

A PARTICIPATORY APPROACH: KEY TO SUCCESS IN MANGROVE MANAGEMENT IN PREDNAI, EASTERN THAILAND

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Abstract

Mangrove ecosystems generate significant goods and services to coastal communities and associated species. However, they have been destroyed at alarming rates over the past few decades worldwide. High population pressure has led to the conversion of many mangrove areas to other uses, including aquaculture, human settlement, tourism infrastructure, salt extraction and industrial development. The temporal changes in mangrove structure and function from 1980s through 2008 in a case study of Prednai, Eastern Thailand were analysed using a framework of “Driver-Pressure-State-Impact-Response” (DPSIR). The results show that mangrove degradation in this area increased substantially over the past three decades and it was correlated with a decline in mangrove function. The extraction activities of logging and intensive shrimp aquaculture were major drivers of mangrove loss. A community resource management scheme initiated in response to the ecosystem degradation was able to improve the mangrove areas. It has demonstrated that the participatory process in natural resource management is an appropriate way to manage the Prednai mangrove forest. The Prednai community conservation effort not only resulted in mangrove recovery, but also contributed to biodiversity conservation, poverty alleviation and sustainable livelihoods as a whole.

Introduction

Mangroves provide a unique and valuable range of resources (Bandaranayake 1998) as well as economic and environmental services to millions of people, as shoreline protection, source of food, pharmaceuticals, and livelihoods along with tourism and recreation (Barbier 2003; Department of Marine and Coastal Resources 2007a). Traditionally, coastal communities collected firewood, harvested fish and other natural resources (Global Nature Fund 2007; Huitric *et al.*, 2002) but in recent decades many coastal areas have come under intense pressure from cumulative effects of natural and anthropogenic causes (Barbier and Cox 2002; Gilman *et al.* 2006), compounded by inadequate and/or ineffective legal and institutional arrangements (Heutric *et al.* 2002).

Mangroves have been overexploited and converted to various forms of land use, including agriculture, aquaculture, salt ponds, tourist resorts, urban and industrial development (McLeod and Salm 2006). Studies have shown that the largest factor of mangrove degradation in recent years has been the expansion of aquaculture ponds into mangrove forests (Aksornkoae *et al.* 2004; Barbier and Cox 2002). Despite a severe collapse of shrimp farming industry in 1987 due to disease and pollution, the industry has spread to most of Southeast Asia and parts of Latin America and Africa (Flaherty and Karnjanakesorn 1995; Kautsky *et al.* 2000). Since 1991, Thailand has been the world’s leading producer and exporter of shrimp, exporting up to 90% of its production (Kongkeo 1995; Barbier 2003).

The existing mangrove forest of Thailand can be found mainly on the coast of the Andaman Sea and the Gulf of Thailand (Sudara 1999) covering approximately 50% of the total coastline (Aksornkoae 2000). During 1979 and 1993, Thailand lost 75% of its total mangrove forests

and 16 to 32% of which was attributed to shrimp aquaculture according to Dierberg & Kiattisimkul (1996).

In this research, the community of Prednai, Trat province in eastern Thailand was selected as a case study. The village has been occupied over a hundred years with a current population of just under 600 inhabitants. Many of the villagers depend exclusively on the local mangrove forests for their livelihood. In late 1970s charcoal concessions in mangrove forest were granted to outside investors and within a few years mangroves were overharvested and converted into shrimp farms (Department of Marine and Coastal Resources 2007a). The community of Prednai responded to these problems by forming a conservation group in order to put a stop to the logging concessions and intensive shrimp aquaculture thereby established their use of mangrove forest. The conservation group was financially supported and operated by villagers themselves. Their conservation efforts have resulted not only protecting existing biodiversity, but also regaining many previously displaced native fauna such as species of wetland birds (e.g. *Mycteria leucocephala*, *Porphyris poliocephalus*, *Ardea purpurea*, *Ardea cinerea*, *Dendrocygna javanica*, *Haliastur indus*) and monkeys (e.g. *Macaca fascicularis*) (Department of Marine and Coastal Resources 2007a; RECOFTC 2007).

Data was collected from various sources including Department of Marine and Coastal Resources (DMCR), Department of Fishery (DOF), Royal Forestry Department (RFD), Office of Environmental Policy and Planning (ONEP) as well as electronic journals. In-depth interviews were conducted with key informants. In order to maintain the anonymousness, information gathered from them will be cited in this paper as 'interview data'. The collected data was analysed within the context of DPSIR framework as a means of understanding the interrelationships among the different types of indicators. The past and current issues were investigated in order to recommend the most efficient and effective management of mangrove regarding ongoing situation and future challenges in Prednai.

The Driver-Pressure-State-Impact-Response (DPSIR) framework

The DPSIR framework was developed by the European Environment Agency. It is being suggested as an advantageous method to define cause-effect relationships between interacting components of social, economic, and environmental systems. The framework highlights the connection among the causes of environmental problems, their impact and the society's response to them in an integrated way (EEA 1999).

The five elements constituting the causal DPSIR chain are: *Driving forces* of environmental change which constitute the underlying causes and origins of pressures on the environment; *Pressures* which describe the variables which directly cause (or may cause) environmental problems; *State* which shows environmental conditions; *Impacts* on population, economy and ecosystems which describe the ultimate effects of changes of state in terms of damage caused; and *Responses* which demonstrates the efforts of society to solve the problems (Jorge *et al.* 2002).

