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## Comparing mangrove forest management in Hai Phong City, Vietnam towards sustainable aquaculture

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### Abstract

This study examined the driving forces of mangrove change and compared mangrove forest management mechanisms in coastal districts in Hai Phong city, Vietnam. Survey data was used to ascertain the driving forces of mangrove change. The market price approach was used to analyze how local people responded to mangrove forest conservation. The results indicated that implementation of mangrove management instigated by the authorities, community or local people has affected mangrove change. The main driving factor of mangrove degradation in Hai Phong was over expansion of shrimp aquaculture. In Trang Cat commune, Hai An district, the average size of shrimp ponds where expansion was controlled by the local people, was 12.81 hectares. This number was over 53 times higher than in Bang La commune, Do Son district, which was mainly converted from salt ponds. Extensive aquaculture in the former case was the main method of farming which provides low net benefits while the improved shrimp culture in the latter case brings higher net benefits. Mangrove plantation programs funded by the Japanese organizations helped the poor guarantee their lives in Bang La. In Trang Cat, the poorer households would like to participate in mangrove conservation more than richer families. Nevertheless, the upper and rich families in Bang La engaged in mangrove plantation programs did more extensively than the middle and the poor did. Mangrove rehabilitation programs in Bang La have been successfully conducted on account of community-based forest management in cooperation with local authorities. The failure to convert shrimp ponds from mangrove forests was clearly recorded in Trang Cat. This commune needed to replant mangrove in abandoned shrimp ponds and follow the mangrove management mechanism in Bang La.

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## 1. Introduction

### 1.1. Background

Mangroves play a vital role in defending against the impact of tropical cyclones and protecting dyke systems. The most obvious evidence is from the Indian Ocean tsunami in Dec, 2004 [1]. Mangrove forests have contributed significantly to the socio-economic lives of coastal dwellers [2]. Rapid economic growth and population pressure have resulted in severe depletion of mangrove forest in the world. Exploitation of tree resources, conversion of mangrove areas to shrimp and mud crab ponds, agricultural use, salt pans and human settlement have contributed to the loss and degradation of mangrove resources [2, 3].

Hai Phong is located on the Northern coast of Vietnam, where the mangroves are distributed within zones I and II among four mangrove zones in Vietnam [2]. This city is vulnerable to rising sea level and big storms associated with climate change. Mangrove conservation and management has been implemented in the city; however, weak policies and practices have led to mangrove deforestation and degradation. An understanding of mangrove change is crucial for coastal environmental management towards sustainability.

The objectives of this research were to examine the driving forces of mangrove change in Hai Phong city and compare mangrove conservation and management mechanisms among coastal districts in Hai Phong. Secondary and primary data were collected during the fieldwork in July and August 2011. We used the market price approach [4] to analyze how local people in the coastal communes rely on mangrove forest and statistical analysis to understand their awareness about mangrove restoration programs in the study site. Finally, we also proposed better mangrove management mechanism to obtain sustainable shrimp culture and guaranteed local livelihoods.

### 1.2. Study site

Hai Phong is located between 20°30' to 20°01' N latitude and 106°23'to 107°08' E longitude. This city belongs to the Northern coastal zone of Vietnam and lies within the tropical monsoons belt of Asia. It borders Quang Ninh province to the north, Hai Duong province to the west, Thai Binh province to the south, and the Gulf of Tonkin to the east. It is about 120 km from the capital Hanoi. The length of the sea coast of Hai Phong is 125 km including the length of coast surrounding the offshore islands.

Hai An and Do Son are urban coastal districts of Hai Phong city. There are eight communes in the former district and seven communes in the later district, of which mangrove forest are found mainly in Trang Cat commune, Hai An district and Bang La commune, Do Son district. There are many similarities between the two districts. In 2002, Hai An was separated from the An Duong suburban district and became one of seven urban districts of Hai Phong following National Decree 106/CP while Do Son became an urban district in 2007, following National Decree 145/CP. The population of Hai An was about 103,300 and 46,200 in Do Son district in 2010.

