Economy and Environment Program
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Adaptation Strategies to Address Coastal Erosion/Flooding:
A Case Study of the Communities in Bang Khun Thian District, Bangkok, Thailand

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Adaptation Strategies to Address Coastal Erosion/Flooding: A Case Study of the Communities in Bang Khun Thian District, Bangkok, Thailand

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Abstract

Coastal erosion is a serious problem in Thailand nowadays. The impacts of coastal erosion on the flat and low-lying Gulf area are expected to be high. The sediment supply to the coasts in the Upper Gulf of Thailand, including Bang Khun Thian district in Bangkok, has been decreasing because of dam constructions, combined with relative sea-level rise (subsidence) due to excessive ground water extraction. The loss of coastal land significantly affects the livelihood of the local people. At present, the Bangkok boundary mark at Bang Khun Thian district is already submerged. The mark was made taller by the Bangkok Metropolitan Administration afterwards. Over the past 28 years, coastal erosion has decreased the shoreline by 4-800 meters, at the rate of 20-25 meters per year. Two villages in Bang Khun Thian, whose major economic activities are shrimp and blood cockle farming, have been affected by coastal erosion.

This study aims to determine households' adaptation strategies to address coastal erosion/flooding. It entailed a site visit, discussion with the local people, literature review, and a household survey. The results indicate that households have individually applied three types of autonomous adaptation strategies, which are (1) protection (e.g., stone breakwaters, bamboo revetments, and dike heightening), (2) retreat, and (3) accommodation. Of these, protection is the most popular. Each household had applied more than one adaptation option.

The annual adaptation cost is approximately US$3,130 per household, which is equal to 23 percent of the average household income. The average inundated area is about 0.9 hectare per household or 8 percent of the household aquaculture area. The existing government's assistance for coastal erosion/flooding is in the form of stone breakwater, which is ineffective, and flooding compensation. This study showed that individual adaptation strategies, without any collective adaptation strategies, may not be effective solutions due to the occurrence of negative externalities if the neighbors do not apply/maintain their own protection structures. Secondly, due to low educational attainment and lack of other knowledge and skills, farmers could not shift to other occupations. This lack of livelihood choices explains why farmers are willing to pay highly to apply/maintain their protection structures. Lastly, for the protection structure to be effective in protecting the shore, it should be planned for the whole Upper Gulf of Thailand. Thus, the cooperation of the national government, local governments, and the public is necessary to address the problem of coastal erosion/flooding.

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1. Introduction

1.1 Research problem

Global sea level has been rising; its continuous rise is one of the most certain impacts of global warming and is expected to result in flooding of coastal areas and negatively impact the livelihoods of people in such areas. In Thailand, the impacts of coastal erosion, combined with relative sea-level rise (subsidence) due to excessive ground water extraction in the flat and low-lying Gulf area, including Bangkok, are expected to be high. A Chulalongkorn University study shows that 11 and 2 percent of the Gulf of Thailand and the Andaman Sea coastlines, respectively, are eroding at a rate of more than five meters a year. This is equivalent to 2 km^2 of coastal real estate, which is valued at around US$156 million, being lost each year (World Bank 2006).

Coastal erosion also leads to losses of roads, electricity systems, aquaculture areas, and other farmlands. Jarupongsakul (2006) finds that 30 coastline areas in Thailand belong to the most severe level of coastal erosion or the “hot spot” areas. The coastlines in Samut Sakorn province, Samut Prakarn province, and Bangkok (Bang Khun Thian district), which are connected (Figure 1.1), are included in the hot spot areas. The principal livelihoods of the local people along the coastal areas in these three provinces are coastal aquaculture and farming. This indicates that these three provinces are facing the same problem; hence similar approaches in addressing the problem could be adopted. However, due to budget and time limitations, this study focused only on Bang Khun Thian district in Bangkok, which is considered to represent the affected local communities. In addition, the Bangkok Metropolitan Administration (BMA) has been planning to deal with the coastal erosion problem in Bang Khun Thian area during the study period. Since the BMA’s study focused on engineering or infrastructure alternatives, this study addressed the aspect on households’ adaptation behavior.

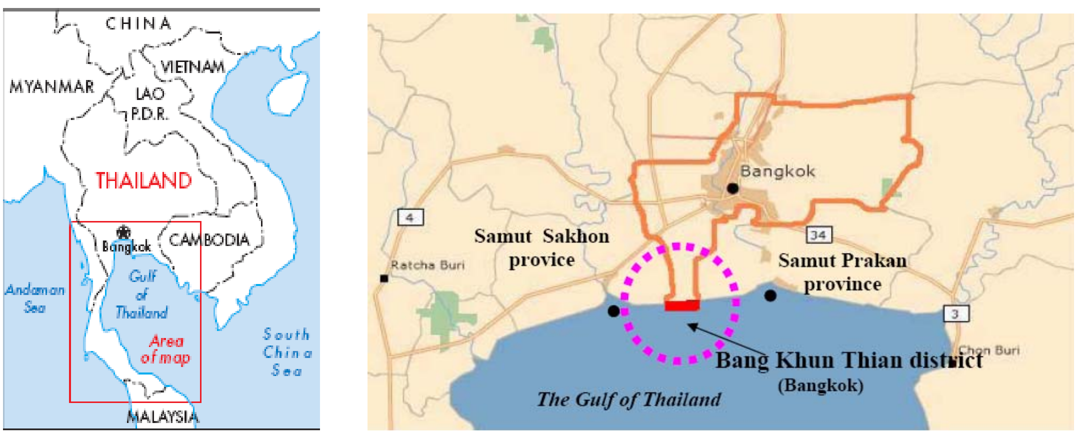

Figure 1.1 Gulf of Thailand (left) and the study area, Bang Khun Thian District, Bangkok (right)

Bang Khun Thian is the only district in Bangkok located on the coastal area; it has 4.7 km of coastline. The area located next to the shore is Ta Kam sub-district with a total population of 38,699 persons and 16,956 houses[1]. The BMA study (2006) showed that communities of two villages (village number 9 and 10) in Ta Kam sub-district have been directly affected by coastal erosion. In 2005, villages' number 9 and 10 had 382 and 327 houses, respectively (BMA 2006).

The area most critically affected by coastal erosion in Bang Khun Thian is village number 9, where the Bangkok boundary mark is already submerged. The mark seen in the picture was made taller by the BMA afterwards. (Figure 1.2); its erosion rate is 20-25 meters per year. During the past 28 years, coastal erosion has decreased the village's shoreline, ranging from 4 to 800 meters (Jarupongsakul 2006).

Figure 1.2 Bangkok's boundary mark at Bang Khun Thian District, Bangkok

1.2. Research objectives

The objective of the study is to determine households' and communities' adaptation strategies to address coastal erosion/flooding. The specific objectives are as follows:

1. To identify how many households/communities are affected by coastal erosion/flooding.

2. To describe how households/communities cope with coastal erosion/flooding.

3. To determine the social and economic impacts due to coastal erosion/flooding.

4. To estimate the costs associated with households/communities adaptation due to coastal erosion/flooding.

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[1] The meaning of houses differs from households in the sense that one house may have more than one household.

5. To describe how local government agencies help the communities to cope with coastal erosion/flooding.

6. To identify the threshold level of households in making a decision to apply adaptation strategies.

7. To gather the lessons learned from the study site's experience for use by other communities, which may be threatened by the same problem in the future.