The case study of Prednai, Eastern Thailand

Physical Characteristics

Prednai mangrove forest is situated in between Latitude 12° 11' 27" to 12° 06' 30.83" north and Longitude 102° 27' 18.15" to 102° 32' 11.62" east in Trat province, near the Cambodian border of Thailand (Figure 1) (Department of Marine and Coastal Resources 2007a). Land-use types in the region depend upon the elevation and distance from the sea. Rubber

plantation can be found in the highest elevation, followed by houses amongst fruit orchards and fish farms in the inter-tidal zone.

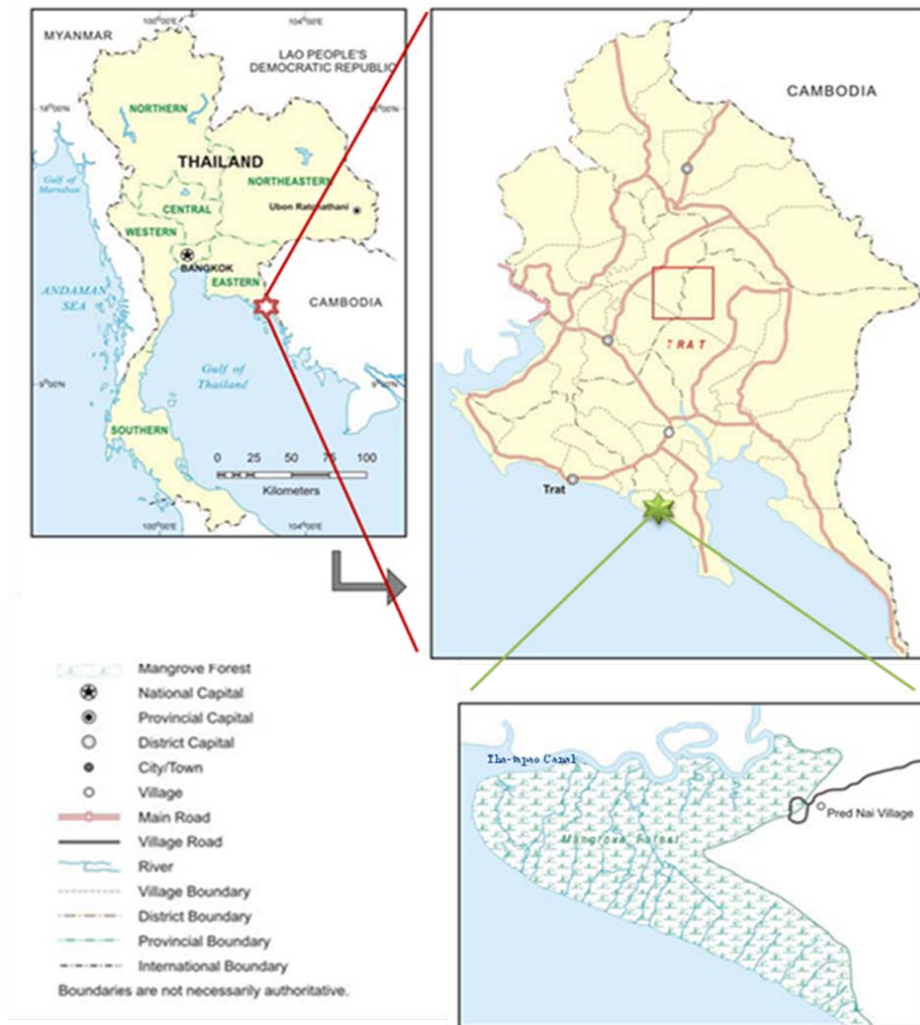


Figure 1 Map of Thailand showing the location of Trat and Prednai mangrove forest.

Socio-economic Characteristics

The major occupation of local residents of Prednai is agriculture, orchards, fisheries and daily wage laboring. For coastal residents, mangrove forests offer dependable, basic livelihoods and sustain their traditional cultures. Fishery products come from the mangrove canals in the form of fish, crabs, natural shrimp farms and fish ponds. Most products are directly sold to an intermediary but some are marketed by the community themselves. An average villager's income is 34,274 Baht/year (US\$991/year). Examples of traditional land-use types of Prednai are displayed in Figure 2.