There were some mangrove plantation programs supported by both international funding agencies and the State undertaken in the two districts in particular and in Hai Phong in general. The Japanese Red Cross (JRC) was the main international organization taking care of mangrove plantations program in

these districts [5]. The 327 program was a national afforestation program related to mangrove plantation on bare land and coastal sand in order to reduce poverty and promote fixed cultivation and sedentarization.

## 2. Methodology

### 2.1. Sampling and data collection

We selected two typical communes from two coastal districts that have similar mangrove rehabilitation programs funded by the State and international organizations mainly the Japanese Red Cross and the ACTMANG. Primary data was obtained from interview with local people and key informants as well as group discussion. The sample size for the in depth interview, we selected randomly from 34 households in the former commune and 36 households in the latter commune based on different social well-being: rich, middle and poor families.

We conducted a survey during July and August 2011 and interviewed the chairpersons of the People's Committee in Trang Cat and Bang La.

### 2.2. The market price approach

In wetland, many researches used the market price method to estimate direct use value. In Vietnam, Tuan also applied this method for a wetland case study in Thua Thien Hue province [4]. The direct use values from local households include aquaculture, agricultural products, and sea grasses collection. In addition, on the coast not only direct use value from wetlands but also other direct values sources were taken into considerations such as: labor hire, handicraft, livestock raising, tourism services, and cultivation. Market prices are utilized to calculate the generated gross income when the products are sold in the market. In this research, we used the market price method to compare the differences in direct use values between the two communes. This research analyzed the direct use values in the coastal zone derived from aquaculture which is a key economic activities currently occurring in the coastal districts of Hai Phong. However, due to time and budget constraints, this research does not include indirect use value and non-use values of the coastal wetlands.

In this research, we assessed direct use value of aquaculture [6] for two coastal communes based on various criteria [4]:

Cost of production (C) refers to the sum of the costs that households paid in order to obtain aquaculture. These costs include direct cost (DC) and cost of borrowing money  $i$ :  $C = DC + i$

The former costs, which households paid in cash, were for purchasing material, breeding shrimp and fish annual pond maintenance, labor hire, taxes, and other cost, were based on market prices (in the year 2010: 1\$ = 18,000 VND).

The latter cost refers to interest rates on loans that households' borrow from the banks and other borrowing sources.

Benefit (Bs) are calculated by multiplying quantity or productivity of aquaculture with the market price (P)

$$B = Q * P$$

Net benefits (NBs) can be calculated following the equation:  $NB = B - C$

### 2.3. Statistical analysis

The questionnaire data were analyzed by Microsoft Excel as well as compiled and coded using the Statistical Package for Social Sciences software (SPSS) version 16 after checking, verifying, correcting, and coding information.

Descriptive statistics were used to describe characteristics of the current situation of local people. For in depth interview results, we also used description statistics to analyze household income sources and the relationship between aquaculture and mangrove change.

### 3. Results

#### 3.1. Direct use value of aquaculture

Aquaculture farming in the study area included shrimp mainly tiger prawn (*Penaeus monodon*), sea crab (*Scylla paramamosain*), and brackish fishes including *Latescalcarifer* and *Oreochromis niloticus* as well as seagrasses (*Gracilaria spp.*). Extensive and improved extensive shrimp farms were the main types of aquaculture in the study area.

Table 1 compares the average shrimp pond size per household of aquaculture farming types. On average, the shrimp pond size per household in Trang Cat commune was 12.81 ha. The same situation occurred in Northern Vietnam. Pond size in the North where they used the tidal cycle to feed shrimps and sea crabs were huge and larger in the South [7]. Pond size in Trang Cat commune was fifty three times higher than that of Bang La commune. The pond size in Bang La was tiny with only 0.24 ha per household on average (Table 1)

Table 1. The average size of ponds per household (ha/household).