1.3 Structure of the report

Section 2 presents a review of related literature, which includes the general impacts of sea-level rise, types of adaptation, and overview of adaptation experiences in some countries. Section 3 describes the geographical characteristics of and economic activities in the study area. It also illustrates the past and present situation of coastal erosion and presents historically the responses to the problem. Section 4 describes the methods of data collection. Section 5 presents important findings from the survey, which put an emphasis on adaptation strategies to address coastal erosion in the study area. Finally, section 6 provides the conclusion of the study and lessons learned.

2. Literature review

Among the potential biophysical impacts of global warming and sea-level changes on coastal systems summarized in Mclean and Tysban (2001), this study focused on three impacts: (1) inundation and wetland loss (and change), (2) erosion, and (3) flood and storm damage. These three problems are also caused by or interact with other relevant factors apart from sea-level rise (Nicholls 2003). For instance, change in supply of sediments is a factor that influences all these three problems. Wetland loss is also caused by direct destruction and aquaculture development. These other relevant factors, which are climate and non-climate factors, should not be ignored in trying to understand the impacts of and adaptation approaches to the problems.

On the other hand, related socioeconomic impacts of coastal erosion and flooding can include the loss of property, coastal habitats, and protection infrastructure. There are also various indirect impacts of coastal erosion that are usually more difficult to analyze. For instance, considering the impacts on aquaculture production, coastal erosion can be expected to result in damages on coastal infrastructure such as pond walls and defenses.

2.1 Types of Adaptation Strategies

According to the Intergovernmental Panel on Climate Change (2001), adaptation is defined as adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climate change and variability.

Adaptations come in a huge variety of forms. Adaptation types are commonly distinguished by purposefulness and timing. Autonomous or spontaneous adaptations are considered to be those that take place in reactive response to climate stimuli, i.e. after initial impact manifest, without the direct intervention of public agency (Smit and Pilifosova 2001). Planned adaptations can be either reactive or anticipatory (undertaken before impacts are apparent), and are often interpreted as a result of policy decision based on an awareness that conditions are about to change or have changed. Autonomous adaptations are widely interpreted as initiatives by the private sector like individuals or communities rather than by governments.

Focusing on adaptation to the impact of global warming and sea-level changes on coastal systems, adaptation options are usually identified as one of three possible approaches (Nicholls 2003; Mclean 2001).

1. ***Retreat***, which implies that all natural system effects are allowed to occur and human impacts are minimized by pulling back from the coast. This approach involves no attempt to protect the land from the sea.

2. ***Accommodation***, which implies that people continue to occupy the land but make some adjustments to avoid the impacts, for example, by elevating buildings on piles, growing flood-tolerant or salt-tolerant crops.

3. ***Protection***, which aims to protect the land from the sea so that existing land can continue, by constructing hard (or semi-hard) structures (e.g., seawalls, sandbags) as well as using soft measures (e.g., beach nourishment)

2.2 Overview of adaptation approaches to address coastal erosion/flooding

Adaptations to impacts of coastal erosion take multiple forms. Empirical studies of how individuals or communities actually adapt to coastal erosion and flooding show that choice of adaptation measures or initiatives depend on particular impacts and geographical factors in each country. Adaptation options are also constrained by economic, social, technological, and political conditions. Responses to coastal erosion are mostly motivated by property owners and coastal communities to protect valuable shorefront property. Below are some examples of adaptation initiatives and measures undertaken in countries affected by coastal erosion and flooding.

Protection strategy, which aims to protect the shoreline, is most often used as adaptation in coastal area where economic activities are highly concentrated. In the case of Japan where most of the major cities and infrastructures supporting industrial production, power generation, transportation, fisheries, etc. are located in the coastal zones, the protection approach is the most important adaptation initiative (Kojima 2000). It has been estimated that 90.3 percent of the existing Japanese sandy beach (24% of the total coastal line) would be eroded if sea level rises by 1.0 m (Kojima 2000). In 1996, about 8,800 km of Japanese coastline have been covered by line structures such as embankment, seawalls, revetments, and bulkheads. These structures are intended to reduce the risk of flooding by decreasing its probability of occurrence and limiting its potential effects. Also, an array of detached breakwaters and artificial reefs, protecting about 700 km of the shoreline, has been used to stabilize beaches and control erosion.

In Fiji, most of whose population and tourism related infrastructure (e.g., towns, airports, and resorts) are currently located on coastal and low-lying areas, resorts commonly adapt to erosion and the risk of storm surge by building seawalls and planting coconut palms or mangroves (Beckon 2005). However, such hard structures often cause erosion elsewhere, necessitating further erosion protection measures. In the case of Egypt, the rise in sea level has been threatening the tourism industry, a major contributor to the country's gross domestic product (GDP), and the entire ecosystem. The coastal protection activities include the construction of jetties to preserve the sediment and breakwater to reduce wave heights (El Raey et al. 1999). In addition, a number of beaches are nourished by sand transported from the desert near Cairo. Also, seawalls and dikes are built to protect the low portion of the local road from flooding.

On the other hand, building structures to deal with coastal erosion is rarely found in Bangladesh. A study estimates that 14,000 km^2, or about 10 percent of the total land area, would be lost if the sea level rises by 1.0 m (Ali 2000). At present, Bangladesh has already adopted afforestation as an adaptation strategy to address the intrusion of surge water and coastal erosion. Ali (1999) claim that planting mangrove along the coastal belt would help stabilize the land, create more accretion leading to more land, and also raise the level of land so that inundation by sea-level rise is reduced.

So far, the studies show that in most countries that have been threatened by coastal erosion and flooding, their governments have played an important role in adaptation. One of the reasons for this may be that the knowledge or information on how communities currently deal with the problem on their own is much less documented than the projects administered by public agencies. However, in countries where communities are the major stakeholders in coastal areas like the United States, coastal communities have initiated a combination of adaptation approaches. Building major protection structure is not the leading approach for communities because of financial resource constraints. It is estimated that 87,000 homes located on low-lying land or bluffs are likely to erode into the Ocean or Great Lakes over the next 60 years (The H. John Heinz Center 2000). Among a variety of coastal management tools, land use planning and zoning is frequently adopted since it is inexpensive to implement and usually acceptable to the locals (Moser 2000). Communities also use dune and wetland protection, which meets multiple objectives like habitat protection and public access to environmental and recreational resources. For many communities, this approach is less expensive than major structural protection and is aesthetically more acceptable. Beach maintenance and smaller shoreline protection measures (such as bulkheads, groins, and geotubes) are also adopted in some areas.

The studies also show that a variety of adaptation measures have been adopted at the same time regarding the conditions of the concerned area such as erosion, subsidence, or related changes of waves. The issues of the adaptation process and the capacity of the coastal communities to adapt are not usually considered in studies. It is now widely recognized that this is inadequate and future studies have been recommended to address this issue (Nicholls 2003).

3. Description of the study area

3.1 Profile of Bang Khun Thian

The coastal area of Bang Khun Thian district is situated along the Upper Gulf of Thailand and is bounded by Samut Prakan province to the east and by Samut Sakon province to the west. The study area has 4.7 km of mud coast, where no mangrove forest has survived so far, except for fringes along the shoreline. Shrimp ponds line behind the shore (Figure 3.1). There is a canal next to the strip of shrimp ponds, where farmers' houses are located; the canal is also the main route of transportation of the coastal communities.

