Final Report

The Interaction between Shrimp Farming, Mangrove Forest and People's Livelihoods in Ban Tha Klang

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Acknowledgements

Abstract

Ban Tha Klang is one of the segments of Ban Phukaothong village located by the port within the local mangrove forest. The village has a short historical existence stretching up to 20 years. It is a fishing community deriving most of its livelihood from sea and mangrove forest fishing. As with many mangrove forest areas in Thailand, the village is a host of two shrimp farms and this activity is potentially having a negative impact. This project was therefore carried out to investigate the effects of shrimp farming on the mangrove and the people's livelihoods. More specifically the study focused on the importance of the mangrove forest and shrimp farming on local people's livelihoods; and the effects of shrimp farming on mangrove forest and local people's livelihood. In order to successfully satisfy the intents of the study, both natural science and social science methods were used to collect information and primary data. The information and data obtained was subjected to empirical and descriptive excel statistics analysis to enable the team draw relevant conclusions related to the study. The key findings of the study indicate that the main livelihood strategy in the village is fishing. In addition, it was noted that the mangrove forest plays an important role in Ban Tha Klang as it is directly linked to fishing and provides various goods and services to the community. There was no direct benefit derived by the community from shrimp farming, instead it was reported to have a negative impact on the aquatic life through release of toxic effluents to the mangrove water channels. The study also revealed a structurally disturbed mangrove forest partly attributed to the existence of the shrimp farms.

List of Acronyms

SLUSE	Sustainable Land Use and Natural Resource Management
ILUNRM	Interdisciplinary Land Use and Natural Resource Management
UM	Undisturbed Mangrove
DBH	Diameter at Breath Height
BA	Basal Area
RD	Relative Density
RDo	Relative Dominance of species
RF	Relative Frequency
IVI	Important Value Index
SF	Shrimp Farming
GPS	Global Positioning System
PRA	Participatory Rural Appraisal
DANIDA	Danish International Development Agency/Assistance
TAN	Total Ammoniacal Nitrogen
EPA	Environmental Protection Agency

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1. Introduction

Responsible authors: All members

Ban Phukaothong is located in the Ranong province, Suk Saman district, Thailand close to the Andaman coast and the boarder to Myanmar. Around 70% of its areas are plains including mangrove forest, adjacent offshore habitats as well as a resource abundant sea. The village can be divided in two different clusters: the first one is located close to the main road where most of the population earns a living from agriculture, i.e. rubber plantations, oil palm and orchards (Sluse ILUNRM, 2010) and the second cluster, Ban Tha Klang, is located by the port within the local mangrove area. This part of the village is where our research project was focused.

The mangrove forest is representing an indispensable source to this part of the village especially for obtaining livelihoods. Different studies have already pointed out the importance of these ecosystems for local people and coastal communities by supporting the functioning of other ecosystems in the seascape (Ogden, 1997), the maintenance of ecological functions and the provision of a wide variety of goods and services (Ewel et al., 1998). The particular environment of the mangrove provides abundant food and protection which represent an incomparable habitat for the survival of aquatic life (Nagelkerken et al., 2008). In this sense, mangrove forests represent a valuable resource for fisheries purposes in the community.

On the other hand, shrimp farms are a common feature in the landscape of Thailand since the end of the 1980's and are often located in mangrove areas due to the ecological benefits, foremost the brackish water, and low lying land that the mangroves provide. The establishment of shrimp farms has been promoted by the government through the department of fisheries because of the high economical profit from exports (Sathirathai 2004). Between 1961 and 1996, 50-60% of the countries mangrove forest was lost mainly due to the establishment of shrimp farms (Barbier 2006). In addition, shrimp aquaculture also affects the mangroves with the effluents released. Intensive farming is input demanding in the use of chemicals, water, fertilizers, antibiotics and other regulators for water quality and disease prevention. The dramatic impact on mangrove ecosystems in coastal areas has had several important consequences for people living in coastal communities depending upon mangrove forests for a variety of direct and indirect benefits such as firewood, charcoal, construction materials, herbal plants and fishing.

Ban Tha Klang has two shrimp farms located one at each side just at the entrance of the village. Both shrimp farms have been in the community since the beginning of the 1990´s and although their activity has generated few benefits to the community, it has led to a new threat for the local mangrove since it is potentially polluting the water sources and affecting the aquatic life. Since most of the villagers in Ban Tha Klang depend directly or indirectly on the mangrove through collection of several products and related fishing activities, it is assumed that the potential pollution from the shrimp farming is indirectly affecting the local people's livelihood.

Under this context, our research project was focused on two main objectives: 1. To study the importance of the mangrove forest and shrimp farming on local people's livelihoods; and 2. To investigate the effects of shrimp farming on mangrove forest and local people's livelihood in Ban Tha Klang. The following sub questions are stated below:

1. What is the relative importance of the mangrove forest and shrimp farming as income sources in the community?
   1.1. How many villagers obtain a livelihood from the mangrove?
   1.2. What products do the villagers get from and outside the mangrove? Cash/non cash
   1.3. How many villagers obtain a livelihood from shrimp farming?
   1.4. How are the villagers involved in the mangrove forest conservation?

2. How is local shrimp farming influencing mangrove forest pollution?

3. How is local shrimp farming affecting mangrove forest use and local people's livelihoods?
   3.1. How is shrimp farming influencing the fishing in the mangrove?

2. Methodology

Responsible authors: All members

In order to gather data to answer our research questions stated above, a number of both social science and natural science methods were used. These were applied together with our Thai counterparts during the fieldwork in the village.

2.1 Questionnaires

The main objective of the questionnaire survey was to enable the group to obtain primary data about the relative importance of the mangrove forest and shrimp farming as income sources and livelihoods in the community. The community of Ban Tha Klang was the basic population for the study and the sample was obtained by stratifying the village into three plots: Zone 1, Zone 2 and Zone 3 (see Fig. 1). In each plot the respondents were selected by simple random sampling with the number of questionnaires corresponding to the population density. The zone with the highest population density was the one with the highest number of respondents. A total of 40 questionnaires were done representing 20 % from a total of 200 households. Most of the respondents were the head of the household and in his/her absence the next of kin (spouse) was interviewed. The data collected included general information about the household, the sources and amounts of incomes and livelihoods obtained from and outside the mangrove, and a final part to find out the level of villager's involvement in the local mangrove forest conservation activities. The data obtained were analyzed by using an excel spread sheet to generate tables and graphs.
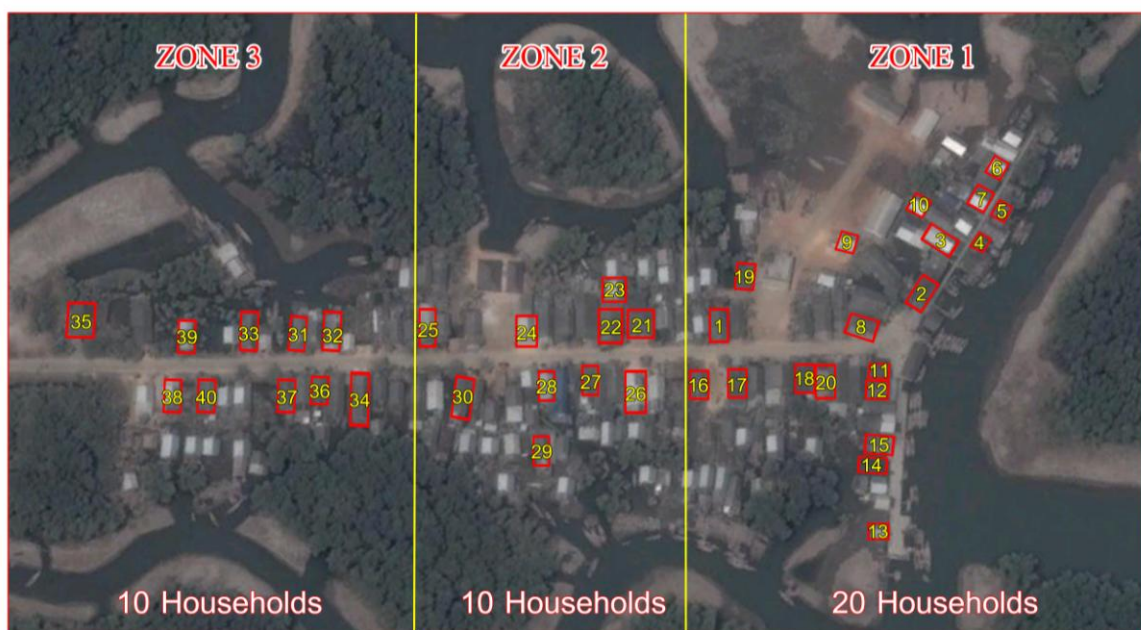

Fig. 1 Stratified questionnaires sampling in Ban Tha Klang

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2.2 Semi- Structured interviews

The main purpose of the interviews was to obtain primary information about the effect of local shrimp farming on the mangrove forest, the mangrove forest use and local people`s livelihood. A set of semi structured interviews was conducted with key informants: 2 shrimp farmers, the village headman, the former village headman and the head of mangrove conservation group. The information obtained was used to triangulate the results from the questionnaires.

2.2.1 Local shrimp farmers

Two in depth interviews were made in relation to shrimp farming practices. The first was conducted with the manager of one of the shrimp farms located just at the entrance of the village (shrimp farm Nr.1.). The second was conducted with the owner of a second shrimp farm located next to the first one at the entry of the village (shrimp farm Nr.2. – for location see Fig. 6).

These interviews were oriented to find out the possible effects on the nearby mangrove area due to pollution by asking the key informant about the shrimp production cycle, chemicals and fertilizers used, the nature and frequency of shrimp farm effluents and regulations related to shrimp farming. In addition, information was obtained to get to know the relationship between the shrimp farms and the local people`s livelihoods. The interviews were combined with guided walks around the farms.

2.2.2 Interview with headman, former headman and the head of mangrove conservation group

These interviews were made to obtain general information about the village, the possible effects of shrimp farming on the mangrove forest and on local people's livelihoods. Additionally the informants were asked about the village relation with the shrimp farms, the importance of the mangrove forest and the mangrove conservation activities and ambitions. The purpose of interviewing both the present headman and the former headman was to find out information about the actual situation as well as to obtain an overview over the village history and development in relation to above mentioned topics.

2.2.3 Open ended interviews and observation

Two informal open ended interviews were carried out on a spontaneous basis in order to get additional knowledge from others than the key informants. As a first step in the study an open ended informal interview was conducted with the assistant headman. This interview gave an introduction to the field site and provided background information to the lives and struggles of the villagers. From this information our research questions and objectives could be reformulated and redefined. The second open ended interview was conducted with an elderly fisherman. Information was provided regarding fishing, different livelihood strategies and general livelihoods in the village as well as perceived problems. The spontaneous talks helped to triangulate the data received from the semi structured interviews and questionnaires and was in combination with observations a natural part of the field research.

2.3 PRA´s: Focus group discussion/Livelihood and problem ranking/Seasonal calendar/Resource mapping/and Diagram of causes of mangrove pollution

In order to facilitate the different PRA techniques and ensure a deeper understanding of the data gathered, this exercise was carried out in three different sets.

The purpose of the first set was mainly to:

Discuss economic issues and identify the perceived importance of each livelihood strategy and the different problems that the villagers were faced with. The effect of shrimp farming on the mangrove, its relation with livelihood strategies and the relationship between shrimp farming and the villagers were also discussed.

For this exercise, three different focus group discussions were carried out:
- The first with six women
- The second with four men
- The third with three members of the mangrove conservation group

The first two group discussions were focused on livelihood strategies and mangrove forest use and were followed by pair wise income and problem ranking. The first part of the PRA was facilitated with an interview guide in order to encourage free discussion. Finally, the problem ranking facilitated. Both ranking exercises encouraged discussion among the participants and were used as a platform for asking further questions.

The third discussion was focused on mangrove forest conservation group activities, its role in the community, mangrove forest use, local regulations and the perceived effect of shrimp farming on mangrove forest pollution and its impacts on the livelihoods of the community. This was followed by the ranking exercise focused on problems regarding the mangrove conservation group.

A second set oriented to draw a seasonal calendar of incomes and livelihoods

As a complement to the results about economic issues obtained during the livelihood ranking and in relation to the resource map, a seasonal calendar of the different livelihoods in the community was drawn. The purpose of the calendar was to reach an understanding of the different livelihoods activities in the community all over the year. 3 men participated in this exercise.

A third set to draw a resource map and diagram of causes of pollution

The resource map was drawn in order to identify the community's natural resources focusing on the areas covered by mangrove forest and its relation with possible effects from the shrimp farming. The diagram of causes was conducted to identify the different causes of mangrove forest pollution. During this exercise people were asked to draw the main features in the village, the different natural resources, the products

obtained from the fishing and the places where the products were taken from. As a flow exercise, the main causes of mangrove forest pollution were identified and marked on the map. Special attention was paid on the relations with shrimp farming, the identification of the main contaminated areas and the location and flow of the sources of pollution. 3 women and 2 men participated in this exercise.

2.4 Mangrove Forest Assessment

Mangrove forest assessment was carried out to measure and analyze the forest structure to describe the quality and productivity of the mangrove in order to relate the possible impact of shrimp farming on the forest. The assessment was done by using the Line Plot Sampling Method which involved the selection of plots near the shrimp farms and those far from it for possible comparison between different vegetation structures in each plot. It was further compared with undisturbed mangrove forest from the literature. 3 sampled plots of 10 X 10m were selected and within these plots, sub-plots of 5 X 5m and 2 X 2m were demarcated for consideration of saplings and seedlings respectively in the analysis.
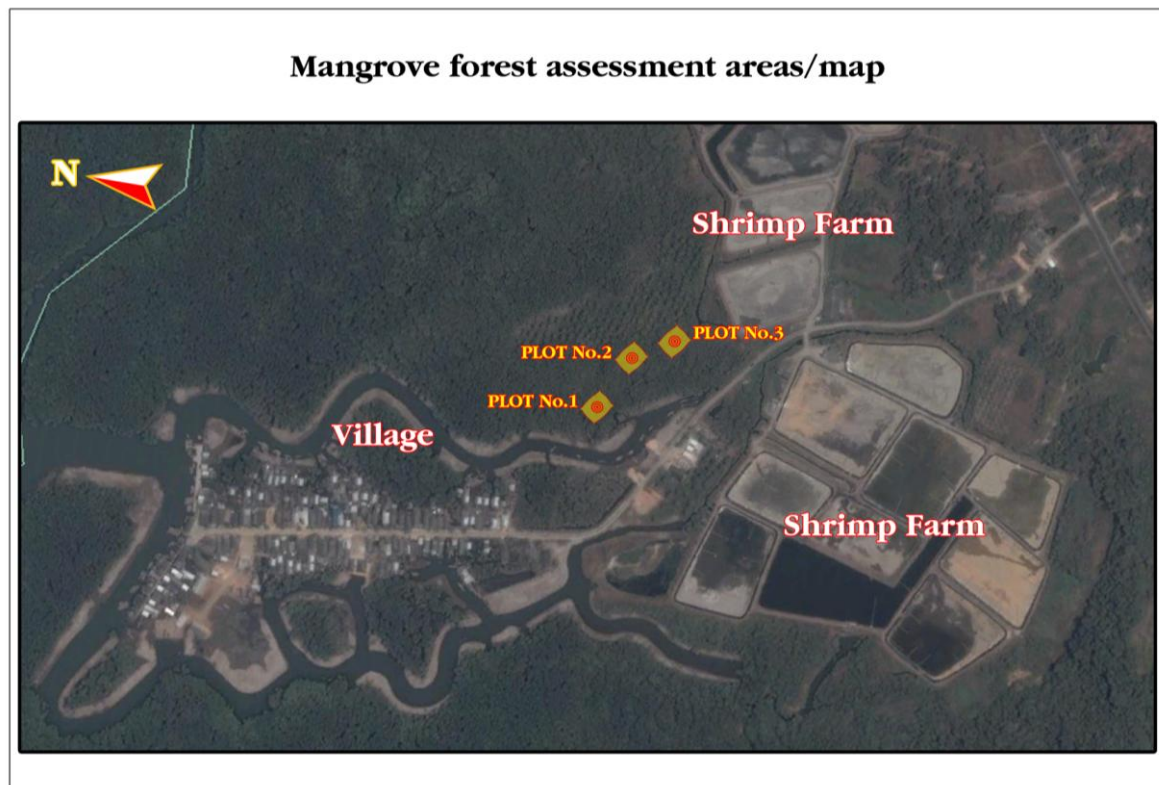
Fig. 2 Mangrove forest assessment areas map

