

In Binh Phu, before the dyke construction, most people cultivated one floating rice crop in flooding season and one vegetable crop in dry season. When farmers had more dikes to protect the crops, they changed to double rice crops and shrimp-rice farming. When the government invested in the full dyke system, farmers started growing three rice crops in this area. Now they could stop worry about the floods, but they are still afraid of losing crops because the weather is worsening such as high temperature, raining not follow the cycles and the price of rice is low. Most people think that the floods are not a problem because a lot of agriculture production lands have been protected by full dike system. However, they were facing with market price of rice. The rice price is low so they were not happy even when they have three rice crops per year. When the price of rice is low, some farmers stopped growing rice on third crop. Some farmers hire out their land to other farmers for continued rice growing. There are many farmers who feel that they do not have any other jobs if they do not grow rice. There are not many alternatives to rice for the people who have land in the full dike areas. However, the group of farmer who cultivate in full dike areas said that they recognize that there is soil fertility reduction and more diseases in the full dike system areas.

6.4.4. Landless group

Table 18: Strategies of landless group in Binh Phu

Risks	Opportunities
- Reducing fish resources in flooding - Loosing job in agriculture activities	- Not any
Strategies	
- Migration - Hire agriculture land for production	

Sources: integrate group discussion and in-depth interview, 2010 Binh Phu commune

This group has different strategies depending on different periods. The group discussion and in-depth interviews suggested that the reasons for households to become landless are production risks due to disease or flooding. Some people who are landless migrated for resettlement to other places. In the time before dyke construction their livelihood was based on catching fish in the flooding season, and hiring out their labor in agriculture production activities. However, according to this group, in Binh Phu commune when the full dike was built it led to decreased natural fish resources, which had serious effects for the livelihood of poor people. Moreover, the tendency in agricultural hired labor in the village has not been in favor of the poor and landless people, who relied mainly on agricultural wage labor. Instead, it brings benefits to the better-off, who own the kinds of machines, which have gradually replaced local wage labor. Therefore the people who are landless have two main strategies for their livelihood, one being the migration strategy and the other to hire agriculture land from others to continue agriculture activities.

The gap between rich and poor is getting bigger when the poor lose their investment due to production risk and have to sell their land. They become poorer because they do not have land for production. So, most people migrate for getting jobs. Production risk does not have such

serious effect for the rich or better off farmers as they are not dependent on the crops. They have other income so they are not so vulnerable to the production risk of rice. In Binh Phu commune most people who are landless choose the migration strategy. On the other hand, a few poor or landless households chose the other strategy by hiring land from some people who have more land. However, sometimes their production was affected by the weather, as well as the price of rice being very low. According to the group discussion, therefore, the poor farmers and the poor landless households have lacked the potential to reconstruct their livelihoods after the dike construction. Since the dike construction, migration strategies have become more common within the land landless households, when compared to the better-off and medium income ones. Migration is perceived as perhaps being a better strategy than hiring agriculture land for cultivation, as expressed through some stories below (box 8 and box 9).

Box 8: People who were facing with risks

Mr T is 54 year old. He is landless. There are four members in his family. In 1999 he sold his paddy land with 6 cong due to production risks because his rice crop got disease. So mainly his livelihood relies on hiring out his labor. He said that he hires paddy land in the neighborhood for 500 thousand VND per cong, and he will get back the money after harvest season. He did not go to HCM city to get the job. He faces difficulty when the weather changes, like more raining or when the price of rice is very low. Interview on 10th January, 2010, Binh Phu commune.

Box 9: People who affected by floods in their production

Mrs L is 45 year old. She is a landless person. In 2000 big floods came to this commune and affected her rice crop in the harvest time and lead to big losses. After harvesting the yield of rice was reduced 2/3 compare to the previous rice crop. This time she got debts. In 2002 she also had losses because the rice crop was affected by disease so that, she got double debts. In 2003 she decided to sell her land to pay her debts and hire land from her relative with 7 cong. Interview on 10th January, 2010, Binh Phu commune.

In Binh Phu commune many households have been able to improve their poverty situation through a migration strategy (box 10), but for some households their situation has become even more desperate when they come back from the city due to the economic crisis. See the case of Mr T (Box 11). It is necessary for the poor or landless people to seek opportunities to go away from their home commune, in an attempt to spread risks and/or increase income. These are important considerations for the households in terms of their decision to migrate.