Figure 3.1 Aerial photographs of Bang Khun Thian coast showing shrimp ponds lining behind the coast. (Source: www.thaigoogleearth.com, October 2007)

3.2 Economic activities

Coastal aquaculture is the major economic activity in this study area, where shrimp and blood cockle farming are the main occupation. All shrimp farmers in the study area use extensive farming, which requires little management and investment. Farmers impound the wild larvae from the sea and then grow them to market size. Shrimp feed on naturally occurring organisms, so farmers do not need to use feed or fertilizer for farming. Therefore, almost all the farming cost come from the construction and maintenance of dikes. Harvesting is done by draining the pond and collecting the shrimps in nets. However, farmers harvest shrimps in such a casual way, according to their own consideration, such that harvesting periods and yields cannot be exactly ascertained. Water quality is the most important factor in shrimp farming.

Due to decreasing yields from shrimp farming caused by water pollution and decrease in wild larval shrimps, shrimp farmers have engaged also in blood cockle farming to support their earnings. Like shrimp farming, cockle farming requires little management since cockles feed naturally on nutrients from clay at the bottom of the pond. Farmers only impound larval cockles and wait for them to grow to market size, which takes about 1 year. Therefore, production costs of cockle farming come mostly from costs of cockle larvae.

3.3 Current impacts of coastal erosion/flooding

Over the past 30 years, it is reported that the Bang Khun Thian coast has eroded by more than 500 meters, or equivalent to a total loss of about 400 hectares (Figure 3.2); the erosion is most severe around the canal mouth. An analysis of aerial photographs from 1952 to 1991 shows that the erosion rate is approximately 7-12 meters per year in the beginning, and increasing to 33.1 meters per year in the 1987-1991 period (Ittaro 2001). Further analysis of these photographs and earlier photographs reveals that the coastal retreat was accompanied by a remarkable change in the shape of the coastline, i.e., from a regular, smooth coastline to a very irregular coastline at present (Winterwerp et al. 2005).

Figure 3.2: Map showing the inundated area of Bang Khun Thian (source: BMA 2002)

Studies show that coastal erosion at Bang Khun Thian is caused by the decrease in sediment yield, natural land subsidence, sea-level rise, and the impacts from waves and storms (Winterwerp et al. 2005; Jarupongsakul 2006; Ittaro 2001). An annual subsidence of 1 cm would result in an apparent coastal retreat of 5 meters per year (Winterwerp et al. 2005). Jarupongsakul (2006) estimates that the sea level at the Upper Gulf of Thailand would rise to 10-100 cm in the next 50 years. When the effect of land subsidence is factored in, about 6-8 km inland from the current shoreline will be inundated in the next 100 years.

An important evidence indicating the seriousness of the inundation of the study area is the deserted old water gates, which belonged to farmers' shrimp ponds (Figure 3.3). Thus far, aquaculture ponds have been relocated inland; that is, farmers abandoned the gate, which was already covered by water, and have built a new one along with the reconstruction of some parts of the pond walls. Moreover, the shoreline of the study area has been affected by strong waves and storm events (Figure 3.3); mangroves at the shoreline have been felled by strong waves because their root system does not provide sufficient anchoring anymore.

Figure 3.3: An old pond's gate that is no longer used (left). Mangroves felled by strong waves (right).

3.4 Future sea-level changes and other climate change phenomena

Besides the current impacts discussed above, it is now widely accepted that the impacts of sea-level rise and other climate change phenomena cannot be ignored. A study conducted by START[2] (2007) gave a forecast on the future coastal sea level in the Upper Gulf of Thailand (including Bang Khun Thian district). As shown in Figure 3.4, in year 2030 there will be risks from higher sea level, which can be divided into two types: 1) inundation (permanent flood) and 2) extreme flood incidences.

1) Risk of inundation (permanent flood)

Assuming no changes in sea level due to annual events (spring tide and monsoon effect), the risk of inundation would be mainly caused by: 1) future sea level rise (i.e., the mean global sea level would increase by 0.3 meter[3]) and 2) the future land subsidence in this area, which is expected to increase by 0.3 meter. In the worst-case scenario, approximately 600 meters inland from the coastline in the Upper Gulf of Thailand are estimated to be inundated.

2) Risk of extreme flood incidences (episodic extremes)

Extreme flood incidences are caused by storm surges. It is estimated that climate change will magnify the current height of storm surges, the current level of which is 1.0 meter plus a buoyancy effect of 0.5 meter. Based on historical data on number of tropical cyclones blowing through the Gulf of Thailand, it is forecast that the frequency of cyclone events will double compared with that in the past 30 years (Snidvongs 2007). The study shows a high possibility of more frequent occurrences of extreme events in the future.

To prepare for these future impacts, increasing the height of the dikes by 0.6 meter may be sufficient to address the risk of inundation (i.e., sea level rise and land

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[2] Southeast Asian Regional Center for Global Change **S**ys**T**em for **A**nalysis, **R**esearch and **T**raining (START), Chulalongkorn University

[3] this number is from one of the scenarios forecasted by IPCC

subsidence). On the other hand, what the area really needs to be prepared for are the episodic extreme events, which have larger impacts and are more difficult to forecast.

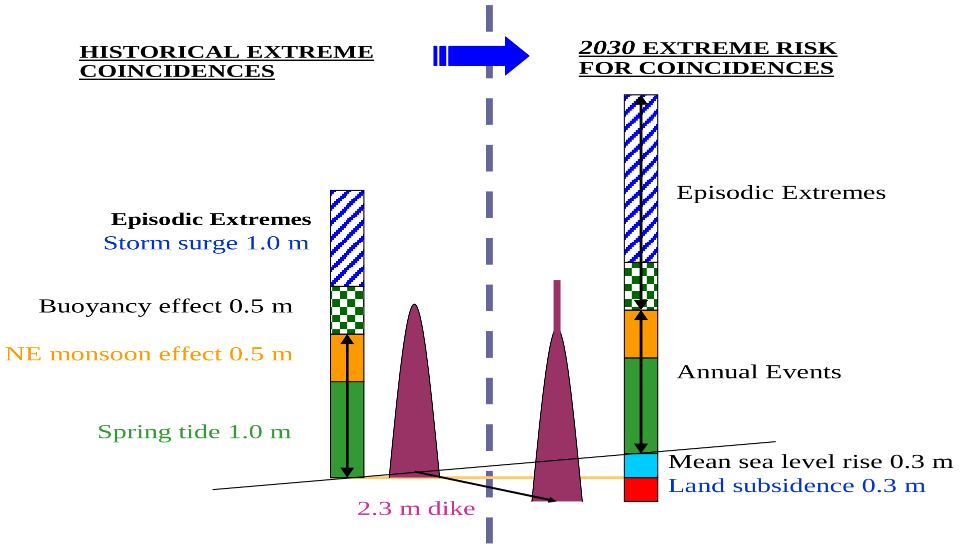

Figure 3.4 Forecast of coastal sea level in the Upper Gulf of Thailand
(Source: START 2007

3.5 Chronicle of responses to coastal erosion in Bang Khun Thian

The coastline in Bang Khun Thian has been severely eroding since 1987 (Krung Thep Thanakom Inc. 2001). Households and the government have made various efforts to stop and reverse the erosion processes such as the reforestation of mangrove forests. The details of events related to the responses to coastal erosion at Bang Khun Thian are presented in Table 3.1.