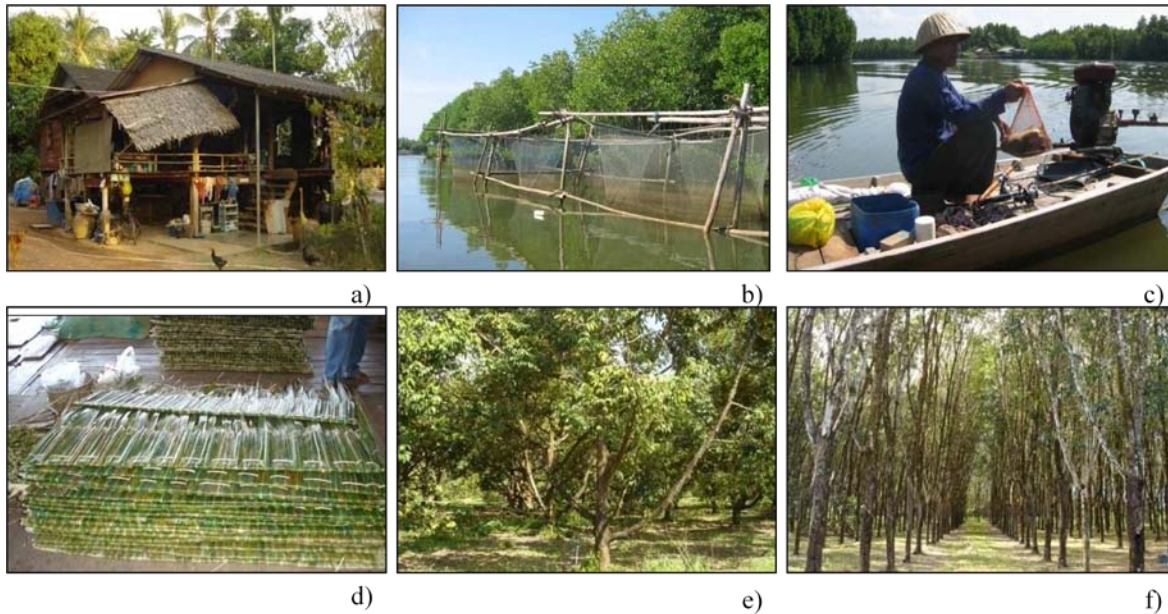


Figure 2 Traditional land-use types of Prednai coastal communities.

- a) Local housing with mangrove products
- b) and c) Local fisheries in mangrove canals
- d) Nipa shingles for roof and wall construction
- e) Fruit orchards
- f) Para rubber plantations

Mangrove Species Distribution

Mangrove communities often have clearly-defined shore parallel zones. Each zone is likely to be dominated by one particular tree species which has adapted to specific environmental characteristics (i.e. tidal changes, elevation of the land, and salinity of the soil and water) (Lee 2008). Each species along the gradient has competitive advantages which becomes a controlling factor in the pattern of zonation (Department of Marine and Coastal Resources 2007a).

Prednai mangrove forest is dominated by species of *Rhizophora sp.*, *Avicennia sp.* and *Bruguiera sp.* Along the shoreline with muddy sandy soil and frequent inundation by high tide, *Avicennia sp.* are dominant species. *Rhizophora sp.* are mainly found along the canals in thick mud flats with inundation by high tides. Inland or drier and more elevated sites are comprised of different species mainly *Ceriops tagal* (Figure 3) (Department of Marine and Coastal Resources 2007a; RECOFTC 2007).

Cause-effect analysis within the context of DPSIR

The diagram below illustrates cause-effect-response relationships between social, economic and environmental components of mangrove ecosystem in Prednai within the DPSIR framework (Figure 4).

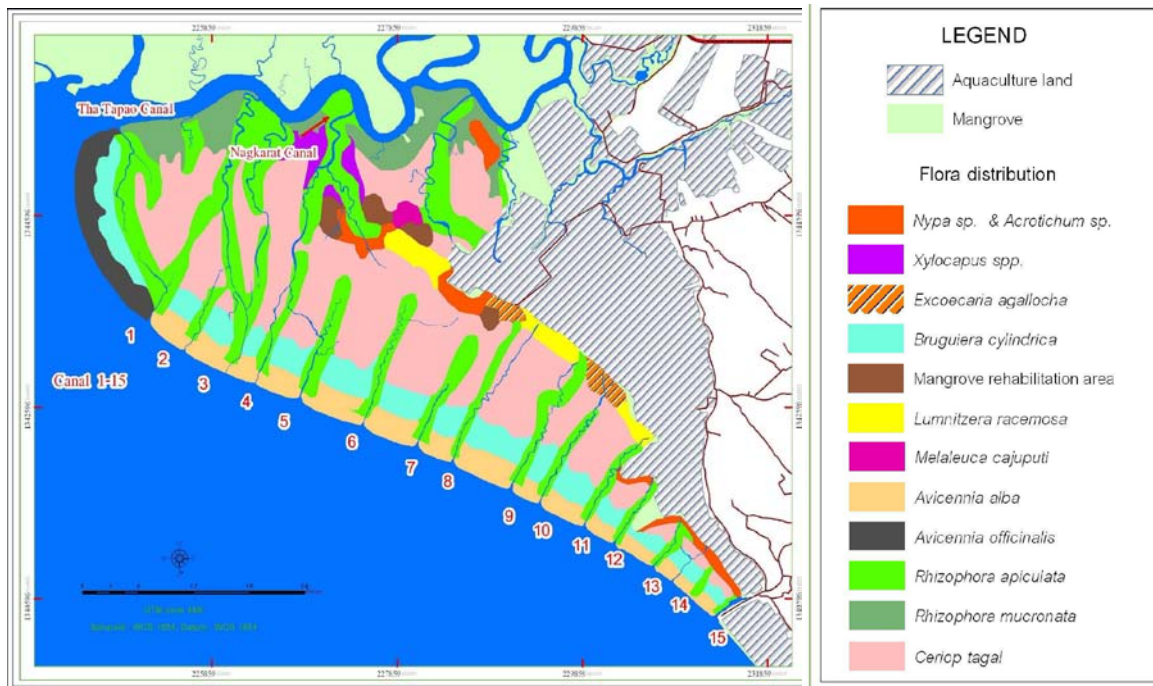


Figure 3 Distribution of flora species in Prednai mangrove forest. (Source: Department of Marine and Coastal Resources 2007a)