For the 10 X 10m plots, all trees with GBH 15cm were measured and their height and species were recorded. For sub-plots of 5 X 5m, saplings with GBH less than 15cm, only species and numbers were recorded. For sub-plots of 2 X 2m, seedlings with a height less than 1.3m, only species and number were recorded
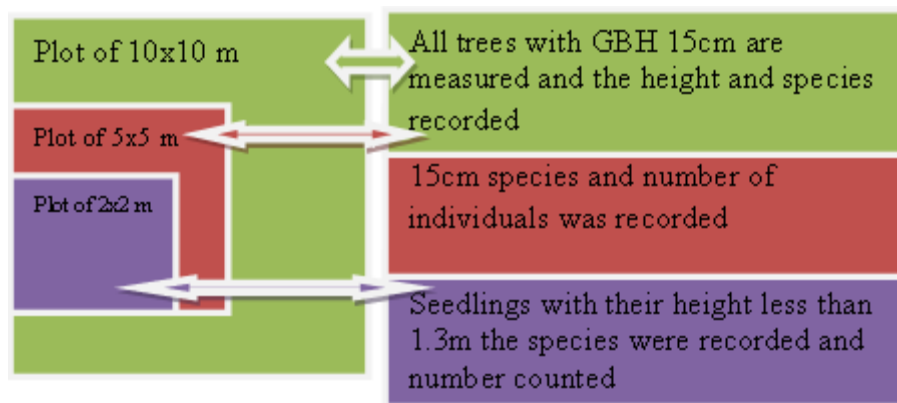
Fig. 3 Mangrove forest plot sections for structural evaluation

For analysis, we used an excel spread sheet and the following parameters were considered;

IVI = RD + RDo + RF (percent) where;

- ✓ IVI stand for important value Index
- ✓ RD stands for relative density of each species
- ✓ RDo stands for relative dominance of each species
- ✓ RF stands for the relative frequency of individuals

2.5 Water sampling

To analyse the water quality in mangrove channels adjacent to Ban Tha Klang nine water samples (S1-S9) were taken on the 15th and 17th of March 2010 from mangrove channels, a shrimp farm and a river above the mangrove area (see Table 1 and Fig. 11). On March 15th four samples (S1-S4) were taken close to and after high tide to get a general overview of the water quality in the village. On March 17th two samples from mangrove channels were taken close to low tide, two samples from a shrimp farm and one sample from a river above the mangrove area in order to relate the possible effect of one of the shirimp farms on water quality, aquatic life and therefore on villagers livelihoods. After sampling all samples were immediately cooled and stored in a temperature of 4°C until further analysis.

The following parameters were measured directly in the field: pH and temperature using the pH-meter EcoSense® pH100. Dissolved oxygen, salinity and temperature was measured using the handheld system YSI® Model 85. On March 17th ammonia and orthophosphate concentrations of all samples were measured in the laboratory. All samples were first filtrated and later analysed by manual colorimetry using a spectrometer.

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Table 1. Main characteristics of water samples taken during water analysis in Ban Tha Klang

Sample	Date & Time	Water body & Location	Tide & Flow direction
S1	15.03.10, 08:50	Artificial channel, close to shrimp farm 1	High tide, upstream
S2	15.03.10, 10:35	Mangrove channel, within the village	High tide, low downstream
S3	15.03.10, 12:00	Mangrove channel, harbour	High tide, downstream
S4	15.03.10, 13:40	Mangrove channel, close to river mouth	High tide, downstream
S5	17.03.10, 16:11	River, above mangrove area	No tidal influence
S6	17.03.10, 14:24	Water storage pond, shrimp farm 2	No tidal influence
S7	17.03.10, 14:11	Shrimp pond, shrimp farm 2	No tidal influence
S8	17.03.10, 14:54	Mangrove channel, close to effluent channel of shrimp farm 2	Low tide, downstream
S9	17.03.10, 15:18	Mangrove channel, close to harbour	Low tide, downstream

3. Results and Discussion

3.1 Livelihoods in Ban Tha Klang

Responsible author: Frida; Contributing authors: James/Ciro

In order to find out the relative importance of the mangroves and shrimp farming in Ban Tha Klang an overview of all livelihood strategies will be given.

For the purpose of the study the following definition of livelihood is used: *"A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household"* (Allison et al 2001). Emphasis will however be made on the activities people engage in and the natural resources they access.

3.1.1 Fishing as a livelihood strategy

The water, represented as open sea and mangrove channels, is an important source of food and income for the villagers in Ban Tha Klang. The merged ranking of livelihoods of men and women indicates that fishing constitutes the main livelihood strategy in the community (see Table 2). This is confirmed by the questionnaire survey showing that 62.5 % of the population has fishing as main income source (see Fig. 4). The villagers also acknowledge the mangroves as an important livelihood strategy both for its importance to the fishing and as a food source of its own it was ranked second in the merged ranking and according to the questionnaire 65 %of the population is dependent on it.

Table 2. Women's and men's Ranking of Livelihood strategies in Ban Tha Klang

	Men	Women	Points	Rank
Fishing	4	4	8	1
Mangrove	3	2	5	2
Merchandising	2	1	3	3
Rubber Production	1	0	1	4
Construction	0	1	1	4

Results of Ranking
1. Fishing
2. Mangrove
3. Merchandising
4. Rubber Production
4. Construction

In fishing there are a number of activities involved and various ways of earning incomes. There is a segregation of activities carried out by the different gender. It is predominantly men that are engaged in sea fishing and repairing boats while women to a greater extent are involved with processing and marketing the fish and repairing nets. The village has five middlemen. The middlemen buy the fish from the fishermen,

employ the women for processing the different aquatic products and transport the fish and processed products for selling on markets in larger towns. The villagers engaged in fishing as an income generating activity are thus directly dependant on the middlemen.

Fishing dependent communities are often characterized as the "poorest of the poor" as it is a highly uncertain resource with fluctuating outcomes not only over season but also from year to year. The system has a high sensitivity to external disturbances such as pollution and overexploitation and low resilience to shocks. Systems dependent on insecure resources in combination with open access are prone to be systems of low sustainability (Allison et al 2001).

A local woman processing fish outside the middleman's house

The villagers in Ban Tha Klang are experiencing an overall decrease in fish stocks. This is regarded as an important problem by the villagers affecting their livelihoods. The decrease in fish stocks is mainly attributed to the overexploitation of the resources. A number of larger fishing boats using modern equipment are fishing outside the coast. According to the former headman the fishing boats are based in Ranong and employ around ten people each. No locals are employed on the boats and the community does not have any further relation with the companies owning them. The competition caused by these boats is hard to meet for the villagers who are still using old, traditional equipment. The bigger boats using fine masked seines to catch fish are believed to be the reason for the loss of fishing equipment hence the nets and cages get carried with or are damaged by the big boats as they pass. The loss of fishing nets was ranked by the women as the most important problem in the village. According to the former headman and the head of the conservation group the regulations restricting the boats from fishing closer than 3000 m from coast are not followed and there seems to be a conflict between the local fishermen and the bigger boats. The decrease in fish stocks and the competition with modern fishing boats is a widespread problem among coastal communities in Thailand. It was reported as a national problem already in 1987 when the modernization and industrialisation of the fishing industry led to an overexploitation of sea resources. The income generated by this modernization was unequally distributed and the industrialisation boom in Thailand led to widened income gaps between the rural and the urban populations as well as more difficult conditions for fishing depending communities (Flaherty & Karnjanakesorn, 1995).

Local fishermen coming back with the catch of the day

3.1.2 Other Livelihood strategies

After fishing the most common income generating activity is merchandising. The village has several smaller kiosks. Some women are engaged in making cigarette "paper" (palm leaves dried and separated) others sell food, snacks and drinks. 10 % of the villagers own or cultivate cash crops in form of rubber trees, resin or oil palm (see Fig. 4).
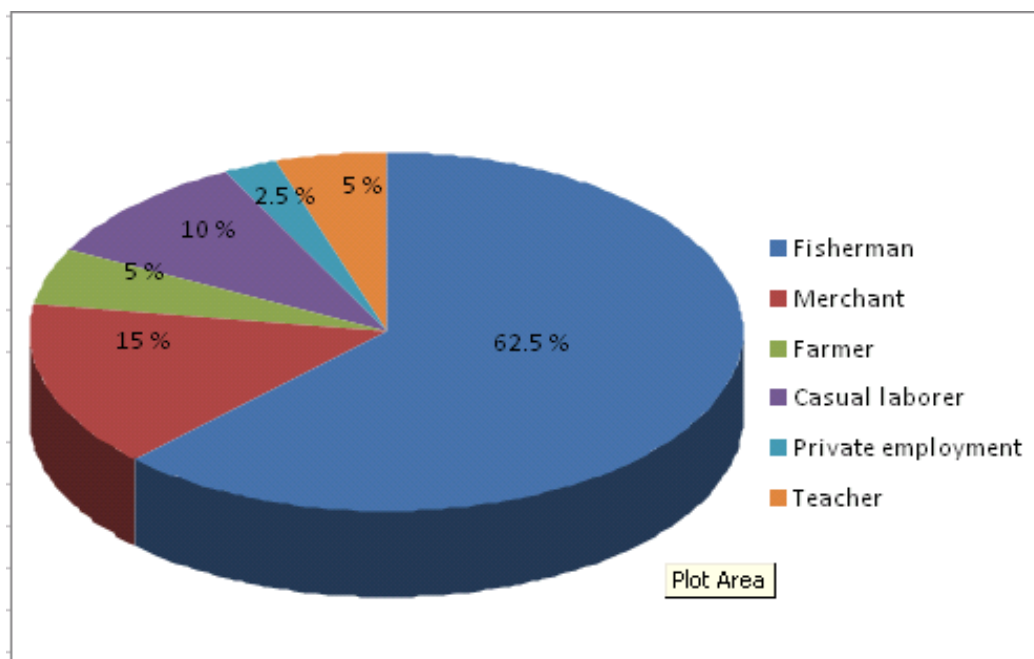

Fig. 4 Main income generating activities in Ban Tha Klang

These cultivations are located outside the village and are currently not providing a significant income for the community. Together with merchandising this is the only activity mentioned in the seasonal calendar that is not related to fishing and not dependent on either the water quality or the mangroves and is regarded as a complement to fishing and a future income security. It is however unclear how extended these plantations are and to what degree they can provide financial security for the village as none mentioned it as their main income source. The causal labour mentioned as an income source by 10 % of the villagers (see Fig. 4) is most likely combined with other income generating activities such as fishing. Other income sources include teaching and private employment such as driving the local bus and making gill nets.

3.1.3 Shrimp Farming

Shrimp Farming grew rapidly in Thailand and globally from the 1980s and into the mid 90s when it peaked in 1995. It is an input demanding industry regarding the high costs of coastal land rights and the capital investments needed for pond construction, chemicals, feed etc. This enables only investors with sufficient financial assets to engage in the business and has led to predominantly urban large scale investors owning farms (Flaherty & Karnjanakesorn, 1995). This is also the reality in Ban Tha Klang. Both farms visited spread out over an area of almost 32 ha in total, and are present in the village since the beginning of the 90´s. The Taksine Marine group, owning shrimp farm Nr. 1 is a larger company residing in Ranong with 18 farms spread out over southern Thailand. Before it was converted into shrimp farm the land was used for coconut plantations. The owner of shrimp farm Nr.2 bought the land from 17 different farmers. The land was formally used for rice paddy fields and coconut plantations. Both owners are large capital investors residing only temporarily in the village in time of harvest and controls. It is common that intensive farms hire local hands to help in the managing and work on the farm (Hutric et al., 2002). The farms are also commonly surrounded by connected industries such as shrimp processors, freezing companies, hatcheries, chemical and fertilizer producers etc. These side-industries can bring work opportunities to the local communities (Hutric et al., 2002). The farms in Ban Tha Klang however are not processing their harvest inside the community. Fodder, chemicals and fry are provided from companies outside the community and, with exception from the manager and assistant manager on the Taksine farm, only Burmese labour is used. The Burmese labourers are employed under special conditions and the majority live with their families on the farms. This implies that despite the dominance of shrimp farms in the physical picture of Ban Tha Klang, they do not directly contribute socio-economically to the local people's livelihoods.

3.1.4 Diversification of Livelihood Strategies and Sustainability

The fluctuating characteristics of fishing makes it an insecure income source and forces people to diversify their livelihood strategies, shifting techniques and focus according to season and availability (Ellis et al. 2000). The diversification of livelihood assets and their distribution over the year can be seen in Fig. 5. Varied livelihood strategies are a common feature in rural communities as a means to secure an income and a food source (Allison et al 2001). Diversification makes the system less vulnerable in the meaning that it

aims to secure income over the year and over unpredicted fluctuations (Ellis, 2000). The diversifications of the fishing activities do thus have minimal contribution in making the system less vulnerable to outside disturbances.

Despite the variation in livelihood strategies and products, the majority of the products that the village depend upon are marine products that are interconnected, and their availability is dependent on the quality of water and the sustainability of the marine and mangrove ecosystem (see Fig. 5. This implies that if one resource would decline due to disturbances of the mangrove ecosystem or the water quality the other resources are prone to do the same.
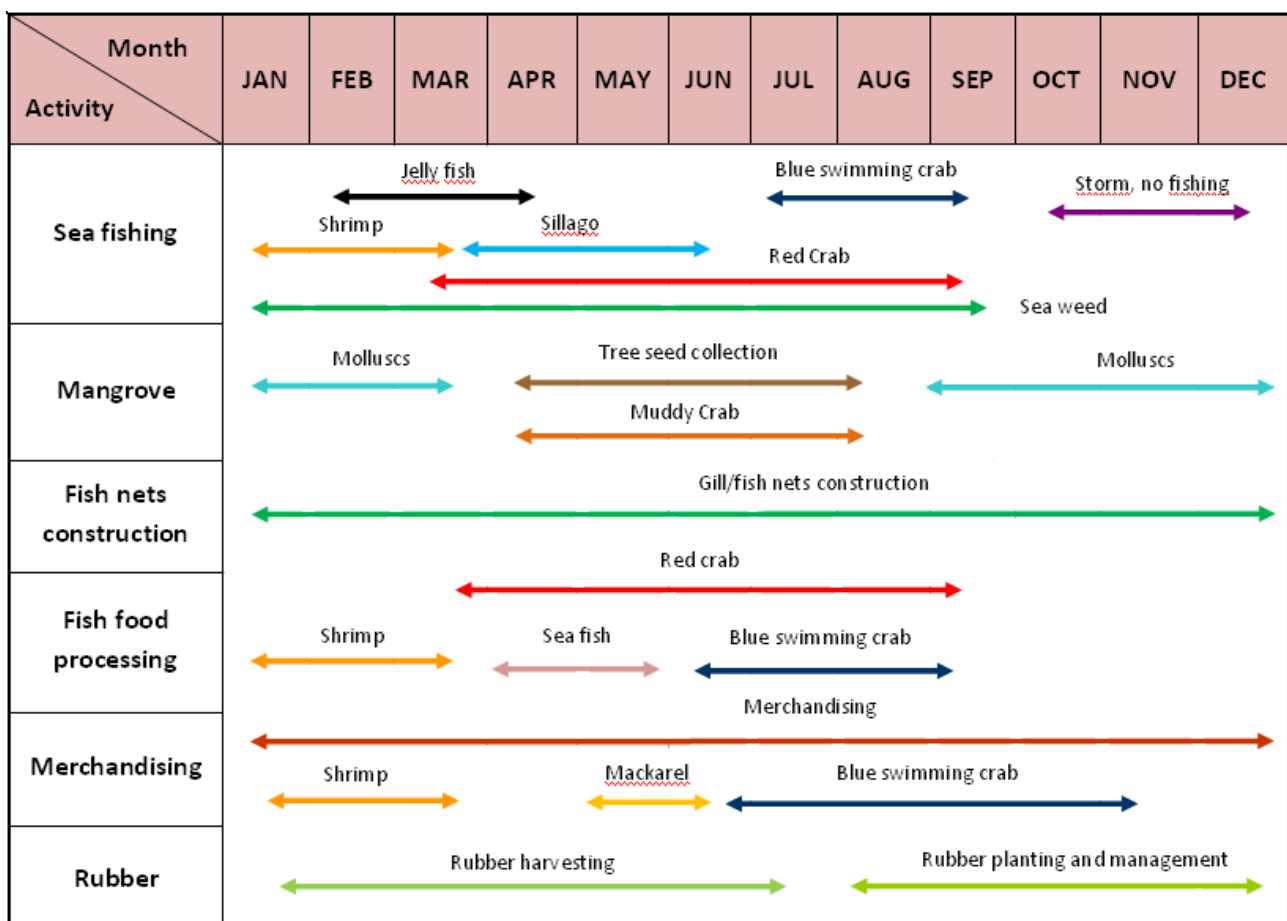

Fig 5. Seasonal calendar of livelihood and its distribution around the year

3.2. Importance of the mangrove forest for the community

Responsible author: Ciro; Contributing authors: Frida/Jan

3.2.1. Economical importance

Several studies have pointed out the importance of the mangrove ecosystems for local people and local coastal communities. Considered as a whole, mangroves provide a support for the functioning of other ecosystems in the seascape (Ogden, 1997), the maintenance of ecological functions and the provision of a wide variety of goods and services (Ewel et al., 1998). Mangrove ecosystems supply protection and food in abundance for motile fauna such as prawns, crabs and fishes. Due to the high abundance of food and shelter and low predation pressure, mangroves form an ideal habitat for aquatic life and a variety of animal species during part, or all of their life cycles (Nagelkerken et al., 2008). In this sense, mangrove forests are widely recognized for its provision of a large variety of plant and animal products (Ewel et al., 1998) representing a valuable resource for fisheries purposes (Barbier, 2004).