4. Methodology

This study conducted site visits, discussions with the local people, a literature review, and a survey to collect information. Data collection began with a focus group discussion (FGD) among the former village headman and local people in the study area. The meeting was intended to gather the relevant issues and to raise the scope for some forms of adaptation options, which have been undertaken in the study area. Also, the draft survey questionnaire was pretested during the meeting; the pretest had 10 respondents.

The questionnaire pretest enabled the researchers to understand better the adaptation processes and their costs, and to realize the relevance of crucial historical events to the subject being studied. The researchers visited the site (i.e., some shrimp ponds and the shoreline) to observe how each adaptation option has been done. The questionnaire was revised by adding more questions about adaptation options and making it easier to track down how households have adapted to the situation and the cost of each adaptation option. The survey was conducted by interviewing a household member who knows the details of the adaptation strategies.

Table 3.1 Chronicle of events on the responses to coastal erosion in Bang Khun Thian

Year	Events and responses to coastal erosion
1987	Villages' no. 9 and 10 have been severely being eroding. The Bang Khun Thian district office under BMA concluded that the villages needed a development plan for the mangrove forest in that area.
1989	The cabinet assigned BMA to take care of the coastal erosion in Bang Khun Thian
1991	The Bang Khun Thian district office undertakes a pilot BMA stone breakwater, which was 80 meters long and cost 224,000 baht (US$8,788; US$1 = 25.49 baht).
1992	- Households in villages no.9 and 10 dedicated their land on the coastline-side (3.75 rai (0.6 hectare)/households) to BMA for the coastal protection project. - Households also built stone breakwaters by themselves; they bore the costs by themselves. - The BMA stone breakwater was expanded to 5,020 meters; the project cost 5.4 million baht (US$212,743; US$1 = 25.38 baht).
1995	The Bang Khun Thian district office maintained the BMA stone breakwater; the maintenance cost was about 20.2 million baht (US$811,568; US$1 = 24.89 baht).
1996	The Bang Khun Thian district office maintained the BMA stone breakwater again; the maintenance cost was 6.7 million baht (US$264,624; US$1 = 25.32 baht).
1999	The Bang Khun Thian district office cooperated with an Italian-Thai Development company to conduct a feasibility study on coastal erosion protection project. The consultant proposed the construction of a stone dam, which cost 119 million baht (US$3,149,023; US$1 = 37.79 baht).
2001	The T.B.S company cooperated with a group of Dutch companies in the conduct of another feasibility study on the coastal erosion protection project. The consultants provided 9 options to address the problem; each option cost 225–2,160 million baht (US$5,063,929 – US$48,613,721; US$1 = 44.43).
2005	BMA hired Consultants of Technology Co., Ltd. And Panya Consultants Co., Ltd. to conduct a feasibility study of the coastal erosion protection project in Bang Khun Thian. Until now, there has been not decision on the option to be chosen to address the problem.

Note: All values in the table are current prices.
Source: Krung Thep Thanakom Inc. 2001 and BMA 2006.

The interview of the former village headman revealed that 200 households were affected by the coastal erosion. At first, the study planned to survey about 60 households. However, the pretest showed that households in the study area are living as extended families. While each family might not live in the same dwelling, the family members would normally work together. They also share the revenues/costs of production and costs of adaptation. However, there is no record of the number of extended families, which posed a difficulty for this study, which needs to refer to the total number of plots of land as its population. The total number of plots of land in the affected area was 108 plots. Moreover, data collection encountered other difficulties due to the following concerns:

(1) Only 50 percent of the landlords are local people who are aquaculture farmers, the rest are absentee landlords who live in town and their land is rented by farmers who have no land of their own.

(2) The farmers who do not own lands did not want to respond to the survey. The likely reason for this is that because they have rented the land for just a few years, they have no idea yet about adaptation to coastal erosion/flooding. Thus, the study's samples were only the landlords who are aquaculture farmers; there were 54 of them.

(3) One extended family may be occupying more than one plot of land. Therefore, one sample may have two or three plots of land.

(4) Some farmers who owned their lands did not cooperate with the survey. This meant that the actual sample was fewer than 54 respondents.

As previously mentioned, the unit of analysis of this study is household, which could also mean an extended family. The total number of samples obtained was 40, which was sufficient to undertake the study.

The sample was composed of 40 randomly selected households who have been affected by coastal erosion/flooding and those who know about adaptation strategies. The survey was conducted in September 2007. Before the survey, a training course was conducted for enumerators in order to minimize biases due to misunderstanding of the questionnaire. A detailed chronicling of events on the households' responses to coastal erosion was one part of the training course since it is necessary for the interviewers to understand how households cope with coastal erosion/flooding. The survey team was divided into two groups to facilitate travel, which was done by boat (each boat could accommodate four or five persons only). The teams conducted face-to-face interviews. Yellow T-shirts and tube skirts were given to household-respondents as tokens of appreciation.

5. Survey results

5.1 Socioeconomic profile of households

As mentioned above, the study had 40 samples, all of whom are aquaculture farmers. There were slightly more male respondents (52.5%) than female respondents ((47.5%). The education levels of the respondents are mainly primary school (57.5%) and secondary school (32.5%). In the past, when wild shrimp larvae were plentiful, farmers earned a lot of money from shrimp farming. Thus, there was no incentive for people in the area to pursue higher education. The majority (65%) of respondents are household heads. Most (80%) of them were born in the study area (Table 5.1)

Table 5.1: Socioeconomic profile of the respondents, Bang Khun Thian, Bangkok, 2007

Characteristics	Frequency (persons)	Percentage
Gender		
- Male	21	52.5
- Female	19	47.5
Total	40	100.0
Occupation		
- Aquaculture farmer	40	100.0
Total	40	100.0
Education		
- No formal education	1	2.5
- Primary	23	57.5
- Secondary	13	32.5
- Diploma/Vocational certificate	1	2.5
- Bachelor's degree	2	5.0
Total	40	100.0
Status		
- Household head	26	65.0
- Spouse	10	25.0
- Daughter/Son	2	5.0
- Siblings	2	5.0
Total	40	100.0
Local people		
- Local people	32	80.0
- Non-local people	8	20.0
Total	40	100.0

The respondents' high average age, which is about 47 years old, reflects the initial screening of household members who know the details of adaptation strategies. The average annual income of households is about 468,278 baht/year (US$13,625[4]), which is triple the mean income of farm operators for the whole country in 2006[5] (National Statistical Office 2006). The average aquaculture farm area is 68 rai (11 hectares) per household (in terms of extended family). Most farmers have their own farm (67.5%), with an aquaculture area of 49.5 rai (7.9 hectares), on the average. For farmers who rent farms (12.5%), the average aquaculture area is 79.8 rai (12.8 hectares). The average inundated area is 5.7 rai or 0.9 hectare, which accounts for 8 percent of the household farm area (Table 5.2).

[4] US$1 = 34.37 baht as of 2 October 2007

[5] The mean income of farm operators (mainly owning land) is approximately 154,044 baht/year/household (US$4,482).