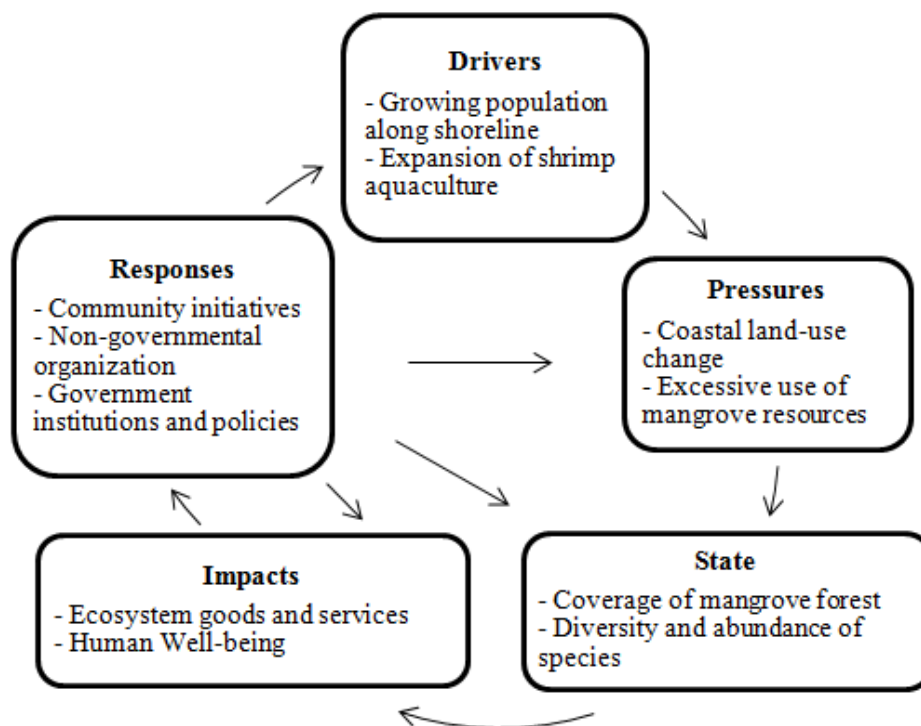


Figure 4 Cause-effect analysis according to DPSIR framework in the context of mangrove resources in Prednai.

Driver

1. Population along Shoreline

In Trat province, the population experienced a dramatic increase from 66,328 in 1960 to 221,904 in 2000 (Figure 5). Areas of mangrove forests have been replaced by other activities in order to serve high demands of the increasing population. Even though the average growth rate slows down between 2000 and 2007, various anthropogenic activities along the coasts continue to play an important role in national economic development and placed coastal areas under intense pressure, resulting in the accelerated degradation of mangrove ecosystems.

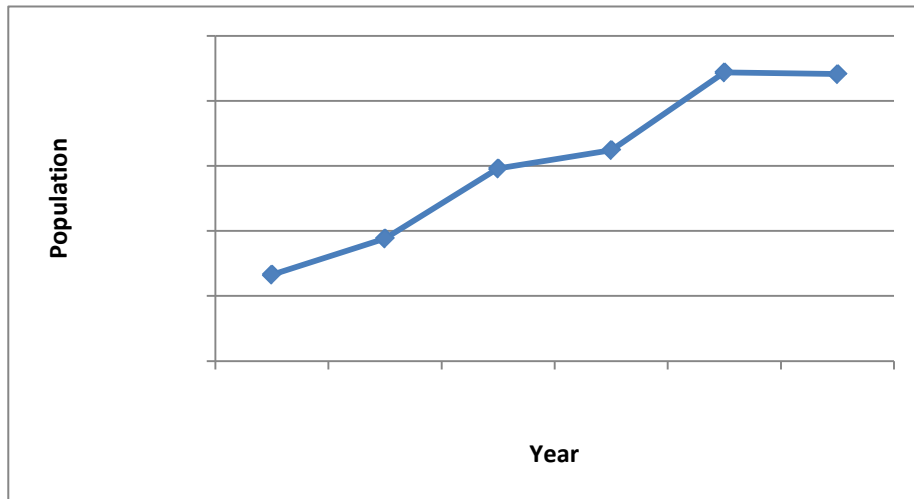


Figure 5 Changes of Population in Trat Province during 1960-2007.

2. Expansion of Shrimp Aquaculture

The long coastline and tropical climate provide ideal conditions for year-round shrimp culture. As a result that shrimp culture gave the good benefit and harvested production in short time, intensive farming has rapidly increased in terms of number of farms, area, output and therefore inevitable environmental problems (Pongthanapanich and Roth 2006).

The number of shrimp aquaculture farms in Trat increased from 5 farms in 1980 to 1,008 farms in 1995, then slowed down in late 1990s due to the economic crisis (National Economic and Social Development Board 1998), the outbreak of disease, lack of wild broodstock (Kittiwanich 2000) and international trade conflicts (Ruangpan 2008) as well as the increased mangrove conservation efforts across the country.