Box 10: People who have been successful in migration strategy

Mr. T is 45 year olds and lives in a poor family with five members. He said that, after many years working as hired labour in agriculture activities, the household income had still not improved. In 2001, following suggestion of by his relatives, he decided to migrate to HCM City in the processing factory. His migration was due to lack of available jobs in the commune, at that time when the level of youth unemployment was rising. He was able to earn 500,000 VND per month in the first three year, then his earnings increased to 1.5 million VND. So that his income was improved and he is very happy with his decision. And he also said that, many people have improved their income through migration in the commune but they must be saving in expenditure. Interview on 10th January, 2010, Binh Phu commune

Box 11: People who have not been successful in migration strategy

Mr. T. is 40 years-old and lives in a poor family with five members, working on 3 cong of farmland inherited from his parents. After several years working hard on that parcel of land, growing rice crops, the household economy had still not improved. In 2002, following a suggestion by his relatives, he decided to migrate to HCM City for working. He was able to earn 500,000 VND per month in the first three years, then his monthly salary increased to 1.5 million VND. He complained that, his salary was not enough for expenditure including daily meals, housing etc and his income can not improve Interview on 12th January, 2010, Binh Phu commune

6.4.5. Vegetables group

Table 19: Strategies of vegetable crops group in Kien An

Risks	Opportunities
- Changes in rainfall and temperature - Low market price of vegetable - Soil quality reduce - More disease	- Developed safe vegetable of commune
Strategies	
- Develop safe vegetable - Change to growing many kinds of vegetable in one year - Using more pesticide and fertilizer in production - Using organic matter	

Sources: integrate group discussion and in-depth interview, 2010 Kien An commune

In general, this group has cultivated vegetables since the building of the full dyke. They have stopped worrying about floods, but they worry about other issues. They have always faced market risks. In order to deal with market risk some farmers change to many kinds of vegetables in their production and even diversify with many kinds of vegetables in one season. Kien An commune built the permanent dike system more than ten years ago, and it has lead to negative impacts such as reduced soil fertility and more disease. In order to improve soil fertility they use rice husk to make the soil softer. However, for disease, farmers use chemical response to any threat to their crop and apply large amounts of pesticides rather than using alternative strategies such as integrated pest management. According to leader of Kien An commune, the commune has developed a safe vegetable strategy to help farmers who face market risk in vegetable production. However, some farmers said that when the government tries to encourage them, it makes them more vulnerable. The government encouraged them to focus on growing one crop. So, many farmers focused on that crop, which lead to the price of that vegetable to be very low. It is very difficult for farmers to respond in this situation because of the accompanying risks. The only way that farmers have to respond is that they try to diversify their crops. At present, farmers who cultivate vegetables tend to increase pesticide use in order to prevent crop losses due to pest and disease in Kien An commune. It was illustrated in two stories of Mr T and Mr T who have grown vegetable all year around (box 12 and box 13).

Box 12: Adaptation to risks

Mr. T, is growing vegetables with 4 cong. In the past time, he cultivated only rice crops. Since, the full dike system was constructed he has changed from rice crop to vegetable crops. He has used the husk to improve soil fertility every year, even each season. He said that he has used pesticides more than in the past. He was using more if his crop gets disease. The main reason for him to change his crop is based on market price of vegetable. He predicts what kind of vegetable will be higher price in comparison with others. Interview on 7th January, 2010, Kien An commune.

Box 13: Change many kinds of vegetable in one year

Mr T, is representative for vegetable groups of farmers. He has been growing many kind of vegetables with 3 cong such as 0,5cong of cai ngot, 0,5 cong of cabbage and 2 cong onion. He focused on growing onion crop following the guidance of local government. Many farmers grow the same crop with him, which led to that the price of onion is very low, approximate about 60 thousands VND per 100 kg. He said that, when the price of onion is highest, it is approximate 800 thousands to 1 million per 100 kg. So it is very difficult to predict market price. Interview on 15th January, 2010, Kien An commune.