Households	Min	Max	Mean	Std	No. of Obs
Trang Cat	1	50	12.81	14.09	34
Bang La	0.07	1.08	0.24	0.23	36

Source: Survey, August 2011

Shrimp pond area was one of the main driving factors leading to the loss and degradation of mangroves in the study area. Local people in Trang Cat mad their own shrimp ponds. Shrimp and sea crab ponds were located outside the dykes system and close to the sea or river mouths where mangrove found. Mangrove areas were converted to shrimp aquaculture by local people. In contrast, the tiny shrimp ponds in Bang La were converted mainly from salt ponds. According to interviews with headmen of the People's Committee and an in depth interview with the local people, in order to use aquaculture ponds, people in Bang La have to pay a yearly tax of 20,000 VND per 360m<sup>2</sup> while people in Trang Cat did not have to pay any tax.

Moreover, shrimp ponds in Trang Cat have utilized an extensive farming method while people in Bang La used the improved-intensive farming method. In extensive farming, breeding sea crabs and shrimps were purchased in the market and then bred in February following the lunar calendar. After about 4 months of feeding for shrimp and 5 months for sea crab, they can be harvested and sold to the markets. In extensive shrimp aquaculture, water was exchanged based on the tidal cycle. The flows also provided natural food for feeding sea crabs and shrimps as well as seaweed [7]. In order to establish the extensive farming system, each household has to construct their own sluices. The cost was about 100,000 thousand VND.

On the other hand, people in Bang La due to the limited area for aquaculture, have to use the improve extensive farming method. In this farming system, shrimps and sea crabs or fishes are fed by extra food.

According to the interviews with local people, the most suitable extra food for feeding shrimp and sea crab was *Corbicula spp.* while small fishes were used for feeding brackish fish *Latescal carifer*. In some households, industrial food was also used to feed shrimp and sea crab.

Table 2. Direct use value from different aquaculture types per hectare between two communes in 2010 (VND).

Commune	Type of aquaculture	Method of farming	Benefits	Production costs	Net benefits
Trang Cat	Shrimp	Extensive	16,935	4,233	12,702
	Fish	Extensive	3,074	0	3,074
	Sea crab	Extensive	7,429	5,833	1,592
	Sea grass	Extensive	21,222	0	21,222
Bang La	Shrimp	Improved extensive	96,092	54,583	41,509
	Fish	Improved extensive	147,406	88,556	58,850
	Sea crab	Improved extensive	124,930	64,722	60,208
	Sea grass	None	-	-	-

Source: Survey, August 2011

Net benefits from extensive farming in Trang Cat commune were very low in 2010. In other words, shrimp culture was ineffective. According to the in depth interview with households, the main reason was that water quality had deteriorated through pollution since in Trang Cat has an open dumping station for collecting municipal solid waste. Many households in 2010 did not get any benefits from aquaculture activities.

On the other hand, improved extensive farming in Bang La can provide higher benefits than extensive farming in Trang Cat despite a higher investment in shrimp farming. However, due to the huge pond size in Trang Cat, people in general can earn more money than people in Bang La. That was the main reason why aquaculture has contributed significantly to the total household income in Trang Cat commune (Table 3). Nevertheless, in Bang La since the size of the ponds are much smaller than in Trang Cat, aquaculture was not the main income source.

According to the interview with local people in Bang La, their shrimp ponds were converted from salt ponds during the period 1998-2003. Moreover, some areas remained fallow since all the salt ponds could not be converted to shrimp aquaculture and salt processing was not able to provide enough income for local livelihoods.

Table 3. Sources of household income in the two communes in 2010 (thousand VND).

Households	Min	Max	Mean	Aquaculture (%)	Agricultural activities (%)	Services (%)	Others (%)
Trang Cat	1,000	25,000	6,263	77.2 %	0%	17.5%	5.3%
Bang La	1,000	10,000	3,398	40.3%	24.4%	6.1%	29.2%

Source: Survey, August 2011

Our research showed that during the year 2010, there were significant differences in terms of average income per month and its sources between the two communes. In Trang Cat commune, Hai An district, the average money income in 2010 was about 6.3 million VND while this figure was approximately 3.4 million VND in Bang La commune, Do Son district. In addition, the maximum monthly income in the former commune was two times and a half higher than that of the latter commune. The numbers

represented considerable differences among the rich, the middle, and the poor classes between the two communes.