Pressure

1. Coastal Land-Use Change

The coastal areas along the Gulf of Thailand and Andaman Sea previously covered by mangroves have now been turned into various types of land use (Sudara 2000). Data from the Office of Environmental Policy and Planning revealed types of land use in mangrove forest area in 1996 as; concession for mining, harbor, illegal occupation for aquaculture, residential area and other uses. Illegal occupation for aquaculture is found to be the major activity.

Prednai community initially relied upon rice cultivation in the lowlands and fruit and rubber plantations upland for its principal economic activities, as well as livelihoods supplemented by harvest of mangroves resources (RECOFTC 2007). After the partial destruction of their

local mangrove forest and the establishment of large industrial shrimp aquaculture operations, most villagers converted their former rice fields to intensive shrimp aquaculture operations. An expansion of shrimp aquaculture concurrent with an ongoing decrease of mangrove coverage can be seen in Figure 6. In late 1990s, the mangroves started recovering due to the Prednai mangrove conservation effort. The seawater gate which had been used to block seawater for intensive shrimp farming was destroyed, the commercial logging stopped and the companies were ousted from the village. Shrimp aquaculture in the mangrove forest was no longer operated (interview data).

In the same year (1998), the Thai government set up a plan to re-establish the “Made in Thailand” brand worldwide as a symbol of quality and safety. The Code of Conduct (CoC) was launched to implement an environmentally responsible management system. In 2001, the Good Aquaculture Practice (GAP) standard was introduced and practiced by shrimp farms. According to the organic system, the environment becomes naturally fertilized; farmers are willing to comply and learn how to control the quality of shrimp under the Thailand Organic Standard. As a result, shrimp farming returns to play a role in the national economics once again (Ruangpan 2008).

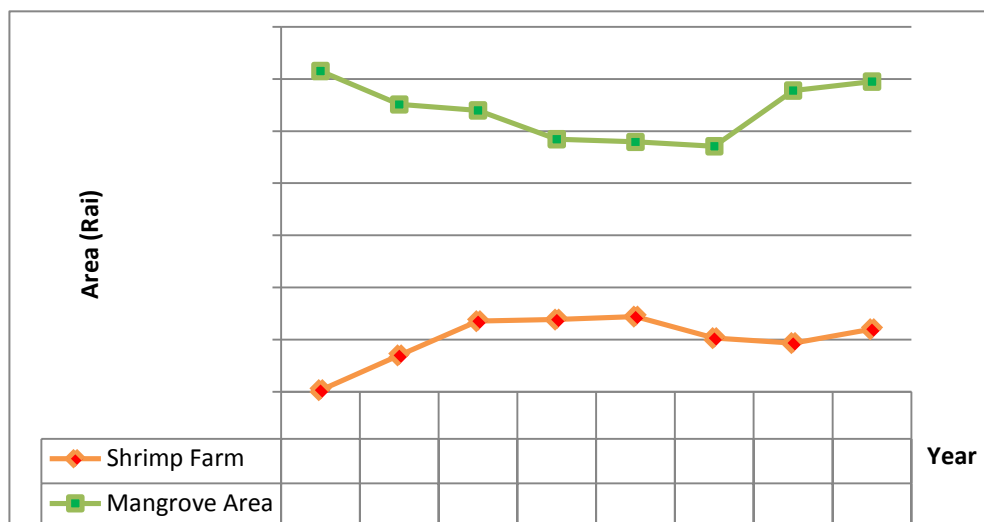


Figure 6 Areas of shrimp aquaculture and mangrove coverage in Trat province 1979-2004.

2. Excessive use of mangrove resources

Utilization of mangroves can be divided into timber and food supply. The traditional uses of mangrove wood are for charcoal and firewood, construction materials, fishing gear, tanning, chemical products and medicines.

The exploitation of mangrove forest was placed under a logging concession in 1941. The Royal Forestry Department (RFD) revised the mangrove management plan regarding concession from time to time due to the difficulty to supervise and control field operations, as well as the degradation of mangroves across the country. The conflict between destructive development and conservation pressured the government to issue a number of mitigation policies including the cancellation of mangrove forest concessions throughout the country. In 1998, the cabinet announced that the concessionaires can further their charcoal productions in their concession areas until their concession expired (Plathong 2000).

Table 1 shows the mangrove concession permission in Trat province during the second period of concession (1986-2001). In this case, the concessionaires can further their charcoal productions until 2001, although any changes or utilization in mangrove area was absolutely prohibited since 1991. The stock was depleted and the land was degraded in many concession areas. Some areas were left with only non-commercial species as reported in Aksornkoae (1993). The rapid loss of mangroves over those years; nevertheless, coincided with a period of double-digit annual economic growth (World Bank 2007).

Table 1 The mangrove concession permission in Trat Province during 1986-2001.