In this study, all informants interviewed agreed on the high importance of the mangrove for the village and indeed its use was identified as the second most important livelihood strategy in the community during the ranking exercise with the men´s and women´s group (see Table 2). Moreover, during the resource mapping exercise villagers expressed the importance of the mangrove as a resource available all over the year, even when it does not always represent a monetary value. The same outcome was observed when the different livelihoods were drawn in the seasonal calendar (see Fig 5).

According to the results obtained from the survey, 65 % of the total respondents obtain a livelihood from it and the main activities are fishing and wood extraction. 32.5 % of the respondents do fishing activities around the mangrove area while 45 % are involved in wood extraction. Even though the mangrove represents one of the main resources in the community, it is difficult to establish to what extent people are depending exclusively on the mangrove forest for obtaining their livelihoods. Generally, mangroves form part of a big ecological complex with inter-linkages between them, adjacent and offshore habitats and the sea (Nagelkerken et al., 2008). These linkages were clearly identified in Ban Tha Klang when the villagers were asked to draw the different natural resources and their products. The result was the representation of the three main different areas/natural resources around the village on which the obtaining of the livelihoods is based: the mangrove, the mangrove channels and the sea. Thus, its location and the different products obtained from each area were well represented on a natural resource community map (see Fig. 6). Four species of crabs, seven species of fish, shrimps, shells, molluscs, sea weed, mussels, snails, squids and wood obtained from the mangrove area were drawn and the location in the community map was identified (See Fig 6 and Table 3).
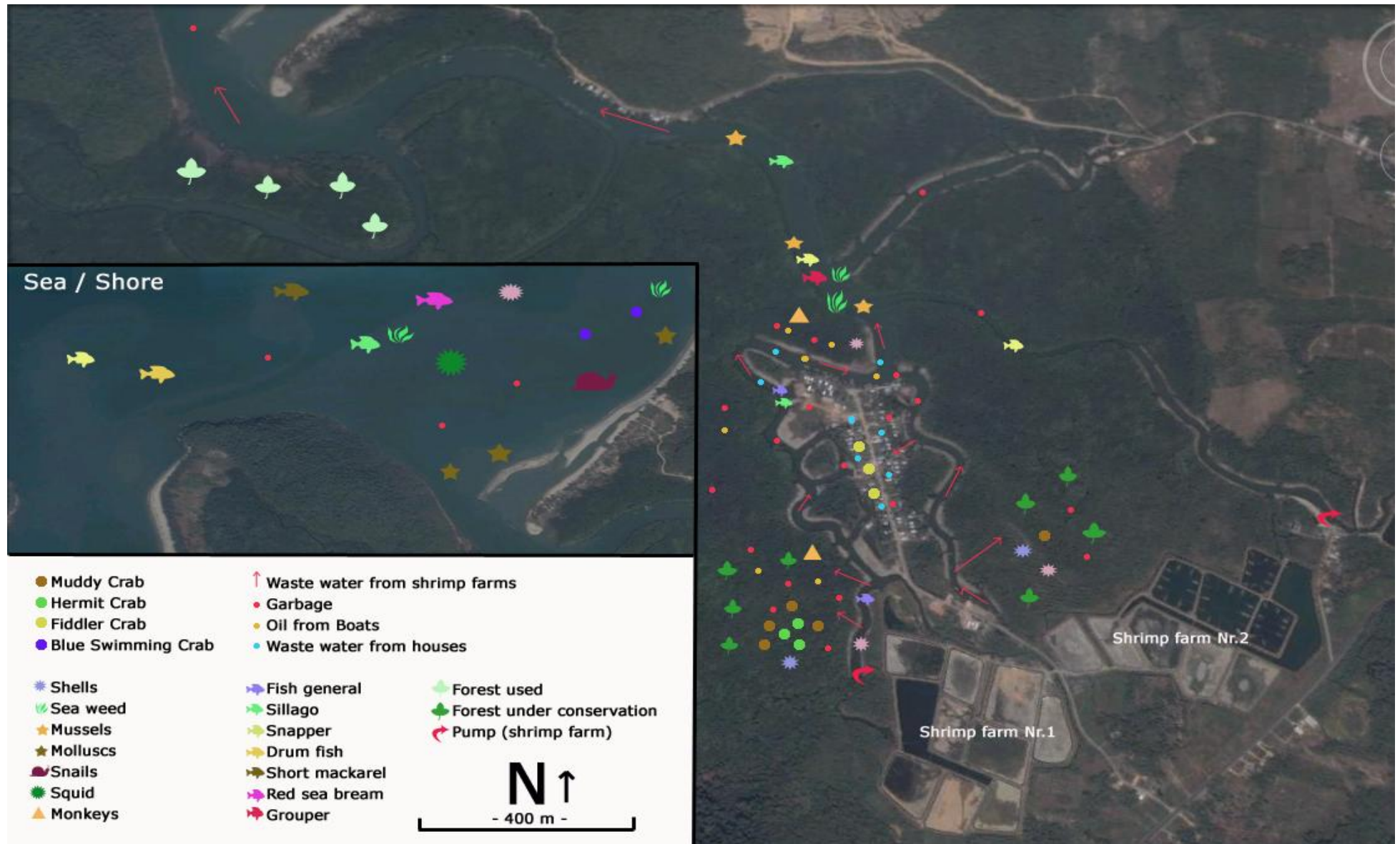
Fig. 6 Natural resource community map of Ban Tha Klang, Thailand

Table 3 Natural resources and its location by area in the natural resource community map

Natural resource/Area	Mangrove area	Main channels	Village area	Sea / Shore
Muddy crab	X			
Hermit crab	X			
Fiddler crab			X	
Blue swimming crab				X
Number of crab species	*2*	*0*	*1*	*1*
Fish (not identified)		X		
Sillago		X		X
Snapper		X		X
Drum fish				X
Short mackerel				X
Red sea bream				X
Number of fish species	*0*	*3*	*0*	*5*
Shells	X			
Sea weed		X		X
Mussels		X		
Molluscs				X
Snails				X
Squid				X
Shrimp	X	X		X
Number of other species	*2*	*3*	*0*	*5*
Wood	X			

Three main mangrove areas were drawn: two areas at each side of the village which remain under conservation and a small area close to the shore under use which meets the villager´s needs of wood for housing and bridges construction and maintenance (See Fig. 6)

Hence, Ban Tha Klang as many other coastal communities in Thailand benefits from the mangrove and depend directly on the forest for fish and wood extraction (Barbier, 2004). The highly variable environmental factors between land and sea and the particular function of the aerial roots which partly stabilize it provide a perfect substratum on which many species of plants and animals live (Nagelkerken et al., 2008). The local mangrove area by itself delivers two species of crabs, shells and shrimps to the villagers, meanwhile, the mangrove channels provide two species of fish (snappers and grouppers), mussels, shrimps and sea weed obtained from cage fishing. Other minor products obtained are vegetables, wood worms (1 respondent each, both for own consumption) and seeds collection (1 respondent) for growth and selling (see Table 4).

Within the village area fiddler crabs are caught. Close to the shore and in the sea one species of crab, five species of fish, sea weed, molluscs, snails, squids and shrimps are either caught with nets or collected (see Table 4). These products are used both to sell (75 % of respondents) and for own consumption (52.5 %).

Table 4. Products obtained from and outside the mangrove

From the mangrove			Outside the mangrove		
Product	Purpose		Product	Purpose	
	Selling	Own Consumption		Selling	Own Consumption
Fishing			Fishing		
1. Crabs	*	*	1. Crabs	*	*
2. Shells	*	*	2. Fish	*	*
3. Fish	*	*	Sillago	*	*
4. Shrimps		*	Makarell	*	*
5. Mollusca		*	Sardines	*	*
6. Sea weed		*	3. Shrimps	*	*
			4. Mussels	*	*
			5. Squids	*	*
			6. Sea weed		*
Others			Farming		
1. Wood		*	1. Rubber	*	
2. Vegetables		*	2. Oil palm	*	
3. Wood worms		*	3. Resin	*	
			4. Vegetables		*

3.2.2. Recreational and protectoral value

In addition to the economic importance that the mangrove represents to the community by the support of the fisheries activities and the variety of forest products harvested, there is an extra non monetary recreational value. Above the water, the mangrove trees and canopy provide important habitat for a wide range of species including birds, insects, mammals and reptiles (Nagelkerken et al., 2008). In Ban Tha Klang, the mangrove forest is also habitat for monkeys which according to the headman could be a touristic potential for the community.

Finally, these forests also provide valuable ecosystem services that benefit coastal communities including coastal land stabilization (Walters et al., 2008), floods, sediment trapping, nutrient uptake and transformation (Ewel et al., 1998) and protection against storms and natural disasters by performing as natural barriers (Conservation International, 2008). Especially when the heavy rainy season makes fishing in the sea impossible (from October to December), this activity is concentrated in the mangrove. One of the most important facts to consider about protection is the safeguard that the forest plays against tsunami. There was a strong consensus in the community that the mangroves are important for this purpose since the village experienced limited effects of the tsunami in 2004.

3.3.3 Mangrove forest conservation

Despite the importance mentioned above, the mangroves have been cut and cleared extensively for aquaculture and infrastructure development purposes (Walters et al., 2008). Between 1961 and 1993 Thailand´s mangrove area declined by 54 % and its conversion to shrimp ponds contributed 64 % (Macintosh et al., 2002). The adoption of shrimp farming has led to a new threat for the mangroves and has generated few benefits for the local communities; on the contrary, it is potentially polluting the water sources and severely damaging the aquatic life.

Ban Tha Klang has two shrimp farms located one at each side just at the entrance of the village. Several informants from the interviews and focus group discussion (including the headman, a fisherman and some members of the mangrove conservation group) expressed their worries about the decrease of fish catch capacity. This problem however, has been perceived since a long time ago for the community. That´s why a conservation group to look after and preserve the mangrove was set up around 1988 and has been more active since 10 years ago, when the villagers realized the importance of the forest in preserving the people's livelihoods and protecting the village against tsunami.

The group is composed of 27 members and it was created with the idea to restore the resources in the local mangrove forest (mainly affected due to the wood extraction) and preserves the breeding ground for aquatic life. Their main activities are:

1. Reforestation of the forest once a year depending on the deforestation density (trees cut). To support this activity they receive funds from the District of Ranong (government). In 2009 the fund was 500,000 baht with which they replanted 100,000 trees; however, the activities can vary from year to year and depend on the available budget.

2. Release shrimp and fish to the mangrove area, for which they receive seedling from the Fishery Department (government). This activity is carried out approximately every 2-3 years.

3. Garbage collection in the village. This activity is done more than 10-12 times a year and most of the participants are children. To encourage the garbage collection the mangrove conservation group trade eggs for collected garbage, however, since the quantity of rubbish is huge children do not want to participate anymore. The garbage can be recycled and the products obtained can be sold to finance the trade.

While increasing awareness of the true value of the mangroves ecosystems has led to renewed efforts to protect and restore them (Macintosh et al., 2002), Ban Tha Klang has not been an exception and in the community this phenomenon can be seen as well. In the village, the mangrove conservation group is known by 92.5 % of the respondents of the questionnaire survey and most of them participate in its activities (77.5 %) between twice a month to 3 times a year.

3.3 The Effect of shrimp farming on Mangroves

3. 3.1 Identified causes of mangrove forest pollution

Responsible author: Jan; Contributing authors: Ciro/Frida

Four causes of pollution were identified and listed by the participants during the diagram of causes exercise. The main causes of mangrove forest pollution were attributed first to the garbage dumped by the villagers from the houses, secondly to the waste water released from shrimp farming, thirdly to the oil released from the fishing boats and lastly to the waste water from the village households. The result of the exercise can be seen in Fig. 7. Afterwards the participants drew the affected areas into the resource map and identified the flow of pollution from shrimp farms (see Fig 6). Waste water from shrimp farms Nr.1 & 2 is released at two spots into the mangrove channels and is transported and distributed into the mangrove area, smaller channels and the sea through the tide currents, thus it is affecting the whole mangrove area close to Ban Tha Klang.
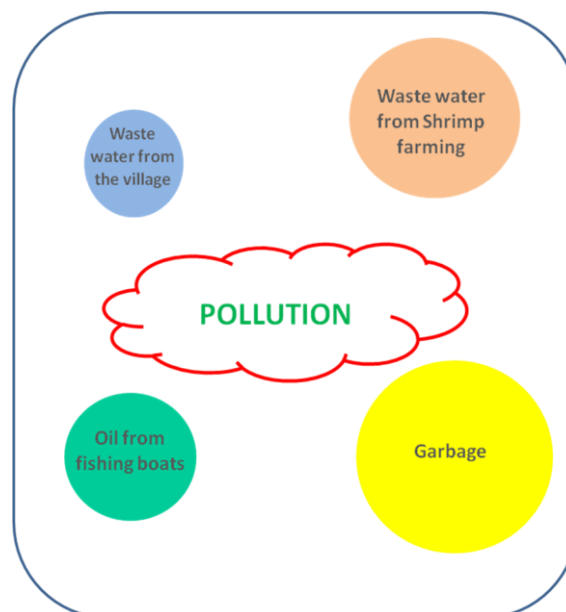
Fig. 7 Identified causes of mangrove forest pollution in Ban Tha Klang

The participants mentioned that since the rubbish comes from and goes to other villages there is no way to control its flow. The amount of garbage dumped by the villagers in Ban Tha Klang and other villages is hence originated in the village areas, is transported then through the main mangrove channels into the mangrove area, smaller mangrove channels and the shore (see Fig. 6). The extent of the garbage pollution can be observed in the sea when rubbish gets trapped in the fishing nets. The same effect was identified with the oil released from the fishing boats, but the flow goes in opposite direction. Oil is released at sea, is transported from the sea through the main mangrove channels into the mangrove area and the village. Waste water from the households is polluting mainly the inner village area but is transported by the main mangrove channels as well (see Fig. 6.). In addition to the causes listed by the villagers, observations

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allowed us to identify the residues from sea food processing as another potential contributor to the mangrove pollution. A landfill with possible effluents to the mangrove area was also situated next to the village; however it was not mentioned at all by any of the villagers during the fieldwork.