Table 5.2: General characteristics of the respondents, Bang Khun Thian, Bangkok 2007

Characteristics	No. of respondents	Minimum	Maximum	Mean
Age (years)	40	30	78	47.3
Household member (persons)	40	2	12	4.2
Household income (baht/year)	40	45,000 (US$131)	1,528,000 (US$44,457)	468,278 (US$13,625)
Total aquaculture areas (rai)	40	30 (4.8 ha)	200 (32 ha)	67.5 (10.8 ha)
Aquaculture areas (for farmers who have their own farm: rai)	27	30 (4.8 ha)	90 (14.4 ha)	49.5 (7.9 ha)
Aquaculture areas (for farmers who rent their farms: rai)	5	40 (6.4 ha)	140 (22.4 ha)	79.8 (12.8 ha)
Aquaculture areas (for farmers who both own and rent their farms: rai)	8	80 (12.8 ha)	200 (32 ha)	124.5 (19.9 ha)
Inundated aquaculture areas (rai)	40	0	18 (2.9 ha)	5.7 (0.9 ha)

Note: 1. US$1 = 34.37 baht as of October 2007.
2. 1 hectare = 6.25 rai

5.2 Attitudes toward general and environmental problems in the communities

Table 5.3 presents the general and environmental problems in the surveyed communities according to rank. The majority (75%) of the local people considered coastal erosion/flooding as the highest priority problem, followed by water pollution (7.5%), and inconvenient transportation (7.5%). Similarly, an overwhelming majority of respondents (92.5%) cited coastal erosion/flooding as top priority among the environmental problems of the community, followed by water pollution (7.5%).

The main impact of coastal erosion in the study area has been loss of aquaculture areas. Farmers have tried to protect their land by constructing stone breakwaters close to the coast surrounding the shrimp/shell ponds but these need to be maintained every year or twice a year. This study intended to determine the point at which the farmers should start doing something to protect their land. During the pretest, one respondent shared that he uses as reference point the difference between the height of the pond's dike and sea level at high tide to determine "***a threshold level***" for him to start reinforcing his dike, such as adding mud to increase the dike's height. Thus, the study used such difference to represent the threshold level for the area. Before the survey asked about the threshold level of sea-level rise, the interviewers presented Figure 5.1 to the respondents to help them to think about the difference between the pond's dike and sea level at high tide.

Table 5.4 shows that most respondents could not indicate exactly the difference between the height of the pond's dike and sea level. They only know that they need to do something when the sea level becomes higher than the dikes or when the dikes collapsed (37.5%). However, some farmers could indicate the threshold level, which on the average is 0.88 meter.

Table 5.3: Attitude toward the top problems in the communities

Problem	Frequency (persons)	Percentage
General - Coastal erosion/flooding	30	75.0
- Water pollution	3	7.5
- Inconvenient transportation	3	7.5
- Insufficient income	2	5.0
- Debt	1	2.5
- Conflict in communities	1	2.5
Total	40	100.0
Environmental - Coastal erosion/flooding	37	92.5
- Water pollution	3	7.5
Total	40	100.0

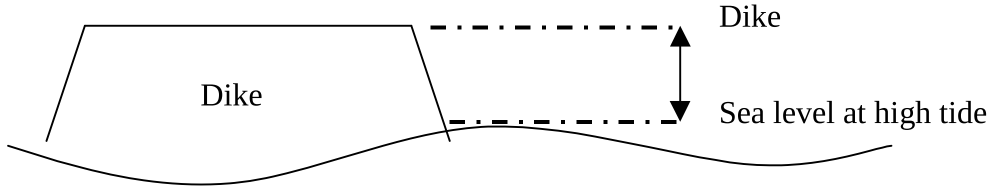

Figure 5.1 Illustration of the difference between the height of the pond's dike and the sea level at high tide

Table 5.4: Respondents' threshold levels of sea-level rise, at which point it becomes critical level for households to implement coping strategies to address coastal erosion/flooding

Difference between the height of the pond's dike and sea level at high tide	Frequency (persons)	Percentage
10 cm	1	2.5
50 cm	10	25.0
100 cm	4	10.0
150 cm	3	7.5
200 cm	2	5.0
Sea level is higher than dikes or dikes have collapsed	15	37.5
Do not know the difference but maintain the dike every year	3	7.5
Cannot answer	2	5.0
Total	40	100.0

Note: The mean value of the difference between the height of the pond's dike and sea level at hide tide is 88 cm (N = 20 samples, Min. = 10 cm. and Max. = 200 cm.)

5.3 Adaptation options and their costs

Farmers in Bang Khun Thian have been trying to protect their shrimp ponds for more than 30 years now. The survey showed that all adaptation strategies of households are autonomous strategies. Moreover, the households have individually adapted to their problems. However, the households also act as a group, led by the former village headman, such as in requesting the government's assistance regarding coastal erosion. This group action may be considered as one type of collective adaptation.

Households have to take care of their protection structures by themselves. If one household neglects to do so, it will generate a negative externality for the neighbors, which sometimes leads to conflicts in the communities. Some households could not afford the maintenance costs so they let the breakwater gradually deteriorate.

In terms of the local people's awareness of climate change issues, the households know that there are natural phenomena caused by global warming, which is a hot issue in Thailand. But most of them do not know that global warming has been causing the sea-level to rise. As such, the households have been addressing the impacts of the flooding problems at hand without considering the possible impacts of the potential rise of the sea level in the future.

5.3.1 Adaptation options

Households have exerted efforts to stop coastal erosion. All of them have applied more than one option. It was observed that when households can afford to do so, they apply all types of adaptation strategies since each strategy has its own function. Unfortunately, the survey data could not explain the adaptive capacity of the households. However, most households complained that they might not be able to survive if the government would not do anything soon because some of them have borrowed money from their relatives or banks to use for their adaptation strategies.

The survey showed that the choices of adaptation do not depend on tenure characteristics. Some farmers who rent the land also try to apply all protection options as long as they can afford to do so. In some cases, the landlords are the ones who pay for the adaptation costs. The choices of household's autonomous adaptation can be classified into three types, which are:

(1) ***Protection:*** Households have applied hard structures parallel to the coast to protect their aquaculture ponds such as stone breakwater (Figure 5.2, left), bamboo revetment (Figure 5.2, right), heightening of dikes (Figure 5.3, left), and concrete-pole breakwater (Figure 5.3, right). Such constructions are intended to lessen the impact of waves and storms. Also, some farmers heighten and reinforce the pond's wall by constructing a bamboo revetment. These methods function like a package, i.e., one option cannot be a substitute for the other options but rather supports them. Among these, stone breakwater is the most popular (Table 5.5). However, there are some physical constraints to the construction of stone breakwater such as in areas where the sea level is too shallow for a large boat to pass through. This is because it would not be possible to transport the stones and other materials needed for the construction. This is a reason why some households did not apply the stone breakwater as protection.

(2) ***Retreat:*** Some farmers moved their ponds inland so that they had to build a new water gate (Figure 5.4) and reconstruct the dikes.