Concession Name	Location	Permission Number	Duration	Area (Rai)
Namchieo-Thatapao (1)	Muang and Laem Ngob District	200/1986	24 Oct 1986-23 Oct 2001	4,206.25
Namchieo-Thatapao (2)	Muang and Laem Ngob District	201/1986	24 Oct 1986-23 Oct 2001	6,493.75

(Source: Department of Environmental Quality Promotion)

State

The rapid destruction of mangroves resulted in the loss of existing biodiversity. The villagers reported that the significant species in Prednai: grapsoid crab (*Sesarma mederi*) and giant mud crab (*Scylla serrata*) were displaced from the mangroves as well as some other species, including honey bees, spider crabs (*Dorippe dorsipes*), mudskipper (*Boleophthalmas boddarti*), crab-eating macaque (*Macaca fascicularis*), firefly, painted stork (*Mycteria leucocephala*), *Porphyris poliocephalus*, purple heron (*Ardea purpurea*), grey heron (*Ardea cinerea*), lesser whistling duck (*Dendrocygna javanica*), and Brahminy Kite (*Haliastur Indus*). Other wildlife such as water monitors (*Varanus salvator*), civets, pangolins, mongooses, snakes, fishing cat (*Felis viverrina*), bats, variety of birds, squirrels and flying squirrels were also reported in declining trends.

Mangrove crabs are considered ecologically significant in many ways, for instance, they keep much of the energy within the forest by burying and consuming leaf litter, their feces form the basis of a coprophagous food chain contributing to mangrove secondary production (Lee 1997; Gillikin *et al.* 2001), their burrows alter the topography and sediment grain size of the mangrove and help aerate the sediment (Warren and Underwood 1986). In addition, crab larvae are the major source of food for juvenile fish inhabiting the adjacent waterways. According to Seys *et al.* (1995), crabs themselves are also food (prey) for threatened species such as the crab plover. Therefore, removing crabs from an area affects the productivity and reproductive output of the vegetation (Smith *et al.* 1991). In other word, the absence of crabs reduces ecological integrity in mangrove ecosystem as a whole.

Impacts

Impacts of the deterioration of mangrove ecosystem can be classified into two categories which are ecosystem goods and services and human well-being. Coastal ecosystems underpin human well-being in terms of the basic material needs for a good life, health, good social relations, security, and freedom of choice and action, through providing provisioning, supporting, regulating and cultural services (Millennium Ecosystem Assessment 2005).

During the time of concessions and the expansion of intensive shrimp aquaculture, massive area of mangroves have been lost which inevitably resulted in descending the capability of the ecosystem to generate goods and services for coastal and marine organisms as well as local communities. In addition, local residents were prevented to access mangroves under concession areas for their daily harvest.

According to information provided by villagers, a significant economic impact was the decreased catch of grapsoid crab. In previous time when there were a large number of crabs, the harvest method was simple: catching by hands, using gas lanterns and stepping on crab holes. Villagers would normally harvest crabs during 7 to 9 p.m. There were no restrictions on catching grapsoid crab owing to their abundance and small numbers of crab catchers. Some villagers bartered for rice with other communities, some pickled them for sale in town (interview data).

Over a period of time, the average daily crab harvest decreased to only half compared to the average catch in the past. Most households owned land were engaged in a mix of aquaculture or agriculture; however, there were landless households who relied solely on the commercial harvest of grapsoid mangrove crabs for their income (interview data). Therefore, mangrove ecosystem changes in Prednai increased not only biodiversity loss but also poverty issue.

Response

1. Community initiatives

In 1982, the community began to take special care of the mangroves since logging activities in the area were not consistent with concession requirements. The villagers submitted a letter to their local government authorities requesting an inspection; however, no action was taken. A letter was submitted again to the central government office outlining the ongoing conflicts which resulted in the abrupt resignation of the provincial governor. In the same year, the villagers started forming a small group of 5-10 villagers in order to fight off the corporate logging and shrimp aquaculture operations operating within Prednai mangrove forest.

Large-scale logging activities occurred regularly in this area for a number of years; however, in 1986 an external corporation partnered with the logging company and began constructing ponds for intensive shrimp aquaculture (Senyk 2005). This activity ensured that natural reforestation or manual replanting would not be able to take place and, thus, villagers' livelihoods and traditional lifestyles were endangered.

The villagers responded, under the leadership of the head of the village, by mangrove patrolling in order to protect and conserve local natural resources from outsiders and concessionaires whose logging activities were inconsistent with the requirements. Their efforts, including physical confrontation when necessary, were successful; commercial logging ceased, the gate blocking seawater for intensive shrimp aquaculture was destroyed and the company was ousted from the village. A conservation group was formally recognized later in 1998 as "*Prednai Mangrove Forest Conservation and Development Group*". The group received no outside funding. All activities were grassroots in nature, organized and carried out by local people and any costs, such as fuel costs for boats during informal patrols, were shared by those in the village (interview data).

Although the villagers were unable to return to a rice-agriculture system, they were successful in converting shrimp aquaculture to a fish aquaculture system, raising primarily Grouper (*Epipephelus malabaricus*) and Sea Bass (*Lates calcarifer*). This shift resulted in

incomes that were more stable and at a lower risk of total failure, as compared to intensive shrimp aquaculture (Senyk 2005). To achieve the preferable outcomes, the group established resource management plans regarding mangroves, significant species and fisheries as following:

1.1 *Mangrove protection;*

Villagers began to plant trees in the denuded mangrove area; some stands began to regenerate naturally under strict village protection (Senyk 2005). The regulations have been formulated on the harvesting of forest products including timber, crabs, fish, shrimp, mollusks, bees, fireflies, and other wildlife. The regulations define the rights of the local community and outsiders in accessing and utilizing forest products as well as guidelines for punishment (RECOFTC 2007), for instance; felling or cutting down mangroves must be informed and permitted by the conservation and development group; the area between canal 7-8 (see also Figure 1&2) is set to be a conservation area for mangrove resources and natural habitats for other wildlife; and the punishment includes warning, imposing fines from 100-500 Baht per tree (US\$3-15) and handing over serious offenders to the police.