To investigate the contribution of shrimp farming in the mangrove forest pollution our group visited two shrimp farms that are located close to Ban Tha Klang (for location see Fig.6), both farms with a total area of almost 32 ha (18 shrimp ponds) and conducted interviews with persons in charge. From both interviews we got to know that shrimp farms depend on the nearby mangrove area mainly as a fresh water resource, water is taken from the mangrove channels during high tide to prepare the ponds and they are used to renew daily around 10% of the pond volume (only shrimp farm Nr.2), as well as to release large amounts of waste water every 4-5 months during shrimp harvest (both shrimp farms). Shrimp farm Nr.1 can be regarded as a closed system without any daily discharge of waste water due to the use of plastic grounds in the ponds. The informants from both shrimp farms claimed that the waste water released to the mangroves is of good quality and environmentally safe. Waste water on both farms is treated with chemicals and tested before discharge.

During the grow-out cycle, the shrimp farms are using antimicrobial substances to pre treat the water and to clean the ponds, different sizes and amounts of fish powder as shrimp feed, fertilizers to ensure an appropriate growth of the shrimps. A wide range of chemicals are used for disease treatment, disease prevention and to control water quality in the shrimp ponds. An U.S. aquaculture certification organization checks the water quality on shrimp farm Nr.1 up to three times per year within the ponds during the grow-out cycle. Water quality is checked on shrimp farm Nr.2 independently, especially for the level of nitrogen and ammonia in the water. The owner of shrimp farm Nr.2 mentioned that there are existing regulations regarding the treatment of waste water before it is released into the mangroves.

However, informants like the assistant headman complained about pollution of the mangrove area due to discharge from local shrimp farms and he stated this as the main problem in the village. He mentioned that the waste water is discharged directly without treatment, before it was cleaned in special ponds but nowadays it seems to be too expensive and rules are ignored. On the other hand the headman stated that although the shrimp farms do not have a wastewater treatment system it does not affect the mangrove area that much. From the former headman we got to know that before there were no regulations about the wastewater, now there are regulations to treat and keep the waste water in special ponds before discharge. Measurements for controlling the water were previously carried out but not anymore due to high expenses involved. Instead the water is presently directly let out to the channels according to the former headman.

With the information obtained from the interviews and the above mentioned PRA exercise, we decided to conduct a mangrove forest assessment and the water sampling within the nearby mangrove.

3.3.4 Mangrove forest assessment

Responsible author: James; Contributing author: Ciro

The mangrove forest assessment results shown below can be used for drawing a snap shot picture of the nature and structure of the forest of Ban Tha Klang, however considering inadequacies in preparation and the time limit of 10 days for collecting the data, it would be overzealous and ambitiously erroneous to use these results for making generalized conclusions. They nonetheless provide an overview of the actual forest situation which was the ultimate reason for considering forest assessment in this project. As stated by Ashton *et al.* (2002), mangrove ecosystems provide valuable ecological and socio-economic goods and services to man and therefore the results here have been used to relate the effects from Shrimp farming and other community livelihood strategies, in terms of use and exploitation, on the forest resource.

The vegetation characteristics of mangrove forest structure obtained at each site during the mangrove forest assessment are summarized in table 5, and additionally it contains data of an abandoned shrimp farm mangrove area and one undisturbed mangrove area, provided for comparison with the study sites. Four different species were recorded in each plot and a total of 14, 21 and 20 individuals at plot 1, 2 and 3 respectively (see Fig. 8). The dominant species in all plots according to the IVI (Important Value Index) were *Xylocarpus granatum (121.55%)* and *Heritiera littoralis(60.11%).* Seedlings were recorded only in plot 3 (*Xylocarpus granatun* and *Heriteria littoralis*).
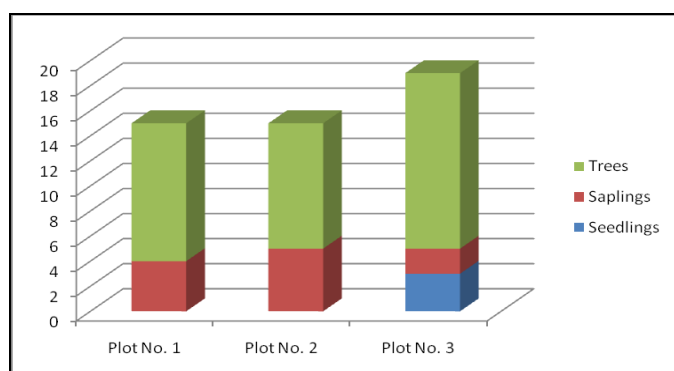

Fig.8 Distribution of Trees Saplings and Seedlings in the 3 plots

Plot Demarcation of the mangrove Forest

Estimates of important Mangrove forest variables

Table 5: Structural measurement of the Mangrove forest in Ban Tha Klang

Data	Plot 1	Plot 2	Plot 3	ASF area	UM
Gbh (cm)	55.2	44.9	50.9	–	–
Dbh (cm)	18	14	16	–	–
Ht (m)	12.6	11.4	10.9	–	–
BA (cm^2)	753	549	736	1,394	4,303
Biomass (ton/ha)	5.47	5.33	6.99	–	–
No.total Individuals	14	21	20		
No. Species	4	4	4	6	6
Density (trees/ha)	1,000	2,700	1,700	–	–
Summarized mangrove structure for 300 m^2 (all plots)					
No.	Species	RD (%)	RDo (%)	RF (%)	IVI (%)
1	*Xylocarpus granatum*	74.26	17.25	30.03	121.55
2	*Heritiera littoralis*	25.71	4.38	30.03	60.11
3	*Rhizophora apiculata*	5.71	23.59	10.01	39.31
4	*Excoecaria agallocha*	5.71	22.00	10.01	37.72
5	*Xylocarpus moluccensis*	2.86	19.98	10.01	32.85
6	*Intsia bijuga*	2.86	12.79	10.01	25.66

ASF = abandoned shrimp farm area, UM = undisturbed mangrove, Dbh=Diameter at breath height BA=Basal area

Ht=height, RD=Relative Density, RDo=Relative dominance of species, RF= Realtive Frequency, IVI= important value Index

The tree species *Xylocarpus granatum* and *Heritiera littoralis* of highest IVI are the species which can withstand the current mangrove ecological changes and pressures and shrive. These species are well adapted for regeneration of the mangrove and could therefore deliberately be used as a species for artificially assisted regeneration strategies for the mangrove forest in BanTha Klang.

The proportion of trees, saplings and seedlings is shown in Fig. 9, which is a summary of the results found in the three plots. It shows the population distribution of trees, saplings and seedlings. It is obvious that this distribution is undesired for the sustainability of the forest. For a sustainable forest, the structure should contain more seedlings than saplings and more saplings than trees.
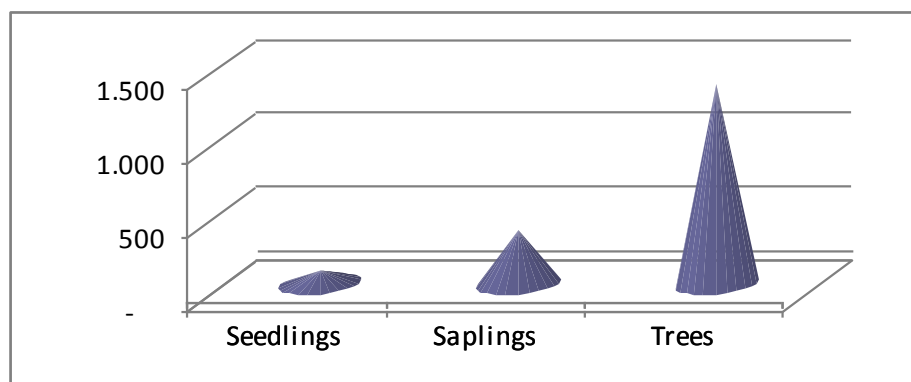
Fig. 9 Proportion of seedlings, saplings and trees in the mangrove forest

Basal Area and Biomass indicators:

Basal area results from our plots show a big difference in comparison with the data obtained from the undisturbed mangrove forest in Ranong and an abandoned shrimp farm area (according to the study by Macintosh *et al.* (2001), the undisturbed mangrove has a standard basal area of 4,303 cm^2 whereas the average result obtained from Ban Tha Klang site is 679.33cm^2, which is 6 times lower). On the other hand, biomass estimations have been used to evaluate the productivity of the forest worldwide (Burton et al. 1998). The maximum biomass obtained for this site was 6.99 ton/ha which is very low when compared with 199.81 ton/ha for fertile mangroves in the Ranong province and 500-550 ton/ha in undisturbed mangroves in Asia as reported by Paijmans and Rollet (1977). This low biomass has a huge negative consequence in terms of the productivity of this forest. All the results of the analysis indicate a massive disturbance of the mangrove forest elaborated by below average values of key indicators (Biomass and Basal area)

Effects from Shrimp farming and other human activities

In this section an attempt has been made to relate the actual mangrove situation in Ban Tha Klang with those activities potentially affecting the forest. Macintosh *et al.* (2001) indicates that a number of factors have contributed to the decline of the mangrove forest. For the case of shrimp farming, Vaiphasa *et al.* (2007) reports that waste materials discharged from shrimp farms are toxicity in nature most especially to the flora and fauna of the aquatic ecosystem. He however acknowledges that detailed laboratory studies (for toxicity analyses) on the effects of these shrimp farm waste products on tropical mangroves are still limited. Additional documentation by Barbier (2006) attributes loss of mangrove forest area to conversion to shrimp farms. However there is limited documentation linking pollution or release of effluents from shrimp farms to the decline of mangroves structure in terms of Biomass and other vegetative parameters. Results obtained from the 3 plots of Ban Tha Klang Mangrove forest, show uniformity between the plots, giving an indication that being proximate to the shrimp farm did not influence the structure of the forest. This therefore leads to the conclusion that additional factors such as timber or wood harvesting could be impacting negatively on the state of the forest.

This study did not venture much into establishing the relationship between the fauna and flora in the mangrove to shrimp farming, however it is generally expressed by the respondents that there is a decline in fish catch from the mangrove which forms part of their livelihoods (see results of interviews and questionnaires) and this may require elaborate scientific studies over a period of time.

3.3.5 The effect of shrimp farming on mangroves water quality

Responsible author: Jan; Contributing author: Frida

Dierberg & Kiattisimkul (1996) stated that water quality impacts from shrimp aquaculture in Thailand are considerable. Loadings of solids, oxygen-consuming organic matter and nutrients to receiving waters are extensive when impacts from water exchange during the grow-out cycle and pond drainage during harvesting are taken into account (Dierberg & Kiattisimkul, 1996, Burford & Williams, 2001). Water quality issues are focused on salinization of freshwater resources, siltation, eutrophication, oxygen depletion, toxicity from sulfide, ammonia, therapeutants and waste water treatment chemicals released into receiving waters. Moreover, given that the daily exchange of pond water with outside water can be as much as 40% for semi-intensive and intensive systems in order to remove excess nutrients and organic matter (Dierberg & Kiattisimkul, 1996).

Intensive shrimp aquaculture is associated with high concentrations of total ammoniacal nitrogen (TAN) as a result of prawn excretion and feed loading (Krishnani et al, 2006, Francis-Floyd et al, 2009, Burford & Williams, 2001). Excessive TAN levels can adversely effect productivity and result in adverse effects on coastal waters (Burford & Williams, 2001). Accumulation of this nitrogenous toxicant and other nutrients in mangroves may cause eutrophication and stress, which is unfavorable to the animals but favorable for disease causing agents, so that fish exposed to low levels of ammonia over time are more susceptible to bacterial infections (Krishnani et al, 2006, Francis-Floyd et al 2009). In shrimp farm culture and wastewater, ammonia remains in the form of un-ionized ammonia (NH_3) and ionized ammonia (NH_{4+}). Un-ionized ammonia is a critical water quality parameter and toxic to aquatic life, of all the water quality parameters that affect fish, ammonia is the most important after oxygen (Francis-Floyd et al, 2009). Ammonia should be maintained below 0.1 mg/l, lethal concentrations for short-term exposure (24 to 72 hours) are between 0.4 and 2.0 mg/l and the sublethal level may occur at 0.1 to 0.3 mg/l for aquatic organisms (Krishnani et al, 2006). The nitrogen cycle process eliminates ammonia from the water by converting it to other less toxic compounds (see Fig. 10)
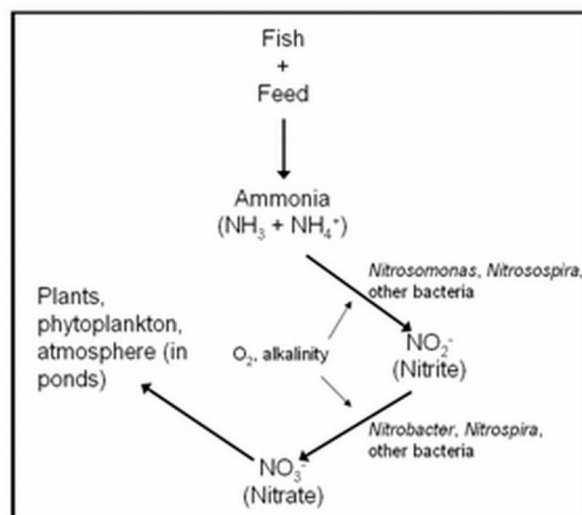
Fig. 10 The nitrogen cycle. Nitrifying bacteria use oxygen and alkalinity to convert ammonia and nitrite into the less toxic byproduct, nitrate, which is then used by plants or returned to the atmosphere. (Francis-Floyd et al, 2009)

Another important point to mention is that both groups of nitrifying bacteria need oxygen and alkalinity to function. If oxygen levels are not sufficient, the process can break down, and ammonia and nitrite levels will increase (Francis-Floyd et al, 2009).

Phosphorus appears in nature in plants, in micro-organisms and in animal wastes, is widely used as an agricultural fertiliser and as a major constituent of cleansing materials, especially those for domestic use. Effluent discharges are thus important contributors of phosphorus to surface waters (EPA, 2001). The significance of phosphorus is basically in regard to the phenomenon of eutrophication of surface waters. Phosphorus gaining access to such water bodies, along with nitrogen as nitrate, promotes the growth of algae and other plants leading to algae blooms, littoral slimes, daily dissolved oxygen variations of great magnitude (EPA, 2001). A useful parameter is orthosphosphate which is the phosphate responding to the analytical procedure without any pre-treatment.

Because of the above mentioned facts our water analysis was carried out by measuring ammonia & orthophosphate concentrations. Other parameters, such as temperature, pH, salinity and dissolved oxygen were also measured. First we tried to get a general overview about the water quality concerning existence of aquatic life in the mangrove channels close to Ban Tha Klang. Therefore four samples were taken during high tide (for location see Fig. 11)
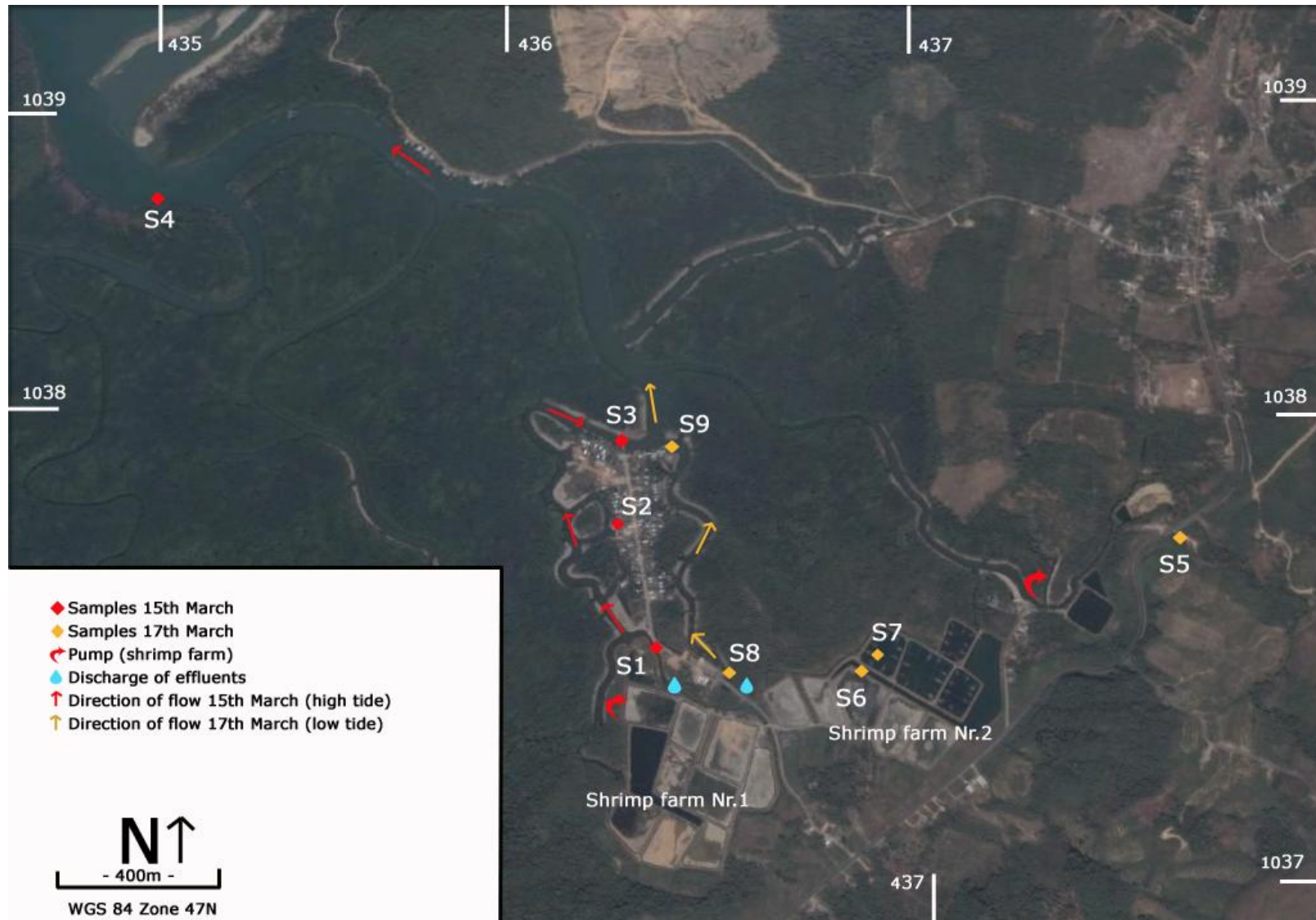
Fig. 11 Location of water samples, shrimp farms and discharge channels

Fig. 12 and 13 pH (solid line), temperature (dashed line) & dissolved oxygen (solid) and salinity (dashed) of samples from March 15th.