(3) ***Accommodation:*** Some households have to rebuild/renovate their houses due to flooding (Figure 5.5)**.**

Figure 5.2 A stone breakwater (left) and a bamboo revetment (right)

Figure 5.3 Heightening of dikes (left) and a concrete-pole breakwater (right)

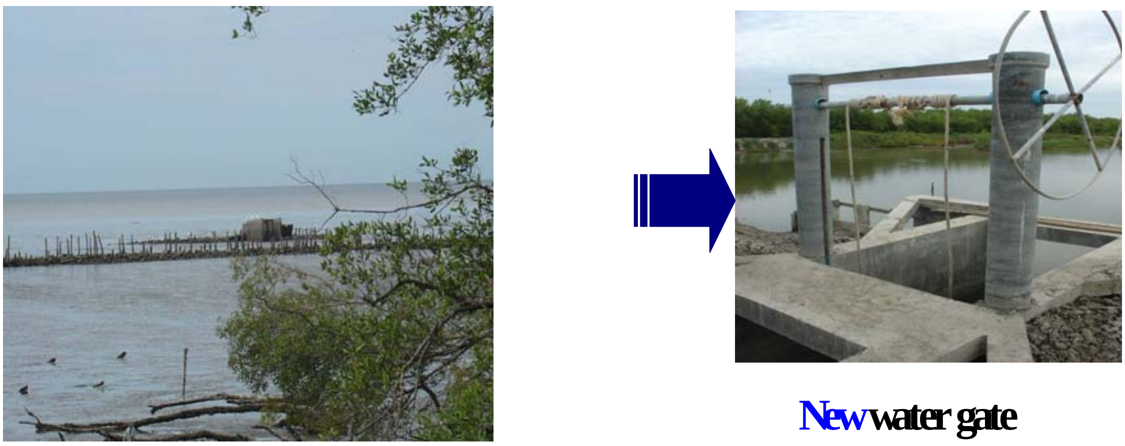

Figure 5.4 A new water gate, which needs to be rebuilt every time the farm is moved inland

Figure 5.5 Example of house rebuilding and renovating

5.3.2 Costs of adaptation

When asked how long they have been affected by coastal erosion, most farmers could not indicate exactly when the impacts have started. Farmers always say that they have been affected for a long time. To calculate the adaptation costs, it is necessary to calculate the costs in the same period of time for each household; otherwise, the costs among households could not be compared. On the other hand, it was easier for farmers to remember events rather than time in calendar years. One event that farmers remember very well is the dedication of lands to BMA in 1993. Therefore, the study set this event to be the beginning time for calculating the adaptation costs for all households.

It should be noted that all households have done more than one adaptation option; they commonly undertook a combination of options. For example, farmers built a stone breakwater to protect the farms from large waves and also heightened/reinforced their pond's walls. The total accumulated costs of adaptation strategies, which farmers have to bear by themselves from 1993 to 2007 (14 years), amounted to 1,506,219 baht (US$43,824) per household[6]. For each year, the average cost is 107,587 baht (US$3,130) per household (Table 5.6), which accounted for approximately 23 percent of the average household income.

Table 5.5 Adaptation options applied by the households

Adaptation option	No. of households who applied adaptation options	%
1. Protection		
- Stone breakwater	32	80
- Dike heightening	26	65
- Bamboo revetment	19	48
- Concrete-pole breakwater	2	5
2. Retreat		
- New water gate	29	73
3. Accommodation		
- House rebuilding/renovation	19	48
Total	40	100

Note: all households have applied more than one option.

[6] 2006 constant price

Table 5.6: Adaptation costs of households

	No. of respondents	Minimum Baht (US$)	Maximum Baht (US$)	Mean Baht (US$)
Accumulated adaptation costs for 14 years	40	78,556 (2,286)	4,035,725 (117,420)	1,506,219 (43,824)
Annual adaptation costs	40	5,611 (163)	288,266 (8,387)	107,587 (3,130)

Note: - The figures in parenthesis are values in US$; US$1 = 34.37 baht as of October 2007.
- All values are in 2006 prices

5.4 Attitudes toward current adaptation strategies and plans

Most farmers (92.5%) think their adaptation strategies can prevent only some impacts, which means that they anticipate residual impacts. Only a few respondents (7.5%) think their adaptation strategies can prevent all impacts (Table 5.7).

The majority (95%) of the respondents consider the future impacts of coastal erosion to be more severe than the current impact (Table 5.8). On the other hand, most farmers (90%) have no plans about coping with the future impacts of coastal erosion. Only a few respondents (7.5%) already have plans to relocate to other places or move to a relative's house (2.5%). Fortunately, their children have attained higher education than their parents and some of them have already got jobs and stay in town. It seems that the children are not interested in being aquaculture farmers like their parents.

Table 5.9 shows the other impacts of coastal erosion/flooding besides impacts on houses and aquaculture ponds. More than half of the respondents (55%) suffered from stress because they are afraid that the impacts of coastal erosion will cost them more. More than a third of the respondents (37.5%) do not think there would be other impacts.

Table 5.7 Attitude toward current adaptation strategies

Item	Frequency (persons)	Percentage
Perception on effectiveness of adaptation strategies		
- Able to prevent some impacts	37	92.5
- Able to prevent all impacts	3	7.5
Total	40	100.0
Sources of information on adaptation strategies		
- Observed/learned from a community	32	80.0
- Discover on my own	8	20.0
Total	40	100.0

Table 5.8 Attitude toward future impacts and plans

Item	Frequency (persons)	Percentage
Impacts of coastal erosion/flooding in the future		
- More severe	38	95.0
- The same as today	1	2.5
- Not sure	1	2.5
Total	40	100.0
Future plans		
- No plan	36	90.0
- Plan to move to my own houses in other places	3	7.5
- Plan to move to a relative's house	1	2.5
Total	40	100.0

Table 5.9 Other impacts besides impacts on houses and aquaculture ponds

Impacts	Frequency (persons)	Percentage
- No other impacts	15	37.5
- Stress	22	55.0
- Conflicts in coping with coastal erosion in communities	3	7.5
Total	40	100.0

5.5 Government's assistance

The BMA and the Fishery Department have provided assistance to households affected by coastal erosion/flooding. Apart from constructing a stone breakwater along the whole shoreline, the BMA also provides other small protection structures and materials, such a tire breakwater (Figure 5.6) and sandbags to reinforce the dikes.

Table 5.10 shows both the assistance provided by the government and that needed by the households. The aquaculture lands of the respondents are mostly located behind the BMA stone breakwater. As such, 70 percent of the respondents indicated benefiting from the BMA stone breakwater. On the other hand, during the focus group discussion, the participants mentioned that the tire breakwater was an ineffective measure. It could not resist a large wave, so that it was washed away within a few weeks. As a result, only a few households (7.5%) mentioned that they received the BMA tire breakwater. Moreover, only a few households received the other assistance, particularly the provision of sandbags and dike reinforcement service. On the other hand, the Fishery Department has provided compensation to households affected by flooding, which accounts for 17.5 percent of the respondents.

It is noted that the BMA has not yet taken into account in its coastal protection plan the potential impacts due to climate change, particularly sea level rise. This calls for a thorough study on the impacts of climate change in order for the concerned public agencies to prepare proper solutions to the problem.