Moreover, the main income source from aquaculture activities accounts for over 77% of the total in Trang Cat. This figure was nearly twice higher than in Bang La. Nevertheless, agricultural activities play a rather important role in Bang La with 24.4% while in Trang Cat these activities did not provide any household income. According to the interviews with local people in Trang Cat, spinach cultivation was undertaken; however, this spinach was only for their consumption. Noticeably, in Bang La many people work as hired labour. The people, who worked as hired labour in Trang Cat, on the other hand, were mainly poor people since they could not borrow money from the banks to do aquaculture.

### 3.2. Participation in mangrove plantation program

According to interviews with chairpersons of the People's Committees in five coastal districts in Hai Phong, international organizations fully supported the mangrove plantation programs via technical advice and wages for hired labor. Each person involved in planting activities received 50,000 VND as a wage from the NGOs. They also provided seedlings of different mangrove species.

Table 4. Households' participation in mangrove plantation program.

Commune	Numbers of HHs	Plantation Programs	Involved		Not involved		Don't know	
			No	%	No	%	No	%
Trang Cat	34	JRC, 327	16	47%	15	44%	3	9%
Bang La	36	JRC	19	53%	17	47%	0	0%

Source: Survey August, 2011

Household participation in mangrove restoration was shown in Table 4. There were significant differences in terms of household participation family in mangrove plantation activities between the two case studies. In Trang Cat where mangrove degradation the percentage of interviewed households participating in mangrove restoration was less than in Bang La. Moreover, it was also interesting to note that 47% of the interviewed households comprised of the poor and the middle families in Trang Cat accounting for half the total. Our survey results were similar to Isra S. and Suthawan. The poorer households would like to participate in mangrove conservation more than richer households [11]. On the other hand, in Bang La where mangroves have been well protected, the numbers of upper and rich families engaged mangrove plantation programs were higher than those of the middle and the poor. The poor families in Bang La were more dependent on mangrove forest since they receive more benefits from mangrove forests. They tended to participate less in the restoration activities [11].

According to interviews at the two communes, it was notable that in Trang Cat case study, there were three families who did not know that mangrove plantation programs took place in the communes whilst all interviewed households' in Bang La understood clearly the objectives of mangrove restoration funded by the Japanese Red Cross (JRC). Many interviewees in Bang La felt very happy since an international organization helped the commune plant mangrove to defend against tropical cyclones and they feel safe when the stormy seasons come.

### 3.3. Comparing mangrove forest management mechanism

There were different types of management mechanisms for mangrove forest in Hai Phong City. Some coastal districts including Do Son and Kien Thuy established community-based forest management after

mangrove plantation programs took place. In two coastal districts, according to the interview with chairpersons of the People Committee's, they also have guard teams who were responsible for taking care of mangrove forests. Every year, the groups have received support funds from the central government of about 100,00VND per hectare. In Bang La commune, Do Son district, the Japanese Red Cross constructed a house for the security group. On the other hand, in other coastal districts, there was no mangrove management mechanism. Trang Cat commune, Hai An district is a typical example. Half of interviewed families said that mangrove forest has been managed by themselves and many household do not know who is responsible for mangrove management (Table 5).

Table 5. Mangrove management mechanisms of the two coastal communes.

Commune	Number interviewed HHs	Local Authority		Local People		Community based forest management		Don't know	
		No	%	No	%	No	%	No	%
Trang Cat	34	8	24%	16	47%	0	0%	10	29%
Bang La	36	21	58%	0	0%	15	42%	0	0%

Source: Survey August 2011

In this research, we examined the awareness of local people about mangrove management. Results on the awareness of local people about management of mangrove were shown in figure 1 and 2.