On March the 15th the samples showed pH-values in the range of 6.9 up to 8.0, with the lowest value at sample 1 (artificial channel). Temperature was in the range of 27.4°C up to 30.2°C with increasing values, certainly due to warming during the day. The lowest amount of dissolved oxygen was found at sample 1 with 3.4 mg/l (51%) and the values of the other sites were in the range of 4.0 (55%) up to 4.2 mg/l (67%). Salinity was increasing from 25ppt at sample 1 (artificial channel) up to 35ppt at sample 4 (mangrove channel close to shore) (see Table 6, Fig. 12 and 13).
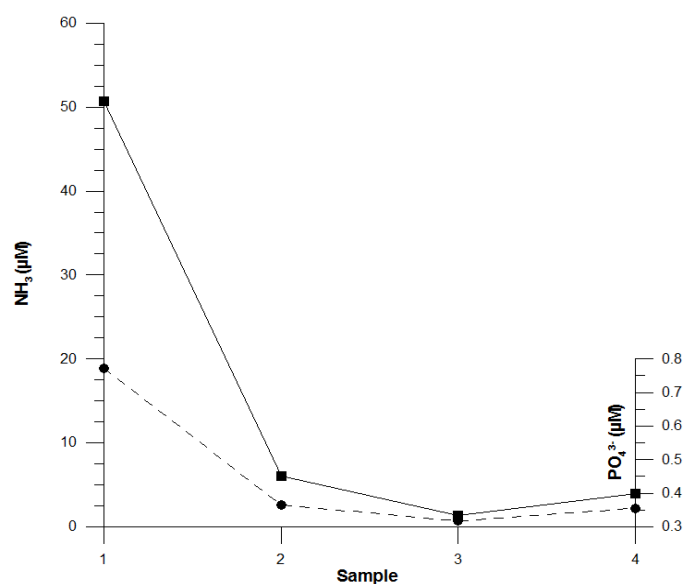
Fig. 14 Concentration of ammonia (solid line) and orthophosphates (dashed line) of samples from March 15th.

The highest concentrations of ammonia and orthophosphates were found at sample 1 (artificial channel) with 51μM (0.86mg/l) ammonia and 0.77μM (0.07mg/l) orthophosphates. Decreasing values of 6.1μM (0,10mg/l) and 1.3μM (0.02mg/l) ammonia and 0.37μM (0.03mg/l) and 0.32μM (0.03mg/l) orthophosphates at sample sites 2 (within the village) and 3 (harbour) were observed. Close to the shore at sample 4 the concentration of ammonia was 4.0 μM (0,07mg/l) and the concentration of orthophosphorus 0.36μM (0,03mg/l) (see Fig. 14 and Table 6). We assume that the relative high ammonia and orthophosphorus levels are probably not due to waste water effluents from the nearby shrimp farm. From the information we got to know by observations and interviews we concluded that shrimp farm Nr.1 has a closed water system with no daily water discharge due to the use of plastic grounds in the ponds.

During high tide the tide currents are flowing upwards and sea water is mixed with brackish water from the mangroves. As a consequence water with the impact from wastewater from the houses can be found upstream during high tide. This is probably why we found here the highest levels of ammonia and orthophosphates. Another contributing fact could be that sediments from harvesting can be found at the bottom of this channel, releasing continously amounts of ammonia and orthophosphates. We believe that the other sample sites were better mixed with brackish and sea water due to high tide, therefore the levels of ammonia and orthophosphates are more diluted. The level of un-ionized ammonia at sample 1 with 0.86mg/l is within the range of lethal concentrations for short-term exposure (24 to 72 hours) to fish (Krishnani et al, 2006), dissolved oxygen is compared to other sites quite low and the concentration of orthophosphorus is relatively high bringing forward algae blooms and daily dissolved oxygen according to EPA (2001). At sample site 2 the level of ammonia is close to the sub-lethal level for aquatic organisms (Krishnani et al, 2006).

On March the 17th the samples showed pH-values in the range of 6.5 up to 8.1, with the lowest value at sample 5 (river above mangrove area) and the highest within a shrimp pond (sample 7). Temperature was in the range of 28,8°C (sample 5 - river above mangrove area) up to 32,9°C (sample 6 - storage pond). The lowest amount of dissolved oxygen was found at sample site 9 (close to harbour) with 3.0 mg/l and the values of the other sites were in the range of 3.7 (sample 8 – effluent channel from shrimp farm) up to 6.6 mg/l (sample 7 – shrimp pond). Salinity was increasing from 0.2 ppt at sample site 5 (no tidal influence) up to 38 ppt at sample 7, followed by lower values of 28 and 35 ppt at samples 8 and 9 (See Fig. 15 and 16).
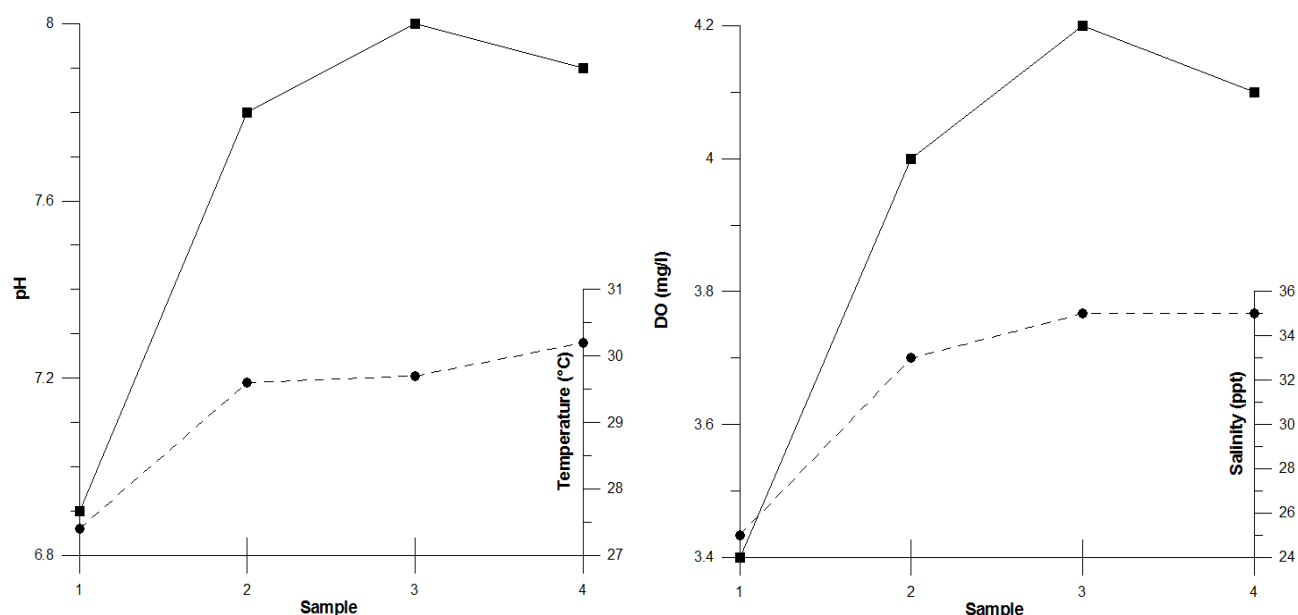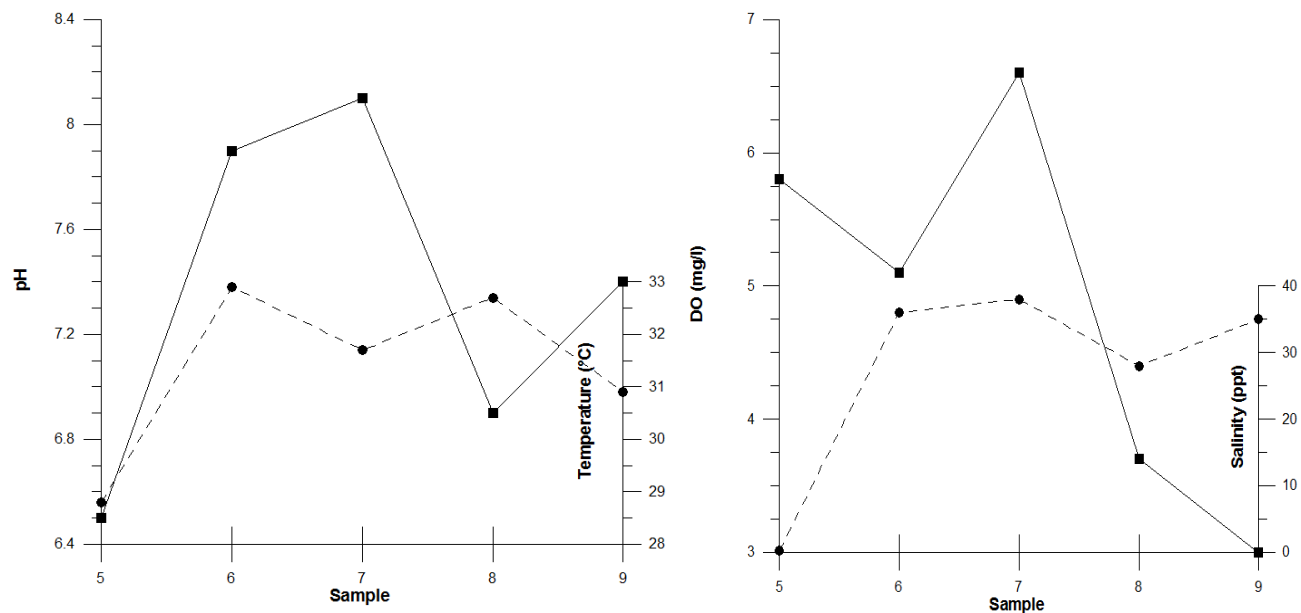
Fig. 15 and 16. pH (solid line), temperature (dashed line) & dissolved oxygen (solid) and salinity (dashed) of samples from March 17th.

The highest concentrations of ammonia were observed at sample site 8 (effluent channel from shrimp farm) and 9 (close to harbour) with 62µM/l (1.06mg/l) and 36µM/l (0.61mg/l) together with the highest concentrations of orthophosphates with 0.76µM/l (0.07mg/l) and 0.79µM (0.08mg/l) (see Fig. 17 and Table 6). Decreasing values from 1.5µM/l (0.03mg/l) down to 0.68µM/l (0.01mg/l) ammonia and orthophosphate values from 0.43µM/l (0.04mg/l) down to 0.36µM/l (0.03mg/l) were observed from sample site 5 (river above mangrove area) up to sample site 7 (shrimp pond). The levels of ammonia and orthophosphates from sample 5 (river above the mangrove) show the impact of an inflow on ammonia and orthophosphate concentrations in the mangrove channel system. The amounts which are relatively low, compared to values from sample sites 8 and 9, have no crucial consequences for eutrophication and aquatic life. They have their origin probably in agricultural landuse and discharges from households above the mangrove area. Additionally this inflow shows a relatively high value in dissolved oxygen. The concentrations of ammonia and orthophosphates at sample sites 6 and 7 are remarkably low due to two different reasons: Firstly the water in the storage pond is treated with antimicrobial substances and chemicals to remove unwanted aquatic life and algae and to guarantee a good water quality, before using it to fill up the shrimp ponds. Secondly due to the use of airpaddels in the shrimp pond we can find a high amount of dissolved oxygen (6.6mg/l – 109% saturation) which supports the bacteria to reconvert un-ionized ammonia into other, less toxic compounds. Sample site 8 and 9 showed a wide difference in

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ammonia concentrations. We assume that the daily discharge from shrimp farm Nr.2 is mixed with water from the effluent channel which contains a small amount of dissolved oxygen, sample 8 showed a value of 3.7mg/l. Hence this level of oxgen will alter the process of transferring ammonia into nitrate, therefore such high levels of ammonia can be observed.

Since the flow during low tide is going downstream there is no tidal influence and sample site 9 could be regarded with the impact of waste water from houses. The levels of un-ionized ammonia at sample 8 with 1.06mg/l and sample 9 with 0.61mg/l are within the range of lethal concentrations to fish, dissolved oxygen is low and the concentration of orthophosphorus is relatively high, bringing forward algae blooms (EPA, 2001).
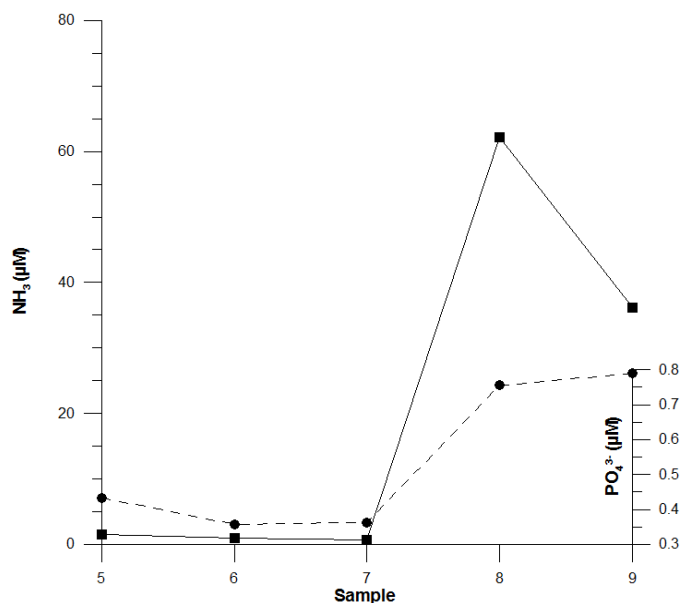

Fig. 17 Concentration of ammonia (solid) and orthophosphates (dashed) of samples from March 17th.