The local mangrove management plan covers protection, forest patrols at least 2 times a week, reforestation by annual planting and monitoring program. The monitoring program includes an inventory of the forest ecosystem and natural resources every 3 years. The management plan was done through participatory data collection and forums to collect ideas from the villagers, especially those who utilize the mangrove resources, community leaders, and other groups in the village (Soontornwong *et al.* 2007).

1.2 *Species conservation;*

Apart from the original crab catchers, some people started to harvest crabs because it was an easy way of making a living after shrimp farming collapsed. Particularly, the price of grapsoid crab was good owing to the increased market demand (Soontornwong *et al.* 2007). However, the villagers noticed the decreased number of crabs and more catching time required. They tried to solve these problems by not collecting crabs during the spawning period. Subsequently, it became harvesting regulations for the grapsoid crab in 1997 under a slogan “*Do not harvest hundreds, wait to harvest millions*”.

The villagers have integrated their knowledge about mangrove ecosystems and the grapsoid crab life cycle into the management plan to decide detailed agreements on catching crabs. They agreed not to catch crabs during spawning period in canals 7 and 8 which are the center of the forest and the source of natural breeding. Crab catching is prohibited on the 4th - 6th days of the waxing moon and the 4th - 6th days of the waning moon (according to lunar calendar) in October (Soontornwong *et al.* 2007).

People outside the community can catch crabs but must inform the committee and follow community regulations (Soontornwong 2006). Additionally, the community has requested the cooperation of crab buyers not to buy the crabs during the closing period as well as not to buy juvenile or small-sized crabs. If any small specimens are found, they would be returned directly to the forest (interview data). After a few years of monitoring, the average daily harvest of grapsoid crab has significantly increased from 8 to 15 kg per collector (Table 2). Furthermore, the collecting time has decreased which means collectors have more time for other income generating activities; led to an increase of the overall income. Currently, it is found that over 40 collectors are catching crabs for their main income. Others catch occasionally during their breaks or when a number of crabs are largely increased. In total,

there are approximately 100 people per night of various aging and both sexes. These numbers reflect the efficient community's management of crabs which is moving in a positive direction.

Table 2 The average daily harvest of grapsoid crab during 1998-2007.

Resource	1998	2003	2004	2005	2007
Volume per person	8 kg	15 kg	15 kg	15 kg	15 kg
Economic value (per kg)	50 Baht	40 Baht	40 Baht	50 Baht	60 Baht
Crab gatherers	6	30	30	40	40
Total catch per month (Baht)	72,000	540,000	540,000	900,000	1,080,000

(Source: interview data; Department of Marine and Coastal Resources 2007b)

Another economically important aquatic species in the area is mud crab (*Scylla serrata*). The villagers protect them and attempt to increase the production by creating a holding area for spawning crabs, locally called "crab bank". They requested the Department of Fishery (DOF) to provide nets so that they could create an enclosure within one of the canals in the mangroves. People who have egg-bearing crabs are requested to place them in the bank (interview data; Soontornwong 2006). Within the enclosure the crabs were able to spawn and the movement of water in the canals allows the larvae to spread out naturally. The crab bank also promotes community learning by involving members in monitoring resources and conducting experiments. They observe the increase of mud crabs and grapsoid crabs, while members also share their experiences and problems with other members.

1.3 Fisheries Management;

According to the villagers, one problem facing the village was large trawlers which not only destroyed the sea bed and sea habitat but also contributed to faster erosion of the shore. The conservation group has taken several steps to alleviate this problem, including patrolling the coastal area along with people from neighboring villages, building bamboo fences 3,000 meters offshore in order to force the boats farther out and to slow down the erosion. They also created artificial habitat for marine life by using old tires, locally called 'fish houses'. The bamboo fences results in stabilizing the shore and eliminating the destructive fishing in their community; however, ineffectively exclude fishermen from neighboring sub-district (interview data and observation).

The "*Prednai Mangrove Forest Conservation and Development Group*" has become well-known due to their strong leadership and community-based management. The community has earned supports from various parties, including government agencies and other non-governmental organizations such as the Social Investment Fund (SIF), the Thailand Research Fund and the Education Institute, Regional Community Forestry Training Centre (RECOFTC).

2. Non-governmental organization

The outside funding was used to buy three boats for patrolling the mangroves, to build a cabin in the mangroves as a station for patrol groups, and to build a 2.8 km walkway through the mangrove forest that could be used for education and tourism.

Shortly after Prednai received funding from SIF, RECOFTC became involved. One of their first actions was to organize study tours for community leadership to other community forests in Thailand to learn first-hand from their peers. RECOFTC developed a three-year

Participatory Action Research (PAR) program with Prednai in 2001, in which they assisted the community through; *capacity building*. This included actual research as well as the social and forest inventories, where villagers learned skills in using GPS receivers and mapping, as well as skills relating to the conduct and documentation of research. Additionally, the assistance included further development and revision of the management plan and the establishment of linkages with university academics, as well as a wider dissemination of their success.