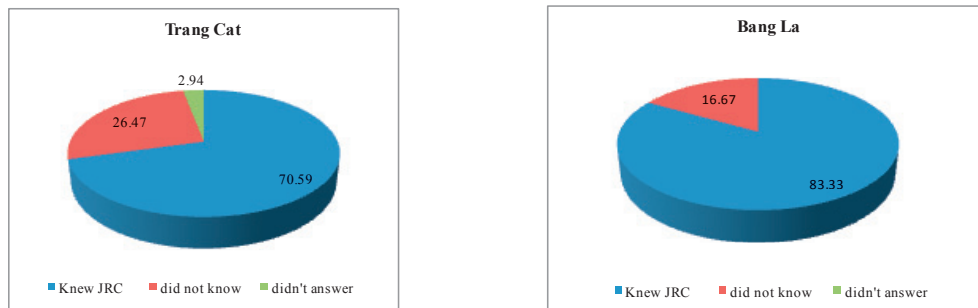


Figure 1. Awareness of local people about mangrove plantation programs in the two communes.

Figure 1 shows the percentage of interviewed people's awareness about the mangrove plantation program mainly funded by the JRC (Japanese Red Cross) between the two communes. In Trang Cat, approximately 70.6% of interviewed people knew about the rehabilitation programs. This figure was roughly 12.7% less than that of Bang La's number. On the other hand, the percentage of interviewed local people who did not know about mangrove restoration in the former commune was 9.8% higher than that of the latter commune. On interviewed person accounting for 2.94% did not answer the question when we conducted the field survey in August 2011. There was a different response between local people at the two communes regarding their awareness of the role mangroves play in their livelihoods (Fig 2).



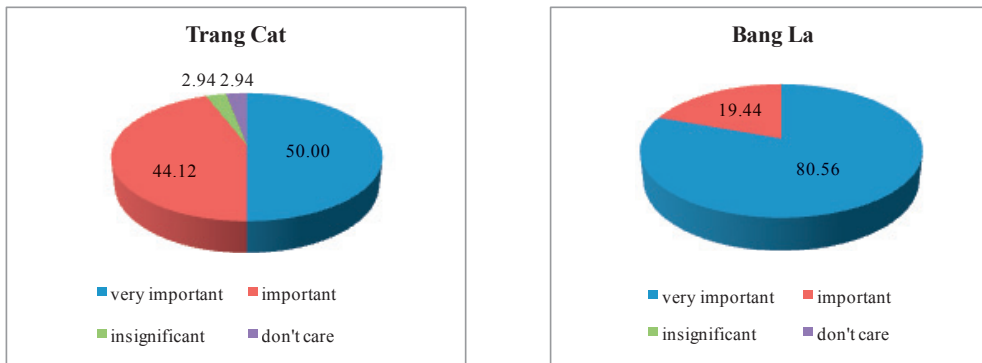


Figure 2. Awareness of local people about the role of mangroves.

In Bang La where mangrove has been well protected, all interviewed families responded positively to the roles of mangrove forest and over 80% said that mangrove is very important for their livelihood and to defend against tropical cyclones and the rest of the interviewed households said that it was important. Thanks to mangrove forest, in recent years their commune has been well protected from typhoons. In 2005, three big storms hit the Northern coast of Vietnam; there was no damage in forested mangrove areas. In Trang Cat commune, half of interviewed families agreed mangrove forests play a vital role in their livelihoods and over 44% thought they were important. Nevertheless, two families accounting for 5.9% did not care about the role of mangroves. Due to mangrove destruction in Trang Cat, when the typhoons hit in 2005, all shrimp ponds were devastated and many households who owned shrimp aquaculture farms fell deeply in debt; they had to borrow money from the bank to re-start their aquaculture activities.

**4. Recommendations towards sustainable aquaculture**

*4.1. Policy implications for sustainable shrimp culture*

Based on our findings, it is clearly seen that the conversion of mangrove areas to shrimp aquaculture, mainly tiger prawn (*Penaeus monodon*) has occurred in coastal districts in Hai Phong, particularly in Trang Cat commune, Hai An district.

In order to control the expansion of shrimp aquaculture in mangrove forests in Hai Phong and manage sustainable shrimp culture, it is necessary to establish policy and management practices in line with the following criteria [8]:

1. Co existence of mangroves with shrimp farming

The ratio of mangrove area to pond area is 7:3. There is no doubt that mangroves are essential for sustainable shrimp farming. In reality in Hai Phong, shrimp productivity was great in the first year but later decreased where shrimp ponds did not have any mangrove.