Table 6 Summarized results of water analysis

Sample	pH	T(°C)	DO(%)	DO(mg/l)	S(ppt)	NH_3 (µM/l)	NH_3 (mg/l)	PO_4^{3-}(µM/l)	PO_4^{3-}(mg/l)
S1	6,9	27,4	51	3,4	25	50,7	0,86	0,77	0,07
S2	7,8	29,6	55	4,0	33	6,1	0,10	0,37	0,03
S3	8,0	29,7	67	4,2	35	1,3	0,02	0,32	0,03
S4	7,9	30,2	70	4,1	35	4,0	0,07	0,36	0,03
S5	6,5	28,8	76	5,8	0,2	1,5	0,03	0,43	0,04
S6	7,9	32,9	91	5,1	36	0,9	0,02	0,36	0,03
S7	8,1	31,7	109	6,6	38	0,7	0,01	0,36	0,03
S8	6,9	32,7	61	3,7	28	62,2	1,06	0,76	0,07
S9	7,4	30,9	49	3,0	35	36,1	0,61	0,79	0,08

T= temperature, DO(%)= dissolved oxygen saturation, S= salinity

3.3.6. The effect of shrimp farming on fishing and on local people`s livelihoods

There was a consensus that the polluted water is affecting the aquatic life in the mangrove. It is generally perceived by the villagers that it is killing fish and other species but does not have a larger impact on the trees. However, according to the headman`s opinion the main cause for the decrease in the fish diversity is the over fishing and not the pollution from the shrimp farms.

There may be many causes contributing to the reduction of catch capacity. According to the results of the water sampling we could partly attribute this effect to the bad quality of the water caused by the shrimp farm effluents. The levels of un-ionized ammonia at a few sample sites, especially sites with an impact from waste water from the houses and close to one effluent channel from one of the shrimp farm, were within the range of lethal and sublethal concentrations to aquatic organisms. Additionally, at these sites dissolved oxygen levels were relatively low compared to others and the concentration of orthophosphorus was relatively high. These water conditions are likely affecting the reproductivity of the fish and threatening the diversity of the aquatic life in the mangrove. Since fishing together with the mangrove is the main livelihood strategy in Ban Tha Klang it can be concluded that shrimp farming has an indirect negative effect on the livelihoods of the villagers.

4. Conclusions

Responsible author: All members

The community is highly dependent on fishing, obtaining the majority of food and income from the open sea and mangrove channels. Almost all of the activities carried out are interdependent and the overall livelihood strategy of the village is from this perspective vulnerable. None of the villagers are employed or involved with the shrimp farms and it is not directly benefitting the village socio economically.

The use of the mangrove was the second most important livelihood strategy in the community and was considered as a resource available all over the year. 65 % of the respondents in the village obtain a livelihood from it, either by fishing (32.5 %) or by wood extraction (45 %). The mangrove provides the villagers with a wide range of products such as two species of crabs, shells and shrimps, while in the mangrove channels two species of fish (snappers and grouppers), mussels, shrimps and sea weed. Other minor products found are vegetables, wood worms and seeds. Outside the mangrove, the main products obtained close to the shore and in the sea are one species of crab, five species of fish (sillago, mackarell, sardines, etc.), sea weed, molluscs, snails, squids and shrimps.

In the village, the mangrove conservation group is known by the 92.5 % of the respondents of the questionnaire survey and most of them participate in its activities (77.5 %) in average twice a month or 3 times a year.

Four main causes of mangrove pollution were identified by the villagers: the garbage dumped by the villagers from the houses, the waste water released from shrimp farming, the oil released from the fishing boats and the waste water from the village households. Waste water from the shrimp farm is released at two spots into the mangrove channels, is transported and is affecting the whole mangrove area. During the grow-out cycle, the shrimp farms are using antimicrobial substances, fish powder as shrimp feed, fertilizers and a wide range of chemicals.

From the mangrove forest assessment it can be concluded that the mangrove forest has been highly disturbed. The results show that the current state of the forest is unsustainable. The decline of the mangrove structure can be attributed to both human activities of exploitation and the existence of the shrimp farms. It was however not possible to measure the exact level of impact from the shrimp farms.

The water analysis results show that the range of lethal and sublethal concentrations of un-ionized ammonia at few sample sites, the relatively low dissolved oxygen levels and the relatively high concentration of orthophosphorus found can be related to the effluents of the shrimp farms. This is likely to be causing a decrease of the aquatic life.

5. Reflexion of the methods used

To be able to fully understand the livelihoods of Ban Tha Klang a more ample study is needed. By only looking at access and use of natural resources and income generating activities we have limited the study and can only describe one aspect of the livelihoods. In analysing the questionnaires it was realized that there were no reliable regarding information given on income. The information given in the interviews will most likely be biased, because it represents the informants own worldview and interests. In order to minimise this problem the information was triangulated with different methods. More focus group discussions were used in order to minimize the bias from particular points of view. The ranking exercises were great tools providing much information. In order to simplify the exercises and take less of the respondents' time, they were changed from matrix ranking to pair wise ranking. Due to practical reasons the different groups met on separate occasions. The youth group was further incorporated into the categories "men" and "women" and the third group discussion was instead conducted with the mangrove conservation group.

Drawing the resource map of the community had initially the objective of relate the effect of shrimp farming to mangrove forest loss and mangrove forest pollution. Mangrove forest loss was not identified as a big problem in the community; hence, the diagram of causes for mangrove forest loss was not carried out. The exercise was focused on drawing the map of the natural resources in the community, identify the main causes of mangrove forest pollution and draw them on the map in relation with the shrimp farming.

In the mangrove forest assessment, the main inadequacies were the time limit for preparation and data collection. In the resource community map there were three main mangroves areas identified, however, only one area was considered and sampled for the assessment. This may have an effect on the outcome of the assessment but due to the close likeliness between the sections, it is possible to make a rough general view of the forest structure and state. In addition, the assessment only considered the above

ground physical structure of the forest. Considering that shrimp farming is mainly affecting the aquatic life it would be important to consider it when assessing the mangrove.

Concerning to the water quality and shrimp farming effluents the information obtained from the different interviews was contradicting. We suppose there was hidden information that the informants were reluctant to share. Reliability and validity of the obtained results are restricted.

Nonetheless the diagram of causes helped to obtain an overview of the situation and the water samples allowed us to draw a general picture of the water quality.

The water sampling gave us a very small overview on the waterquality regarding ammonia, orthophosphate and dissolved oxygen concentrations, three important parameters especially for aquatic life, in the mangrove channels close to the village. Nevertheless we are missing more samples over a longer period of time, more parameters, e.g. especially those which measures chemicals and fertilizers used by the shrimp farms, to see an effect of shrimp farming on the adjacent water area.

Caution must be exercised in considering the results of phosphorus analysis as the element exists in bound and unbound forms which are very difficult to separate totally in analysis, as we got to know from our supervisors. There is the possibility that some of the bound polyphosphates forms being changed by hydrolysis to orthophosphate under the actual analytical conditions, especially when water samples are analyzed not immediately like our samples. Samples taken during March 15th were analyzed March the 17th (EPA, 2001).

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7. Appendix

Appendix 1. Final synopsis

University of Copenhagen
Faculty of LIFE Sciences
SLUSE Joint Course: Interdisciplinary land use and natural resource management
February – April 2010

Final Synopsis

The Interaction Between Shrimp Farming and Mangrove Forest
-   A Fieldstudy on Livelihood Strategies in Ban Phukaothong, Thailand

James Epilo, Ciro Dominguez, Frida Rodhe, Jan Makurat
Village group No.4

February 24th, 2010

1. Introduction

1.1 Study area: Ban Phukaothong, Ranong district, Thailand

Table 1. Basic Information about Ban Phukaothong

Number of households	364
Population	1367
Average income (per Person/year)	42.000 Baht
Village area	8.850 Rai
Average population density (per sq.km)	80
Orchard farmers	140
Herdsman	50
Artisanal fisherman	200
Merchants	20
Workers	200
Government officials	5

Source: Sluse ILUNRM, 2010 a & Sluse ILUNRM, 2010 b

Ban Phukaothong is located in the Ranong province, Suk Saman district close to the Andaman coast and the boarder to Myanmar (for location see Fig.1). Around 70% of its area are plains including mountains, forests, mangrove forests, beach forests as well as a resource abundant sea. The local agricultural production includes mainly oil palm plantations, rubber plantations and orchards. Important fisheries are artisanal fishing, such as shrimp gill nets, crab gill nets, fish gill nets and sand whiting gill nets (Sluse ILUNRM b, 2010). The village can be divided into two different clusters: The first one is located close to the main road where most of the population earns a living from agriculture, i.e. rubber plantations and orchards (Sluse ILUNRM b, 2010). The second cluster, on which our study will be focussed, is located by the port within the local mangrove area. At this place most of the villagers earn their living from fisheries (Sluse ILUNRM b, 2010). Ban Phukaothong directs a committee on local community forests and rules have been set up for utilization of the mangrove forests, since the villagers identify the importance of mangroves on other resources related to people's way of life, particularly on aquatic animal breeding area (Sluse ILUNRM b, 2010). Close to the village area several shrimp farms are resident. Which…

1.2 Research objectives: Shrimp farming and mangrove forest in Ban Phukaothong

From the provided information we got to know that the local shrimp farms are potentially polluting the adjacent water canals with contaminated effluents during shrimp harvest resulting in conflicts within the community. A herbal plant composing a broad-spectrum insecticide, piscicide and pesticide called rotenone is used by local farmers to crucify unwanted fish in shrimp ponds, hence affecting the adjacent mangrove forest (Sluse ILUNRM a, 2010). On the other hand, Shrimp farm owners are usually hiring farmers as well as a few farm hands to work at the shrimp ponds, thus generating livelihood in village communities (Huitric et al., 2002). However the dramatic impact on mangrove ecosystems in coastal areas has several important consequences for people living in coastal communities. Often these communities depend upon mangrove forests for a variety of direct (firewood, charcoal, construction materials, herbal plants for traditional medicines and other products) and indirect benefits and if mangrove area is declining, rural populations are forced to concentrate their collection activities on a smaller mangrove area which leads to further degradation through overuse or forces them to travel greater distances to obtain these necessities (Flaherty & Karnjanakesorn, 1995). Indirect benefits are ecological functions, such as controlling shoreline erosion and sedimentation, acting as windbreaks and providing habitats for marine wildlife (Flaherty & Karnjanakesorn, 1995). Mangrove loss has a great impact on the productivity of inshore and offshore fisheries. Ban Phukaothong was established 20 years ago, people had moved from the coastal zone due to problems with erosion, so that interactions between local shrimp farms and local mangroves persist at most for this relatively short duration. From the provided informations or assumption is that parts of the village community obtain their livelihoods from shrimp farming as well as from the mangrove area. Both livelihood sources will be connected with each other in a certain degree through socio-economic and environmental aspects.

In this project, the group will investigate how shrimp farming and mangrove as livelihood strategies interact and influence each other. In addition, the team will investigate the importance of the two strategies mentioned above in relation to other livelihood strategies available in the community of Ban Phukao Thong

The mangrove forest is a natural resource which the group intends to investigate how the community of Ban Phukao Thong access and exploit it to meet their livelihood needs. In

addition, the mangrove forest falls directly under the overall management of the Royal Forest Authority of Thailand, it is of interest therefore for the project to seek and find out whether there is a level of involvement of the local community in Mangrove forest management. The various regulations and laws governing access and use of the mangrove forest resources will be sought and examined.

This overall context leads us to following research objectives and sub questions:

1. To investigate the interaction between shrimp farming and mangrove forest livelihood strategies in Ban Phukao Thong.

2. To investigate the role/importance of local shrimp farming and local mangrove forest livelihood strategies in the community.

Sub questions

1. How is local shrimp farming influencing the mangrove forest?

   1.1 How is local shrimp farming influencing mangrove forest loss?

   1.2 How is local shrimp farming influencing mangrove forest pollution?

   1.3 How is local shrimp farming influencing mangrove forest use?

   1.4 How is local shrimp farming influencing mangrove forest management?

2. How is local mangrove forest affecting shrimp farming?

   2.1. How is the local regulation/legislation constraining the shrimp farming expansion?

   2.2. How is the local regulation/legislation constraining the shrimp farming access to mangrove services (fry fish, hatcheries)?

3. What is the conflict potential between the two activities?

   3.1 What are the conflicting interests between both groups?

4. What are the sources of income in the community?

   4.1 What is the relative importance of each income source?

5. How are the villagers involved in mangrove forest use and management?

5.1 Who uses the mangrove forest?

5.2 Who manages the mangrove forest?

5.3 How many villagers obtain a livelihood (timber/non timber, cash/non cash) from mangrove forest use and management?

6. How are the villagers involved in local shrimp farming?

6.1 Who owns the shrimp farms?

6.2 How many villagers obtain livelihood from shrimp farming?

Definition of Livelihoods and Livelihood Strategies

In the context of this project, livelihood is defined as resource use combinations and activities executed in order to earn a living. The livelihoods of the people of Ban Phukao Thong are derived from among other means, shrimp farming and the mangrove forest. The group assumes that there is a close relationship between shrimp farming and mangrove forest. The livelihoods of this community are by no doubt supported by other livelihood strategies. Resources used in various combinations and the activities undertaken are the livelihood strategies.

2. Background on shrimp farming and mangrove forests in Thailand

2.1 Development of shrimp farming in Thailand

In 1935 extensive shrimp farming was introduced along the eastern coast of the Gulf of Thailand, often in rice fields with low yields and shrimps were harvested for domestic consumption and for vending on local markets (Huitric et al., 2002, Flaherty & Karnjanakesorn, 1995). In following years relatively high prices led to the expansion of extensive shrimp farming and exclusive economic zones have been established in the 1970`s. A large demand for shrimp from Japan, US and western Europe and a steady price prompted the national Department of Fisheries to promote semi-intensive marine shrimp farming in 1973 through establishment of hatcheries (Huitric et al., 2002). During the 1980`s the technology allowing the intensification of shrimp farming (very high stocking densities of shrimp supplied by hatcheries, use of processed feed, frequent water flushing and mechanisation of the farms with aerators, water pumps and lighting) was developed

(Huitric et al., 2002, Flaherty & Karnjanakesorn, 1995). During the end of this decade there was a widespread intensification of shrimp farms in Thailand, thus in 1994, 80% of them were intensive (Huitric et al., 2002). The number of farms increased from 3.500 farms in 1980, to 26.000 in 1996 covering around 80.000 ha, of which 85% were intensive farms (Huitric et al., 2002). An increased demand for shrimp on the global market, high potential returns and improved technology have contributed to the growth and intensification of the industry. Since 1995 yields from shrimp farms in Thailand have been dropping due in part to disease problems caused by the lack of water treatment, high densities of farms all of which is conductive to the rapid spread of disease. The result was that farmers reduced stocking densities, decreasing the proportion of intensive farms from 84% in 1995 to 25% in 1999 (Huitric et al., 2002).

Table 2. Statistics on the Thai shrimp industry's development and production (1980–97) Refer table in the text

	1980	1985	1990	1995	1996	1997
No. farms	3600	5000	15 100	26 200	26 000	25 000
Area of farms (ha)	26 000	40 800	64 600	74 900	84 000	80 000
Revenue (USD $\times 10^6$)	23	50	600	1600	1700	1500

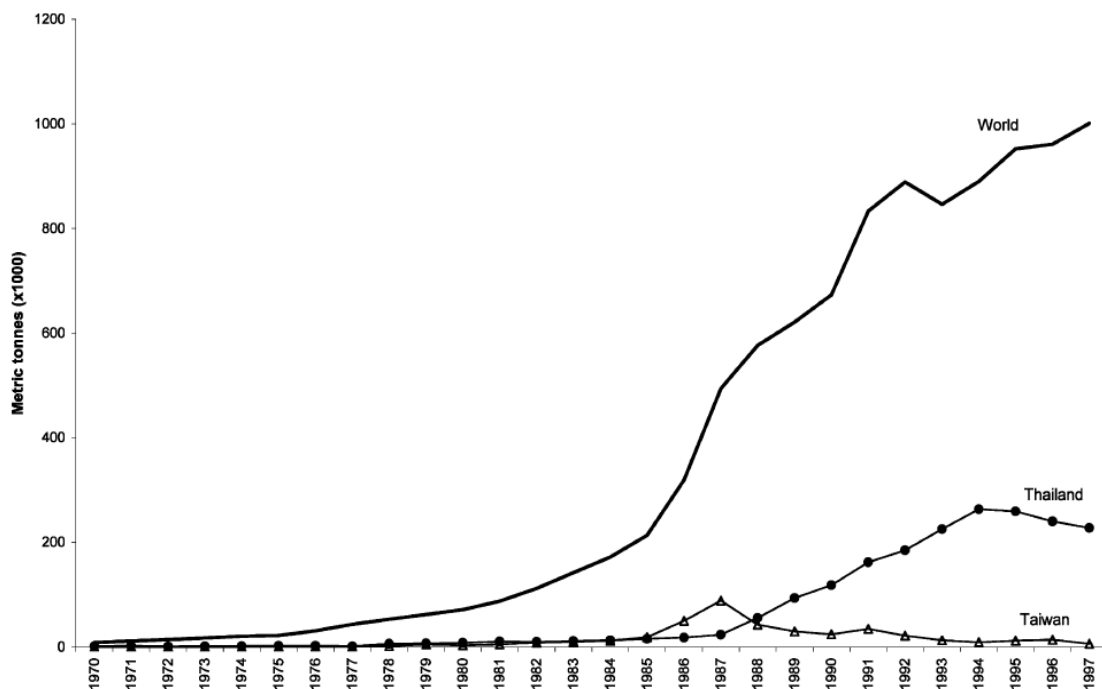Source: Huitric et al., 2002.