6.4.6. Three rice crop group

Table 20: Strategies of three rice crops group in Kien An

Risks	Opportunities
- Change in rainfall and temperature - Low market price of rice - Soil quality reduce - More disease - Increasing price of input	- Increasing yields of rice - Many crop per year
Strategies	
- Continue with three rice crops per year - Apply new technical in rice production - Change from rice crop to vegetable crop	

Sources: integrate group discussion and in-depth interview, 2010 Kien An commune

In general, the farmers of this group have cultivated rice crop for a long time since the building of full dyke in Kien An commune. They are now concerned about the increased use of chemicals and their impact on soil quality reduction. In order to improve soil quality the farmers use a greater amount of manure or husk and reduce the amount of chemical fertilizer used in their rice production. There has been some talk on the need to re-open the dikes and allow floodwater to return to the fields. To carry this out, the needs of different groups would need to be reconciled: rice farmers might benefit, but fruit tree and vegetable growers might experience losses. In addition, they are facing with low market price for rice and increasing price of inputs, leading to low profit in rice production. Moreover, the weather and diseases are challenges for them in production. Some farmer said that they will continue to growing rice because this is their main income and for food security. They also apply new techniques such as "one right and five reduce" it mean that farmers must use quality seed and reduce fertile, pesticide, seeds, water for

irrigation, post harvest losses in rice production. Some others intend to change to vegetable crop following the safe vegetable strategies of the commune.

Box 14: How to deal with the market price fluctuations

Mr T is 50 year old. He said that even two months after harvesting he was not able to sell his rice. His household could not manage the money to pay back debts and to purchase inputs for the next crop. He says: "I feel that we, the farmers, were the objects of Government policy. I was constantly changing my crop pattern, since I did not know how to deal with the market price fluctuations, while the Government did not provide any help. It cost me a lot, since I had to convert from rice to vegetable land again". Interview on 14th January, 2010, Kien An commune.

6.5. The role of climate consideration in farmer decision making

In the previous sections we have seen that all farmer groups have been concerned about the changing weather and risk in their production. It was affecting their decision making in their production and household strategies. According to the discussion group on rice production the rice started to flower early when the rains came early, which lead to low yield. Moreover, farmers are also aware of increases in temperature. It means that the weather is hotter than in the past. The hot weather increases disease and insect development that affects agriculture production. Farmers know only a few options on how they are able to respond, which are often variations on their current farm practices. In order to mitigate impact of climate change some farmers have some ways to adapt to the changes such as shifting the seasonal calendar to avoid damage, change the seed to cope with pest and technical changes.

In Binh Phu commune, farmers are generally aware of changes in climatic conditions and the impacts of these changes on their production activities, such as increased temperature and larger variability and unpredictability in rainfall patterns. However, it can be difficult for farmers to distinguish between natural climatic variability and increased variability due to climate change. Most farmers are aware that the rain patterns are changing and becoming difficult to predict. It means that the rainy season comes not following a certain cycle or seasonal. When the rain comes in an unpredictable way it affects agricultural production activities, especially rice crop production.

In Kien An commune, most of farmers who are cultivating rice and vegetables are aware about climate changes in terms of that the temperature has been increasing over time and rainfall has been not following the normal cycle. Through group discussions in two groups, including rice production and vegetable production group, showed that despite farmer have perceived change in temperature and rainfall, most of farmer in both groups did not take adaptive measures particularly for adapting with climate changes. However, there were common changes in their farming practice, including use of different crop or crop seed, shifting seasonal calendar, changing farming type and improving soil fertility. These were not only adapting to climate changes, but also to deal with other changes, especially to adapt with economic purposes.

Most of farmers do perceive changes in the climate, but only a few farmers adjusted their farming practice directly in response to change in climate. Most of farmers' decisions were not based on long term changes in climate condition. They responded that they change their farming practice due to other factors. Those factors include economic factors and the environment risks that influence farmers' decision making process.

CHAPTER VII. CONCLUSION

Adaptation has an important role in reducing impacts of climate change, floods and other risks. It is one part of the changes in household's decision making on production structure. However, the farmer's perceptions on the way to adapt with floods are influenced by the perceptions and ways to adapt with flood of province government, as well as other factors. This research discusses how the irrigation and dyke systems affect the way of adaptation with floods of local people and how they change production structure. The research investigates the changes in farmer's decision making on production structure in relation to floods and other factors. Based on results from findings, below is the summary of the conclusions:

The local people's responses and adaptation to floods and changes in production structure can not be understood in isolated from other factors as their decision making process is complex. Adaptation ways to floods are related to many factors such as government policy, natural conditions, and climate condition, market price of agriculture products and household conditions, which were considered in the analysis of adaptation. Farmer's decision making process is complex in that they face many risks related to their production structure. Risks are related to flooding, climate, policy strategies, market price and agriculture production. Government policy was focused not only on the objective of protection against floods, but also on maintaining agricultural production for increasing productivity. This also contributes to making farmer's decisions more complex. Examples of this can be seen in Binh Phu and Kien An commune where decisions of farmers were not only based on those risks that related to production structure but also on the government policy. This can be seen as some farmers would like to transfer from rice production to the other crops when the price of rice is low. However, the government policy compelled people to grow rice in this area.