Figure 5.6 Part of the BMA-constructed stone breakwater (left) and a tire breakwater (right)

Table 5.10: Assistance provided by the government and needed by the households

Item	Frequency (persons)*	Percentage
Assistance provided by the government		
- BMA stone breakwater	28	70.0
- BMA tire breakwater	3	7.5
- BMA sandbag	4	10.0
- BMA dike enforcement service	2	5.0
- Flooding compensation	7	17.5
Assistance needed by the households		
- BMA stone breakwater	38	95.0
- Road in communities	21	52.5
- Any help that can cope with coastal erosion	7	17.5
- Loan for adaptation	2	5.0
- Subsidy for adaptation	1	2.5

Note: * respondents indicated more than one choice

6. Conclusion and lessons learned

Coastal erosion has become one of the most serious problems in Thailand in recent years. The impacts of relative rises in sea level, due to either land subsidence or climate change or both are expected to include the inundation of coastal areas, thus creating a negative impact on the livelihoods of the local communities in such areas. The sediment yield in the Upper Gulf of Thailand has been decreasing as a result of the dam construction, while land subsidence is mainly caused by excessive withdrawal of ground water (Winterwerp et al. 2005). Thirty coastal areas in the country have been identified to belong to the most severe level of coastal erosion, or the so-called “hot spot” areas. Bang Khun Thian district in Bangkok province is among those located in a coastal erosion hot spot; in fact, the Bangkok boundary mark is already submerged; the mark was made taller by the BMA afterwards. The rate of coastal erosion in Bang Khun Thian is approximately 20-25 meters per year, resulting in the shoreline’s decrease from 4 to 800 meters within the past 28 years (Jarupongsakul 2006).

Two villages in Bang Khun Thian district, whose main economic activities are shrimp and blood cockle farming, have been directly affected by coastal erosion. The households in these villages have applied on their own adaptation strategies to address the situation. The strategies can be categorized into three types: 1) protection strategies, which consist of stone breakwaters, bamboo revetments, and heightening of dike, 2) retreat, wherein farmers move their farms inland, necessitating the rebuilding of a new water gate, and 3) accommodation, which means rebuilding/renovating their houses to cope with the impacts of coastal erosion or flooding. All households have applied more than one adaptation strategy.

In terms of economic impacts, the financial costs of the adaptation strategies were significant. The annual adaptation cost was approximately 107,587 baht (US$3,130) per household[7], accounting for 23 percent of the annual household income. Furthermore, a number of aquaculture farms are inundated, resulting in losses of a valuable asset. On the average, each household had approximately 5.7 rai (0.9 hectare) of its farms under water, which accounts for 8 percent of its aquaculture area.

Even though the local government agency has provided a protection structure, i.e., the BMA stone breakwater, it is merely a temporary solution and is not in fact functioning well at present. On the other hand, the national government agency has provided flooding compensation to the villagers.

The following are the lessons learned from this study:

1) The existing adaptation strategies undertaken autonomously by the households may not be the "right" solution. According to engineering knowledge for coastal protection, the protection structure needs to be built along the entire shoreline for it to be effective. If the protection structure is built only in some parts of the coast, the impact on the other parts without any protection structure could become even worse. In the case of autonomous adaptation strategies done by the households, since some households cannot afford the adaptation costs, negative externalities created may affect their neighbors.

2) In the past, wild shrimp larvae were plentiful and farmers could make a lot of money from shrimp farming. There was no incentive for farmers to attain a high level of education. However, wild shrimp larvae are becoming increasingly scarce in recent years. This situation has tremendously affected negatively the performance of the shrimp farms, resulting in lower earnings for the farmers. Also, due to their low educational attainment and lack of other professional skills, the farmers could not shift to other occupations. This is a reason why farmers are willing to pay the high adaptation costs to protect their farms. Fortunately, the children have attained higher education levels than their parents; hence the next generation has more opportunities to find other jobs.

3) At present, the local government in each coastal area is responsible for addressing coastal erosion in its area. As such, the strategies for coastal erosion protection in each area are independently planned. As mentioned before, for the protection structure to be effective, it should be designed for the whole Upper Gulf of Thailand. Therefore, the intervention of the national government is needed to deal with the problem.

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[7] 2006 constant price

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Appendix

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Questionnaire

For the project

Adaptation strategy for sea-level rise: A case study of the communities in

Bang Khun Thian, Bangkok

Conducted by

Thailand Development Research Institute and EEPSEA

September, 2007

Name of interviewer:………………………………… Date……..../………./ 2007

Reviewed by:……………………………………………………………………….

- **Before starting the interview, make sure that the respondent is the households who have been affected by coastal erosion/flooding.**
- **The respondent must be household's member who knows the details of adaptation due to the impacts from coastal erosion/flooding.**
- **Introduction statement to be read to the respondent.**

"I am a research assistant from Thailand Development Research Institute. We are conducting a study about the adaptation of households and communities due to the impacts from coastal erosion in Bang Khun Thian on behalf of the Economy and Environment Program for Southeast Asia (EEPSEA). May I take about 15 minutes to asking you some questions about your attitude towards adaptation due to coastal erosion? Your information and opinion will be useful for coastal erosion protection in the future."

Household's socio-economic background

1.1 Name: ………………………………………………………………………………

1.2 Address: House no.: ………… Contact number:…………………………………

1. Village no.9; Which community?
   1. Chai Ta Lay Bang Khun Thian 2. Saen Tor 3. Klong Sam
   4. Luang Por Tao 5. Baan Bang Pa Niang
2. Village no. 10; Which community?
   1. Sao Tong 2. Klong Pittaya Longkorn
   3. Sri Kuman 4. Baan Chong Ta Pae

1.3 Gender: 1. Male 2. Female

1.4 Age: (specify)…………….years

1.5 What is the highest level of education you have obtained?

1. No formal education 2. Primary
3. Secondary 4. Diploma/Vocational certificate
5. Bachelor's degree 6. Higher than Bachelor's degree
7. Others (specify)……………………..……………………………………..

1.6 Are you the head of household?

1. Yes
2. No, the relationship with the head of household is……
   1. Spouse 2. Daughter/Son/Grandchild
   3. Parent 4. Others (specify)……………………………

1.7 Are you local people?

1. Yes 2. No, moved from (name of a province) ……… since (year)………

1.8 How long have your family lived here? ……………………………….………..years

1.9 Number of household members:…………………………persons.

Number of members who are studying:……………………persons.

1.10 In which way does your family occupy this residence?

1. Own house 2. Rent, with rental fee: …………..baht/month.
3. Others (specify)……………………………………………………….

1.11 What is your household's main occupation? (tick in more than one box if required)

1. Coastal aquaculture (shrimp, shellfish, or fish)
2. Government employee/State Enterprise employee
3. Laborer
4. Own business
5. Other (specify)……………………………………………………………

1.12 Revenues and costs from coastal aquaculture

1.12.1 Total aquaculture area: …………..…rai. (the total area after the dedication of land to BMA in 1993)

1. Own farm: ………………rai; with the farm's width………..meters.

Revenues and costs (own farm)	Amount (baht/year)
Total revenues	
Total costs	

2. Rented farm: ………………rai; with the farm's width……..meters.

Revenues and costs (rental farm)	Amount (baht/year)
Total revenues	
Total costs	

1.13 Does your household have income from any other sources besides coastal aquaculture?

1. No
2. Yes, other sources of income are from;
    1. Government employee/State Enterprise employee
    2. Laborer
    3. Own business
    4. Other (specify)……………………………….………….