Fig.2. Production of cultured brackish water shrimp in Thailand, Taiwan and globally (in 64 countries) from 1970 to 1997. Source: Huitric et al., 2002.

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2.2 Appropriation and exploitation of mangroves by the Thai shrimp farming industry

The mangrove ecosystem is a category of wetland systems rich in flora and fauna that shelters coastlines and estuaries with environmental services like storm protection, shore stabilization and control of shore erosion and flodding (Sathirathai, 2003). Mangroves are also biomass export and a habitat for marine life. In Thailand mangroves rapidly disappear of approximately 38.909 rai (6.225 ha) per year (Sathirathai, 2003). The major cause of mangrove clearance is the conversion of mangrove areas into intensive shrimp farms. During the period between 1961 and 1993 Thailand`s total mangrove area halved from 364.000 to 168.700 ha (Huitric et al., 2002). Extensive and semi-intensive shrimp farming setup ponds in the mangroves due to benefitial conditions provided: brackish water, abundant fry, cheap land and low lying area (Huitric et al., 2002, Flaherty & Karnjanakesorn, 1995). Intensive shrimp farming continued to use mangroves through the conversion of existing ponds as well as the spread of farms (Huitric et al., 2002). Shrimp farms have also indirect impacts on areas beyond the farm. It includes lowered water tables due to the use of freshwater in the ponds, salinisation of the surroundings due to infiltration of seawater, transport of effluents to other areas, fish are caught to produce fishmeal and wild-caught shrimp larvae are used, therefore reducing their wildstocks (Huitric et al., 2002, Flaherty & Karnjanakesorn, 1995).

Methodology

In order to answer our research questions we will use a set of methods which are described below:

Semi-structured Interviews

To obtain important information about the local shrimp farm and the local mangrove forest use and management we will use semi-structured interviews with key informants.

Semi-structured interviews is a qualitative method that allows the interview to move into new paths and discover relevant issues that might not be thought of initially. This means to ask both closed and open questions that allows interviewer and interviewee to follow up on interesting new leads without losing focus from the information wanted. The semi-structured interview is much like a conversation or a discussion between interviewer and interviewee. It is often used to go into depth with an issue. It is a time consuming method which means that only a limited number of respondents can be interviewed. We will triangulate and complement the results with

other methods such as questionnaires, literature review and PRA's to not loose the breadth in our research (Gilliam, 2000). However, by using semi-structured interviews we will be able to better understand the nature and role of the shrimp farming and mangrove forest in the local context and obtain a deeper knowledge about the problems and relations.

We will do a minimum of 5 semi structured interviews in field, one with a key informant from the local shrimp farm, one from the mangrove forest management group, two with villagers who uses the forest and one with a local/regional environmental official. There will be two students together with an interpreter present at each interview. When analysis the data obtained we use the technique triangulate analysts meaning that the two observe, compare and combine their analysis of the same qualitative data (Patton 1990).

Key informant from the local shrimp farm:

This interview will be focused to find information about how shrimp farming affects the mangrove forest in terms of pollution and how local mangrove forest affects the shrimp farms in terms of accessibility (new areas for expansion) and services such as water quality, fries and hatcheries, etc due to possible legislations and regulations. We will also ask for basic information on the about the local farm such as production cycle and capacity. From an analysis of the interview we also hope to reach an understanding of the conflict potential between the two activities (See Annex 1).

Key informant from the local mangrove forest management group:

This interview will help us to understand how shrimp farming affects the local mangrove forest use, forest management/changes in strategies, mangrove forest loss and pollution. Like in the interview with the key informant from the shrimp farm, the information retrieved from the interview will be used to find out the conflict potential between the two activities. From the interview, information will further be asked for regarding villagers' involvement in the local forest management, who manages the forest, how it is managed and the importance of the forest for the villager's livelihoods both in monetary and non monetary value (See Annex 2).

Key villager informants:

Two interviews will be carried out with the villagers. This will preferably be made on a

participatory observation base. It means that we intend to go with the villagers to the forest and observe what products that are commonly collected from the forest how and where they are collected and its importance for the villager's livelihood. These interviews will give us information about how shrimp farming affects the local mangrove forest and how this further affects the villager's livelihood strategy as well. Also an understanding will be reach on the villagers' involvement in the local forest use (See Annex 3).

Environmental government official:

We will finally interview an environmental government official of the region. The government official can provide us with a different perspective than the informants from the shrimp farm, the mangrove forest management group and the villagers hence he is not directly involved in the activities but knowingly of them. The focus will be on legislation and regulation around mangrove forest conservation and use and shrimp farming. We will however also use this interview to complement the others in terms of how shrimp farming affects mangrove forest use, management, loss and pollution. Finally we hope that it will give us information about the conflicting interests of the two activities in the village (See Annex 4).

We are aware of that the information retrieved from the interviews is likely to be biased. The information will be partly if not fully influenced by the informants' perception of the situation. Some information might also be sensitive to ask for and the informants might not want to reveal it. We will have this in mind when we do our analysis and we will triangulate the information from the interviews with information obtained from questionnaires, literature research, PRAs and observations to reach an objective and true result as possible.

PRA: Focus Group Discussion/Ranking/Seasonal calendar/Resource mapping/Causes diagram

Participatory Rural Appraisal (PRA) techniques are known to be fast, visual, low-cost, involving active participation of the stakeholders, systematic, facilitative and promoting discussion among participants, two-way learning process, and generally beneficial to the community or respondents. The techniques involved are numerous, including all type of group work, ranking, calendars and mapping of time and space using charts and diagrams (Fielding et.al., 1998). During this project focus group discussion will be used and under this the team will use a matrix

ranking tool to obtain various types of preferences of income/livelihood strategies. Ranking and scoring have long been used to assess people's expectations, beliefs, attitudes, preferences and opinions (Mikkelsen, 2005).

The focus group discussion will also be used to draw a seasonal calendar of livelihoods/incomes which have been broadly used to indicate the annual variations of income, a resource map which will be substantiated by conducting a transect walk in the village & the mangrove area and a diagram of causes for pollution & forest mangrove loss. Transects walks and mapping with local informants through the area are exceptionally good to observe, discuss, identify and register the limited spatial and physical space of natural resources (Mikkelsen, 2005).

In order to ease the facilitation of the different PRA techniques and ensure a deeper understanding of the data gathered, this exercise will be preferably carried out in two sets.

1. The first set mainly to:

    - Draw a resource map of the community in order to identify the possible effect of shrimp farming on the mangrove forest loss. People will be asked to draw the area covered as well as former areas covered by mangroves forest and other resources important for the community. In the process of making the resource map we will discuss the relation between the two livelihood strategies (See Annex 5).
     - Discuss the possible causes which have contributed or are contributing to the mangrove forest loss and pollution (See Annex 5). For that, a sheet to list and rank the different causes (Annexes 5.2 and 5.3) will be spread to each member and then a group discussion will encourage the villagers to draw both diagrams of causes, for pollution and mangrove forest loss.

To compare the map done by the community we may construct our own map based on estimations from cartographic maps if available in the regional forest offices.

2. A second set oriented to:

     - Discuss economic issues and rank their preferences of livelihoods/incomes in order to discover its perceived importance by the community. During this exercise, the participants will be asked to identify the most livelihood strategies in the community and rank them.

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Afterwards the whole group will be sub-divided into smaller groups of men, women and youth in order to obtain the different perceptions of these categories in the village. In the sub-groups, each member will be asked to rank the livelihood strategies and members will converge to make one consolidated group rank. During this process, the members will be encouraged to discuss and give reasons for their ranking. Each group will then present their rankings for consolidation into one matrix rank for the whole village. The results from both the individual and the sub-group ranking will later be considered in the analysis. We will do this to make sure that important information is not lost on the way (See Annex 6). The results can be summarized in a matrix format shown in Fig 2 and Table 3.

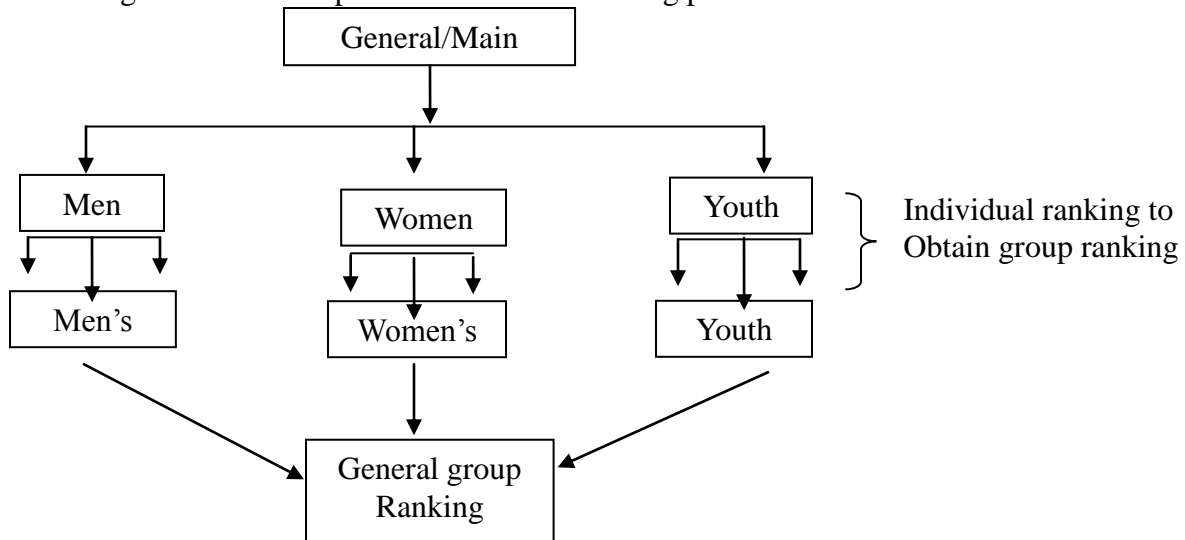Fig 2. Structural representation of the ranking process:

Table 3. Title: Matrix Ranking of Livelihood strategies for Ban Phukao Thong Village

Livelihood strategy	Men	Women	Youth	Total mark	Rank
Shrimp Farming	0 0 0 0	0 0 0	0 0	10	1
Mangrove forest	0		0 0 0	5	4
Cassava production	0 0 0	0	0 0 0	8	2
Fishing	0 0		0 0 0	7	3
Trading	0	0 0	0	4	5
Hunting	0		0	2	6
Etc……					Etc…..

The reasons for the various ranks by each group can be obtained

- Draw a seasonal calendar of livelihoods/incomes (See Annex 6.2) in which the whole group will draw the different livelihoods in the community all over the year and its monetary or non monetary outcomes represented by pictures, symbols, etc. (money, fish, wood, plants for example).

Secondary data collection

The main sources of secondary data will be gathered from literature review of related articles and books, the local and regional municipalities and forest and fisheries offices. Cartographic maps could show the evolution of the landscape in the community and illustrate the possible mangrove forest loss. Statistics can reinforce our observations from maps and estimations. Employment and income data can be a valuable source to find out how many people depends on shrimp farming and mangrove forest and its importance for the people's livelihood.

Questionnaires

The main objective of our questionnaire survey is to enable our group to access primary data/information about incomes and livelihoods within the community households (Annex 7). The data to be collected will include simple demographic data as well as monetary and non-monetary income sources of household members. The head of the household will be the forefront target for administering the questionnaire. However in the absence of the head of the household, the next of kin (spouse) will be interviewed. To determine the sample size we will use the simple random sampling technique which ensures that each and every household in the community has an equal chance of being selected in the sample. A total of 20 households will be selected using this method and an interview will be done with the services of the translator. A larger sample could have been targeted however because of the time limit; the group will concentrate on the above mentioned sample size.

The data obtained will be complemented and triangulated with that obtained using other methods, mainly semi structured interviews and PRA's, to ensure that the team prepares a formidable analysis and conclusion in the final report. The questionnaire design will be made simple and understandable and will contain both closed and open ended questions that allows for probing and the capture/recording of some qualitative information. It will be translated into the

local language for ease of handling by the translator. The questionnaires will be administered by the group assisted by the translator and the Thailand counterparts who have knowledge of the local language and culture. The translator and the Thai counterparts will help to sanction words and statements that may not be culturally acceptable in the norms of the village community. The data obtained will be subjected to statistical analysis using excel spread sheet and other statistical software to generate tables and graphs. This will be used by the team to describe the main sources of income in the community, those derived from the shrimp farming and those from the mangrove forest, its relative importance and the number of people who perceive a livelihood from these activities.

Observation

Observation of physical structures, behaviours, actions and symbols provides important information for posing central question (Mikkelsen, 2005). Hence, in addition to the above mentioned methods we are using for data gathering, observation will give that complementary/missing information which can enrich the data collection. It can be used to answer either obvious events/relationships or hidden information/effects which local people are unable to perceive or unwilling to provide. Observation can be applied during all the research but will specially be used to identify those issues related to the interaction between shrimp farming and mangrove forest, i.e. how local shrimp farming influence the mangrove forest and vice versa. Focus will be the forest mangrove loss, pollution, forest use, forest management, sources of income from the forest (timber/non timber, cash/non cash) and the conflict potential between the two activities. Participatory observation will be used in combination with the interview to the villagers.