Government policy decisions have strongly affected production conditions of local farmers through the building of irrigation and dyke systems. It means that change of production structure of local people much more depend on government programs for irrigation and drainage and dyke system. Farmers in Binh Phu can not diversify production away from rice, as the infrastructure requires a unified rice production system. However, household's production decisions did not rely completely on the policy because in different periods, since the construction of the dyke system, the farmer's adaptation and production structure strategies related on other factors more than flooding. In Kien An the farmers tend to focus on the risk of increasing insect attacks and heavily fluctuating market prices. Basing on findings from field work, there are many factors affecting farmer's decisions in term of adaptation of the activities that those farmers do in order to reduce risk and take advantage of opportunities. My fieldwork suggests that some farmers in Binh Phu cultivated Rice-Shrimp farming to make use of available labor and natural resources in the flooding season to reduce the impact of flooding. These include climate and natural conditions, market price of agricultural products, government strategies and household conditions in term of financial, physical and human capitals. However, government programs and market price factors have important effects to their decision. Market price factors affected more to the farmer decision than other factors in term of adaptation to floods and change production structure. My fieldwork shows that farmers in Binh Phu were weighing the risk of floods against the risk of market losses due to low prices, and were thus voting against an

extension of the dyke system. However, there were many studies on the factors, including credit and markets, that influence farmers' decision to adapt to climate changes at the farm level. (Vogel & O Brien, 2006) and (James Hansen 2004) identify factors influencing the decision making process through examining farmer's perception. Several studies find that the factors uptake adaptation measures are farming experience, socio-economic position, access to resources, credit and extension services (Maddison, 2007) and (Ziervogel *et al.*, 2006). However, my study shows that the factors on the decision making on production structure of farmers that are most important include flood water, market price and food security. Different adaptation ways led to different strategies on livelihood of farmers. The change of flood impacts over time and the establishment of irrigation and dyke systems, provided opportunities as well as risks to farmers. The dyke system has led to an intensified production with high investments, which make people vulnerable to low market prices. Examples of this can be seen in both Binh Phu and Kien An communes. Depending on natural condition, inside or outside of dyke system, the production structure of different farmer groups, such as three rice crop, rice-shrimp farming and vegetables etc., have different strategies in order to make use of the opportunities and reduce the risks in future for their production activities.

In order to facilitate adaptation policies and change production structure, the lessons learn from the intervention program of government is that the Government need to pay more attention to structural problems of poor people, especial landless people. Example for this in my fieldwork is that some poor people and landless get more difficulties for their livelihoods since building full dyke system. This is because no fishing opportunities in the flooding, and less jobs on agricultural production because of the replacement of labor by machines. Miller argues that the dominant risk strategy of the State in relation to floods and salinity intrusion has resulted in the re-distribution and creation of new risks socially, spatially and at multiple scales (Miller, 2003). Other government measures of adaptation to non-climatic stimuli, influences adaptation to climate change, because it may increase the risk on mal-adaptation and thus reduce the resilience of a system to subsequence changes in climatic conditions (Adger & Arnell, 2005) (Adger et al., 2005).

There is need for careful consideration on which areas should have full dyke or not. How to avoid negative impacts should be a concern in the policy making process on production strategies. Example for this can be seen as some farmers did not dare to develop rice shrimp farming because they recognize that the government going to built full dyke system in the next few years. The responses from the government are mainly aimed at "flood prevention" while the farmer strategies also focus on "flood exploitation". Therefore, there is a need for further research on the development potential of floods. On the other hand, farmers can undertake adaptations to climate change, even when the farmer is not aware of climate change as those adaptations are in response to other stimuli. (Bryant *et al.*, 2000) There is a high risk of poverty due to climate changes such as long floods, temperature rise, more disease, etc (Watkins, 2008) My fieldwork results reinforce this concern as findings show how farmers' struggle with the new risk of increased insect attacks, irregular rain and drought periods.

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