2. Development of eco-tourism

This approach follows the suggestion of UNESCO. A typical successful case can be found in the Southern part of Vietnam in Can Gio mangrove biosphere reserve. It was adopted by UNESCO in 2003 [3].

3. Issuing land use certificates (*Red Book*) to households who are involved in aquaculture and fishery activities following proper policy [9].



4. Community based forest management needs to be extended [9] to all coastal districts and follow the practices of successful operations such as in Dai Hop commune, Do Son district.

#### *4.2. Recommendations for sustainable shrimp culture coexistence with mangrove*

Economic analysis, based solely on economic returns from shrimp culture showed that farming systems with a mangrove coverage of 30-50% of the pond area gave the highest annual economic returns [10]. According to Binh [10], this is a better economic return for farmers who maintain mangroves in their farming systems.

The silvofishery approach combines mangrove planting with diversified aquaculture. This means that mangroves are planted surrounding the shrimp ponds providing a more natural habitat, which in return also attracts wild shrimp to come into the pond. Species diversification leads to a more varied income. Furthermore, the mangroves provide a barrier for coastal protection and a habitat for other animal species.

Expansion of shrimp aquaculture in Hai An district without permission from the central government has to be prohibited. Mangroves should be replanted in the abandoned shrimp ponds.

The remaining mangrove area should be designated as conservation and economic zones. Moreover, community based forest management should be established in both the economic and conservation zones [6] in other coastal districts in Hai Phong beside the successful cases in Bang La, Do Son. Importantly, the community mangrove forests should be co-managed by the government and the local community. An effective co-management strategy is required for the active involvement of coastal community organizations and will allow the representatives of such organizations to have the right to make decisions in terms of management plans and regulation needed in the use of mangrove resources [11]. In Bang La, Do Son the co-management between community-based mangrove forest management and local authority is a typical example of success.

Finally, the government has to provide technical, educational and financial support for local community organizations joining in management activities of mangrove forest [6]. The case study in Hai Phong illustrated that the support funds from the central government for local community organizations such as the guard groups need to be taken into consideration. Up to now, the guard teams at these two coastal districts including Do Son received small support funds from the central government. The amount of money is not enough to support each member of the guard group as a salary. Therefore, the central government has to consider the current situation in Hai Phong. Compared with the guard team at Can Gio mangrove biosphere reserve, the salary is five times higher than the team at Hai Phong. The salary increased significantly from 185,000 VND to 316,000 VND; and then the figure reached 445,000 VND per hectare in 2006 [12].

## **5. Conclusions**

Over expansion of aquaculture is the main driving factor of mangrove deforestation and degradation in Hai Phong. Trang Cat commune, Hai An district is a typical example where the average size of shrimp ponds, was approximately 12.81 hectare. This number equals over 53 times higher than that in Bang La, where shrimp ponds were mainly converted from salt ponds. Expansion of shrimp aquaculture in Hai An district without permission from the central government has to be prohibited.

Extensive aquaculture in Trang Cat is the main method of farming that provides low net benefits while the improved shrimp culture in Bang La brings higher net benefits. Mangrove plantation programs funded mainly by Japanese organizations can help the poor guarantee their lives in Bang La. In Trang Cat, the poorer households would like to participate in mangrove conservation more than their richer families.

Nevertheless, in Bang La the upper and rich families engaged in mangrove plantation programs more often than those of the middle and the poor families did. The poor families in Bang La were more dependent on mangrove forest.

Mangrove rehabilitation programs in Bang La have been successfully managed thanks to community-based forest management in cooperation with local authorities. The failure of converted shrimp pond from mangrove forests is recorded clearly in Trang Cat. This commune needs to replant mangrove in abandoned shrimp ponds and follow the mangrove management mechanism practiced in Bang La.

The government has to provide technical, educational and financial support for local community organizations joining in management activities of mangrove forest. The central government has to consider the current situation in Hai Phong and should pay more attention on the support funds from the central government for local community organizations such as the guard groups.

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