Logical Framework Approach

Research Question	Subquestion	Data required	Proposed Methods	Assumptions
1. How is local shrimp farming influencing the mangrove forest?	1.1 How is local shrimp farming influencing mangrove forest loss?	- Area Loss of mangrove area through: -displacement -and pollution	- Observation - Resource mapping - GPS, own estimations from maps - Diagram for causes - Interview mangrove forest management group - Interview environmental official	- Shrimp farms compete with the forests for territory. Pollution from shrimp farms affects the mangrove area negatively, poisonous plant and eutrophication - Possibility that there is no influence from shrimp farming on mangrove forest loss -There are no maps or information about former area covered by mangrove
	1.2 How is local shrimp farming influencing mangrove forest pollution?	- Forms of contamination and frequency - Amount of contamination	- Interview shrimp farmer - Interview forest management group - Interview environmental official - Diagram for causes	- Pollution from shrimp farming
	1.3 How is local shrimp farming influencing mangrove forest use?		- Interview villagers - Interview environmental official	
	1.4 How is local shrimp farming influencing mangrove forest management?	- Changes in management strategies - Legislation on shrimp farming, land titles and forest conservation - Local regulations, exceptions/violations	- Interview mangrove forest management - Interview environmental official - Literature/archive review	
2. How is local mangrove forest affecting shrimp farming?	2.1. How is the local regulation/legislation constraining the shrimp farming expansion?	- Legislation on shrimp farming, land titles and forest conservation - Local regulations/ exceptions/violations - Access to mangrove areas to build	- Interview shrimp farmer - Interview forest management group - Interview environmental official	- Possible legislation in mangrove conservation affects shrimp farming, difficulties obtaining land titles

			- Literature	
	shrimp farming - Access to services (fries, hatcheries)		- Literature	
	2.2. How is the local regulation/legislation constraining the shrimp farming access to mangrove services?		- Interview shrimp farmer - Interview forest management group - Interview environmental official	
3. Is there any conflict potential between the two activities?	3.1 What are the conflicting interests between both groups?	- Different Interests of both groups and which of these that do not compile	- Literature - Interview shrimp farmer - Interview mangrove management group - Interview government official	- The two activities have clashing interests and influences each other negatively therefore the conflict potential is high - The two activities do not have clashing interests and do not influence each other negatively therefore the conflict potential is low
4. What are the sources of income in the community?	4.1. What is the relative importance of each income source?	-Types and number of income sources - Average annual/month incomes from the income source - Ranks of the various income sources - Non cash incomes - Number of unemployed people	- Questionnaires - Focus group discussion - Ranking - Seasonal calendar	- The translator and guide understand and translate English to the community - Community available for interviews and focus group discussion
5. How are the villagers involved in mangrove forest management?	5.1. How is the mangrove forest managed? 5.2. Who manages the mangrove forest? 5.3. How many villagers obtain cash or non cash livelihood	- Number of villagers involved in mangrove management - Level of involvement - The authority controlling the Mangrove (laws) - Types of mangrove resources that the community can access/ obtain	- Questionnaires - Interview villagers - Participatory observation	- Local government officials accept to be interviewed - We have access to the mangrove forest

	from mangrove forest management?			
6. How are the villagers involved in local shrimp farming?	6.1. Who owns the shrimp farms? 6.2. How many villagers obtain livelihood from shrimp farming?	- Number of people employed in shrimp industry - Level of involvement - The authority controlling the shrimp farms	-Questionnaires - Interviews shrimp farmer	Shrimp farming is an important/main source of income - Sampling error could influence the results - Income is a possible sensitive question

Timetable

Activity	Inputs required	Responsible persons	Time needed
Designing Questionnaire		Group	**18/02**
Pilot-Test Questionnaire	Questionnaire	Life students	19/02/2010
Translation of questionnaires	Paid translator,	Life and Thailand Counter parts Translator,	20-26/02/2010
Meeting with Thailand Counterparts and Translator, presentation to community headman/villagers. Ask for key informants for interviews	Tea/coffee/refreshments	Course coordinators Life, Thailand Students	11/03/2010
Observation and transect walk	Transport, guide, translator, GPS	Life students, Thailand students	12/03/2010
Area recognition and sketch map design	Guide, translator, headman	Life students, Thailand students, translator, headman	12/03/2010
Secondary data collection	Transport, translator	Life students, translator,	13/03/2010
Semi-Structured interviews	Transport Questionnaires print out, translator, recorder,	Shrimp farmers, forest management group, environmental official	14-15/03/2010
Focus Group Discussion - Ranking - Resource mapping - Seasonal calendar - Causes diagram (pollution mangrove loss)	Community hall/ meeting venue Transport, Flip charts, Marker pens, beverages	Life and Thailand students. Translator, Village head	16/03/2010
Questionnaires handling and administering	Questionnaires Print outs, Transport, Camera, Translator	Life and Thailand Counter parts Translator, Forest group, Headman, government officials	17-18/03/2010 (3 days)
Second transect walk for construction of own map	GPS, Maps from local office, translator, guide, transport,		19-20/2010
Possible follow up on interviews and missing questionnaires	Transport, translator,		20/02/2010

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Appendix 2. Guiding questions for semi-structured interview with the shrimp farmers

This interview was designed by students from the University of Copenhagen, Denmark and Kasetsart University Bangkok, Thailand. The purpose is to obtain an overview about the importance of the mangrove forest in the community and the effects of shrimp farming on the forest and people's livelihoods.

We really appreciate your effort and patience.

- -

Name of Enumerator: _____Interview No.:_____

Date: _____

General information/livelihoods

Location of the shrimp farm:
Name   Origin-district

How long time have you been in the shrimp farming business?
How long have you had a shrimp farm in this village?
How many shrimp farms do you own?
How does the shrimp farm work?

Production cycle, feeding, growing, harvest, proportion,
How many times harvest /year?
      Water change/ water management, water supply where from?
      Sediments managed?
      Shrimp seeds taken from?
What is the difference between plastic ponds and soil ponds?
How long can the soil ponds be used?
What was the pond land use before?
How many ponds do you have?
Size of the ponds?
Capacity of the ponds?
What is the total area?

How many employees do you have,
How much do they earn?
Seasonal labour?
Local people or not?
Where do the employees come from? (From the village from other places)

Do you have any problem with diseases?
How are they managed? (Products used?)
Do you have problems with unwanted fish in the ponds?
How is the problem managed?
What is used to grow the shrimps?
Any fertilizers used?
Are there any regulations local or national in what is allowed to be used in terms of inputs (fertilizers and pesticides)?

Interaction between Shrimp farming and Mangrove

What is the importance of Mangroves for the shrimp farm?

Water quality, services, hatcheries, water source, infrastructure into the mangroves

What products do you use from the mangroves?

How is the relation between you and the mangrove forest group?

Do you own the land on which your shrimp farm is located?

Are you affected by any legislation or regulations regarding forest conservation?

Pollution and territorial…

What is your feeling about the regulations if any?

Have there been changes in the regulations regarding forest use?

Additional comments?

Thank you!

Note to interviewer:

Explain that we are interested in how a shrimp farm works the practices and technique used (indirect questions for pesticides and fertilizers pollution)

Ask to do a walk, with a GPS to measure area. If not ask for a simple overview drawing or measurements of the farm. Ask if we can do our own measurements another

Appendix 3 Guiding questions for semi-structured interview with the village's headman

This interview was designed by students from the University of Copenhagen, Denmark and Kasetsart University Bangkok, Thailand. The purpose is to obtain an overview about the importance of the mangrove forest in the community and the effects of shrimp farming on the forest and people's livelihoods.

We really appreciate your effort and patience.

- -

Name of Enumerator: _____Interview No.:_____

Date: _____

General information/livelihoods

1. Number of inhabitants in Ban Tha Klang?
2. Number of households in Ban Tha Klang?
3. What are the main activities in the community?

Mangrove forest

1. What products are collected from the forest?
2. Have you noticed any changes in forest coverage/area?
3. What do you think have caused these changes?
4. Are there any local regulations to use the forest?
5. Can you give us a brief overview of the legislation/laws?
6. Is there any limitation for the community to access the forest resources in relation to the legislation?
7. How does the mangrove conservation group work/main activities?
    - How many people involved
    - What do they do
    - How often
    - Participation from other people non members

Shrimp farming

1. Is any member of the community involved in the shrimp farming?
2. Is there any interaction between shrimp farming and mangrove forest?
        In relation to:
        Pollution, Forest loss/forest conservation
        General activities before and after SF
3. Is there any law or legislation on shrimp farming?
4. Can you give us a brief overview of the legislation/laws?
5. How is the relationship between people in the community and the SF

Appendix 4. Guiding questions for semi-structured interview with Mangrove Forest Management Group member

This interview was designed by students from the University of Copenhagen, Denmark and Kasetsart University Bangkok, Thailand. The purpose is to obtain an overview about the importance of the mangrove forest in the community and the effects of shrimp farming on the forest and people's livelihoods.

We really appreciate your effort and patience.

- -

Name of Enumerator: _____Interview No.:_____

Date:_____   Interviewee name_____   Age _____

Position/responsibility in the group
Time involved in Mangrove Forest conservation

Forest Conservation
How many people are involved?
When was the group created?
What is the purpose of the group? / Why was it created?
What are the main activities?

Forest use
How is the forest used by the villagers?
What is collected?
To what extent is it used? (amount and frequency)
What is the importance of the forest for the village? Economic/cultural/environmental

Local regulations and national legislation
What is the relevant legislation?
Is this implemented?
How can it be noticed in forest use and conservation?
Are there any local additional regulations?
If so what are they?
Are they implemented?
How are they practiced?
What are the constraints and advantages with the legislations/regulations?

Relation with Shrimp farming
Is the local shrimp farming affecting the local mangrove forest?
        - If so, in what way is the forest affected by the shrimp farms?
        - Pollution- if noticed, how? What is affected? How can it be seen?
        - Forest loss? how can it be seen?
Are there any strategies of the forest conservation group to handle the problems?
How is the relation between shrimp farmers and the management group (good, bad, cooperation, conflict??)

Any additional comments?

    Thank you!

Appendix 5. Annex 5. PRA´s resource map and diagram of causes for mangrove forest pollution

TIME	ACTIVITY
1. THE RESOURCE MAP	
5 min	1. Introduction. Why are we here? Brief explanation of the project
5 min	2. Brief explanation of Natural Resources, what is it?
10 min	*3.* Identify the natural resources in the community - Distribution of the *"Community´s Natural Resources sheet"* - Discuss about the natural resources in the community - List (individually or in groups of 2-3) at least 5
5 min	4. Call for draw the Resource map - Brief explanation of what is a resource map - What do we want them to represent on it?
40 min	5. Drawing the resource map *(all together, at least 10 people)* - Natural resources in the community - Areas covered by mangrove forest
15 min	6. General overview of the map, what it represents? *(all together)* - Explanation by the villagers
2. DIAGRAM OF CAUSES FOR MANGROVE FOREST POLLUTION	
5 min	1. Discussion and introduction to perceived causes for pollution
10 min	2. Individual exercise - *Distribution of "Causes of pollution sheet"* - Identify possible causes of pollution. List at least 5 - Rank them according to the perceive importance
10 min	3. Group discussion of possible causes for pollution *(all together)*
20 min	4. Drawing the diagram of causes for pollution *(all together)*
3. RELATIONS AND CONCLUSION	
20 min	1. Drawing relations of causes on the Resource map *(all together)* - Identify relations between shrimp farming and mangrove forest - Identify the shrimp farming impact on mangrove forest loss and pollution
15 min	2. Conclusion *(all together)* - Perceptions and opinions by the villagers/Thanks to participants

TIME NEEDED

1.40 hr.   Resource map
45 min.   Parallel exercise Diagram of causes for mangrove forest loss and pollution
20 min.   Drawing relations on the map
15 min.   Conclusion
TOTAL TIME 3 hours

Appendix 5.1.   Community´s Natural Resources sheet

RESOURCE MAPPING EXERCISE
Ban Tha Klang, Thailand. March 2010

Group names: _____

A. Think about the natural resources in your community. List at least 5 of them

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

B. Discuss with the other groups. Which other natural resources they identify?
_____

Appendix 5.2.   Causes of pollution sheet

DIAGRAM OF CAUSES FOR MANGROVE FOREST POLLUTION Ban Tha Klang, Thailand. March 2010 Name: _____	

A. Think about possible causes of mangrove forest pollution. List at least 5
 	
    1. _____
 	
    2. _____
 	
    3. _____
 	
    4. _____
 	
    5. _____
 	
    6. _____
 	
    7. _____
 	
    8. _____
 	
    9. _____
 	
    10. _____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____

B. Rank them according to which you consider is affecting most the mangrove forest loss. Use the columns on the right (1 for the most important, 5 for the less) C. Discuss with your group the causes you found out, which is for you the most important and why?	

Appendix 6. PRA´S ranking and seasonal calendar of livelihoods/incomes

TIME	ACTIVITY
	3. LIVELIHOODS RANKING
5 min	1. Introduction and logistic, plan for the day - Why are we here? Brief explanation of the days project work - Explanation of the ranking process
10 min	2. Identification of the village livelihood strategies *(all together)*
10 min	3. Individual exercise - *Distribution of the "Livelihood strategies forms"* - Ranking the livelihood strategies in the village
20 min	4. Converging the consolidated village ranking *(all together)* - The plenary group make a consolidated village ranking for the livelihood strategies - Discussion and summary of the reasons for the ranking
	4. SEASONAL CALENDAR OF INCOMES AND LIVELIHOODS
10 min	1. Call for draw the seasonal calendar - Brief explanation of what is a seasonal calendar - What do we want them to represent on it? Cash and non cash
30 min	2. Drawing the seasonal calendar *(all together)* - Main activities in the community all over the year - Representation of monetary/non monetary activities. Pictures of products obtained
15 min	3. General overview of the seasonal calendar, what does it mean? - Explanation by the villagers
15 min	4. Conclusion *(all together)* - Perceptions and opinions by the villagers - Thank you to participants by the team

Appendix 7. Seasonal calendar of livelihoods/incomes

Month / Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Livelihood **1.** _____												
2. _____												
3. _____												
4. _____												
5. _____												
6. _____												
7. _____												
8. _____												
9. _____												
10. _____												
Outcome												

Appendix 8. Questionnaire

Copenhagen University, Denmark
Faculty of LIFE Sciences
Ciro Dominguez, Frida Rohde, Jan Makurat and James Epilo
Kasetsart University Bangkok, Thailand
Andaman Coastal Research Station for Development
Kawalee PIANDEE, Yaowalak NETSING, Ratchadaporn
SUWANNALARP, Teerapat SRIHIRAN and Sittichai MANEERAT
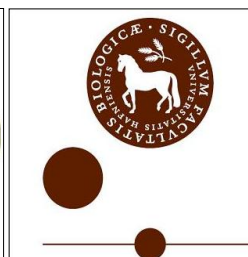
Questionnaire survey: „Sources of livelihood in Ban Phukaothong"
Ban Phukaothong, March, 2010

This questionnaire was realized by students from the University of Copenhagen, Denmark and Kasetsart University Bangkok, Thailand. The purpose is to obtain an overview about sources of income and livelihoods in Ban Phukaothong as part of the research project called "The effects of shrimp farming on mangrove forest and people's livelihood in Ban Tha Klang" under an interdisciplinary field course organized by both universities. Hence, we would like to speak to the head of the household or the representative and ask him/her about employments, incomes & livelihoods in each household. To answer all questions it will take you around 15-20 min.
- We really appreciate your effort and patience, taking part in this household survey.

Date: .3.2010	Time:	Interviewer/s:
Location:		

Personal information about head of household

Q1. **Name** (first name/s & surname/s):
Q2. **Gender** (please mark): ☐ Male   ☐ Female   Q3. **Age** (years):
Q4. **Origin:**   ☐ Ranong province   ☐ Other province   ☐ Other country
Q5. **Marital status**:   ☐ Single   ☐ Married   ☐ Widowed   ☐ Divorced
Q6. **Status in the family?**   ☐ Head of the household   ☐ Member of the family
Q7. **Size of household** (number of people living and eating daily at the same house/room like respondent):
Q8. How long have you been living in this village? ☐ 1-5 years   ☐ 6-10 years   ☐ 11-15 years   ☐ 16 years and above
Q9. **Level of education** (please mark): ☐ None ☐ Primary school ☐ Lower secondary school (up to grade 9) ☐ Upper secondary school (up to grade 12) ☐ College or university ☐ Other (please specify):
Q10. **Ocupation** (please mark): ☐ Fisherman ☐ Governmental official ☐ Merchant ☐ Private employment ☐ Farmer ☐ Other (please specify): _____ ☐ Casual laborer
Q.11. **Income** per household/month ☐ Less than 3,000 baht ☐ 6,001 to 10,000 baht ☐ 3,001 to 6,000 baht ☐ 10,000 above
Q.12. Do you have any loan? ☐ Yes ☐ No
Q.13. Do you have any debt?

☐ Bank for agriculture	☐ Village fund
☐ Bank	☐ Private sector
☐ Other (please specify)_____	

Q14. Does your family obtain a livelihood from the mangrove?   ☐ Yes   ☐ No

Q15. Which products do you get from the mangrove and what do you do with them?

Product	Purpose	Income (baths/week)
1. Aquatic products		
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
2. Timber products		
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
3. Non timber products		
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	

Q16. What other sources of income do you obtain outside the mangrove/what do you do with them?

Activity	Purpose	Income (baths/week)
1. Products outside the mangrove		
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
2. Sea fishing		
	☐ Selling ☐ Own consumption	
	☐ Selling ☐ Own consumption	
	☐ Selling	

	☐ Own consumption	
	☐ Selling	
	☐ Own consumption	
3. Farming		
	☐ Selling	
	☐ Own consumption	
	☐ Selling	
	☐ Own consumption	
	☐ Selling	
	☐ Own consumption	
	☐ Selling	
	☐ Own consumption	
4. Employment		
5. Shrimp farming		

Q17. Do you or your family know that there is a conservation group in the village? ☐ Yes ☐ No

Q18. Do you or your family take part in the mangrove forest conservation group? ☐ Yes ☐ No

Q19. If you are, what do you do?

    ☐ Executive committee   ☐ Participant (non member)

    ☐ Member   ☐ Supporter

  Other (please specify) _____

Q20. How often do you participate in the mangrove forest conservation group activities?

    Weekly _____   Monthly _____   A year _____