With average **monthly income** from other sources:

1. less than 2,500 baht
2. 2,501-5,000 baht
3. 5,001-7,500 baht
4. 7,501-10,000 baht
5. 10,001-15,000 baht
6. 15,001-20,000 baht
7. 20,001-25,000 baht
8. 25,001-50,000 baht
9. More than 50,000 baht

1.15 At present, is your household in debt (either bank loan or informal loan)?

1. No
2. Yes, the loan is for: 1. Consumption

   2. Adapting to coastal erosion (building breakwaters etc.)

   3. Other (specify)…………………………….

2. Impacts from coastal erosion/flooding

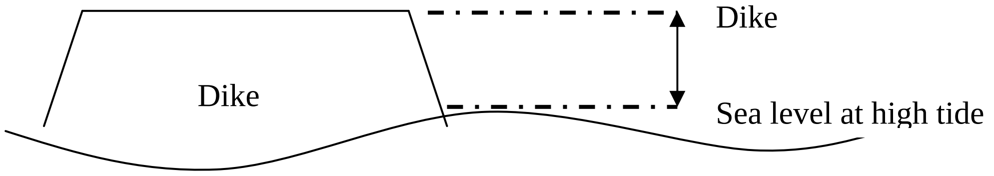
2.1 What do you think which problem is the **most important general problem** in your community?

1. High living expenses
2. Debt
3 Landless
4. Insufficient income
5. Coastal erosion/flooding
6. Water pollution
7. Inconvenient transportation
4. Other (specify) ………………………………………………

2.2 What do you think which problem is the **most environmental problems** in your community?

1. Water pollution
2. Land subsidence
3. Coastal erosion/flooding
4. Solid wastes
5. Other (specify) ……………………………………………………………

2.3 How many meter of a difference on your farm dike and sea level at the high tide is the threshold level that you have decided to cope with coastal erosion/flooding? ....meters.



Or for what reasons did you decide to response to the problem?.............................

2.4 **<u>After your household dedicated land to BMA in 1993</u>**, how has your residence/farm been affected by coastal erosion/flooding? (***tick in more than one box if required***)

1. Inundation of land:………………………………rai

2. Other (specify)……………………………………………………………

2.5 **<u>Since your household has dedicated land to BMA in 1993, which</u>** options has your household adopted for adaptation to coastal erosion/flooding so far? **(*tick in more than one box if required*)**

1. Moving residence/farm inland (Retreat)

1. Own farm; number of times of retreat ………………………times

The 1st retreat: In year: ……………	**Amount (baht)**
1.cost of building a new water gate	
2.cost of building a new dike	
3.labor cost	
Total costs of the 1st retreat	
The 2nd retreat: In year: ……………	
1.cost of building a new water gate	
2.cost of building a new dike	
3.labor cost	
Total costs of the 2nd retreat	
The 3rd retreat: In year: ……………	
1.cost of building a new water gate	
2.cost of building a new dike	
3. labor cost	
Total costs of the 3rd retreat	

2. Rented farm; number of times of retreat ....times

The 1st retreat: In year: ……………	**Amount (baht)**
1.cost of building a new water gate	
2.cost of building a new dike	
3.labor cost	
Total costs of the 1st retreat	
The 2nd retreat: In year: ……………	
1.cost of building a new water gate	
2.cost of building a new dike	
3.labor cost	
Total costs of the 2nd retreat	
The 3rd retreat: In year: ……………	
1.cost of building a new water gate	
2.cost of building a new dike	
3. labor cost	
Total costs of the 3rd retreat	

2. Restructuring residence (for example, elevating the house to avoid flooding)

When was the restructuring? In year: ....

The total costs of restructuring:…………………………………baht

3. Building stone breakwaters to protect coastal erosion

1. Own farm; Length of breakwaters ……………………………meters.

Details of a stone breakwater in own farm	
Date of breakwater building in the first time	In year: …………
Total cost of a building in the first time	………………baht
Average cost of maintenance	………………baht
Number of maintenance till now	……………times

2. Rental farm; Length of breakwaters…………………………………meters.

Details of a stone breakwater in rental farm	
Date of breakwater building in the first time	In year: …………
Total cost of the first time of building	………………baht
Average cost of maintenance	………………baht
Number of maintenance till now	………………times

4. Building bamboo revetment to protect the dike

1. Own farm; Length of a bamboo revetment ………………………meters.

Details of a bamboo revetment in own farm	
Date of a revetment building in the first time	In year: …………
Total cost of a building in the first time	………………baht
Average cost of maintenance	………………baht
Number of maintenance till now	………………times

2. Rental farm; Length of a bamboo revetment……………………meters.

Details of a bamboo revetment in rental farm	
Date of a revetment building in the first time	In year: …………
Total cost of a building in the first time	………………baht
Average cost of maintenance	………………baht
Number of maintenance till now	………………times

5. Heightening a dike by filling up the coast-sided dike with mud

1. Own farm; Length of the heightened dike……………………….meters.

Details of dike heightening in own farm	
Date of dike heightening in the first time	In year…………
Total cost of dike heightening in the first time	……………baht
Average cost of maintenance	……………baht
Number of maintenance till now	…………times

2. Rental farm; Length of the heightened dike ……………………meters.

Details of dike heightening in rental farm	
Date of dike heightening in the first time	In year: ………
Total cost of dike heightening in the first time	……………baht
Average cost of maintenance	……………baht
Number of maintenance till now	…………times

6. Other (specify method and average costs)……………………………….

………………………………………………………………………………………

2.6 Before **the dedication of land to BMA in 1993,** has your household taken any response to coastal erosion/flooding?

1. No

2. Yes (specify the method and when?) ……………………………………..

2.7 How did you find out about the adaptation options in question 2.5?

1. Discover on my own
2. Learned from community
3. Learned from external sources (specify the name of organization)……
   ………………………………………………………………………….

2.8 Up to now, how effective have the adaptation options stated in question 2.5 prevented the impacts from coastal erosion/flooding?

1. Unable to prevent any impacts at all
2. Able to prevent some impacts
3. Able to prevent all impacts
4. Other (specify)………………………………………..

2.9 Over the past 5 years, has your productivity been changing? In which way?

1. Increasing
2. No changes
3. Decreasing because
   1. Water pollution
   2. Coastal erosion/flooding
   3. Other (specify)…………………………………..

2.10 Do you consider that your residence/farm will be affected by coastal erosion/flooding **<u>in the future</u>**?

1. Yes, and expecting that the impacts will be
   1. The same
   2. More severe
   3. Other (specify)……………..
2. No
3. Not sure

2.11 How does your household plan/prepare for preventing the impacts from coastal erosion/flooding in the future?

1. No specific plan

2. Plan to move to 1. Own house in other place

2. The house/farm which has bought after getting the impacts

3. Relative's house

3. Want to move to other place but hasn't planned anything yet

4. Have other plans (specify)…………………………………….

2.12 Do you consider that there are any other potential impacts from coastal erosion/flooding besides impacts to your dwelling and occupation (livelihood)?

1. No other impacts

2. There are some potential impacts:

1. Conflicts in solving the problem within community

2 Stressed

3. Security of life and property

4. Other (specify)……………………………………………………

3. Government's assistance

3.1 How has your household received assistance for coastal erosion/flooding problems from government?

1. No, we have not received any assistance from government agencies

2. Yes, we have received some assistance, which has details as below,

1. Stone breakwaters provided by BMA

2. Tire breakwater provided by BMA

3. Compensation for flooding

4. Other (specify)……………………………………………………

3.2 What is the government's assistance your household needs to deal with coastal erosion/flooding problem? ***(tick in more than one box if required)***

1. Building small-scale dam
2. Building road to help travelling easier
3. Provision of loan for adaptation expenses
4. Other (specify)……………………………………………………………

Thank you for taking the time to help us

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