3. Government agencies and legislation

In Thailand, several government agencies and policies are involved with marine and coastal resources management. The various laws and regulations have been developed at different times and for different purposes, involving multiple agencies and stakeholders.

3.1 Responsible agencies

Prior to 2002, the Royal Forestry Department (RFD) was the governmental department with the legal responsibility for the management of mangrove forest. The RFD was involved in providing saplings for village reforestation efforts and stocking young aquatic wildlife (shrimps, crabs and fish) into the canals of the local mangroves.

Currently, the National Environment Board (NEB) and the Sub-committee on Marine and Coastal Resources (SMCR) are the national bodies with primary responsibility for coastal management policy. The primary mission of the SMCR is to develop the strategic policy framework and management plan that will improve and maintain the sustainability of Thailand's coastal and marine resources.

The Department of Marine and Coastal Resources (DMCR) which was established in 2002 has primary responsibility for promoting sustainable coastal management. However, other ministries and departments are also involved in policy-making, planning, and management of mangrove areas under their respective jurisdictions including the Office of Natural Resources and Environmental Policy and Planning (ONEP), Department of National Park, Wildlife and Plant Conservation (DNP) and the Department of fisheries (DOF) (Department of Marine and Coastal Resources 2007a).

3.2 Regulations and policies

The national policies are currently set based on the Thai Constitution of 1997, which calls for good governance, people participation, and the rights of individuals and local communities to participate in decision-making processes and to have access to a sustainable use of natural resources (World Bank 2007). National policies include 1) Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality 1997-2016, 2) Thailand National Marine Policy and 3) Policy and Management Practices for Mangrove Land Use.

In addition to the overall natural resource policies, many sector policies and government administrative plan (GAP) apply. Relevant sector policies include those for fisheries, agriculture, industries, towns and cities, land transportation, and tourism development. GAP targets to build a balance between development and conservation, protect biodiversity, rehabilitate land resources, manage water resources, and including local communities and the private sector in resource management. Nonetheless, policies for coastal erosion and marine based pollution control remain lacking (World Bank 2007).

Issues and challenges in national perspective

Recognition of the environmental, social and economic impacts associated with the decline and degradation of mangroves are now being addressed through legislative, management, conservation and rehabilitation efforts aimed at mitigating the negative impacts of development on mangrove ecosystems. These include the introduction of new legislation and new governing bodies with clearer administrative or advisory roles on environmental issues; stronger conservation status for some mangrove areas of outstanding value (e.g. as Biosphere Reserves); and more emphasis on public awareness raising and education. However, many of the current management policies adopted are still sectoral in nature, which frequently leads to conflicts of interests, and to continuing unsustainable exploitation of mangrove resources. Although progress has been made in the management, the restoration and the protection of mangroves, the outstanding issues and challenges remain considerable as following:

Obscure regulations and weak enforcement;

Government regulations with respect to mangroves are often either too complicated or inadequate to ensure the required conservation. This situation led to illegal encroachment of many mangrove lands all over the world (Choudhury 1997). In Thailand, many laws and regulations related to management of coastal and marine resources have been developed, including those related to the use of resources (e.g. fisheries, forests, and oil and gas), human activities (e.g. industries, buildings, transportation), natural areas and wildlife, culture, as well as local government administration (Department of Marine and Coastal Resources 2007).

Integrated coastal resources management has been identified in the national policies. Its implementation, however, remains a challenge due to overlapping and outdated regulations, limited government resources, and a lack of reliable data. In addition, responsibilities for marine and coastal resources management remain scattered among various agencies, including the Office of Natural Resources and Environmental Policy and Planning (ONEP), the Department of National Parks, Wildlife and Plant Conservation (DNP), the Pollution Control Department (PCD), the Department of Water Resources (DWR), the Royal Forestry Department (RFD), and the Department of Marine and Coastal Resources (DMCR) (IUCN, 2006). These overlapping responsibilities hinder an efficient implementation of environment-related plans and regulations, especially when combined with ineffective cooperation. Limited government budgets and personnel further put restrictions on the monitoring and enforcement of regulations.

Inefficient rehabilitation and restoration techniques;

The mangrove plantation programs in Thailand have been in place for nearly 30 years. Most of the activities were focused on replanting mangroves in degraded areas exclusively by *Rhizophora sp.* and *Brugueira sp.* (Aksornkoe 1993). After the cabinet resolution in June 1991 which approved the five-year plan for recovery and establishment of mangroves, together with an approximately 750 million Baht budget, the mangrove plantation programs were launched and operated under the responsibility of the RFD (Bamroongragsa 2000; Havanond 1997). However, mangrove restoration projects in Thailand have brought only mixed results.

There have been numerous failures due to a lack of understanding of the restoration site through planting inappropriate species and/or in inappropriate locations. Much money was spent on developing mangrove seedling nurseries, while little money or time was put into

determining the site-specific needs of mangroves at each restoration location. The failure of restoration projects discouraged all parties involved, particularly the local communities who need positive encouragement to restore and protect mangroves not discouragement over project failure (Havanond 1997; Mangrove Action Project 2006).

Lack of knowledge and overall awareness;

One major factor contributes to mangrove degradation is a lack of understanding at all levels regarding the importance of mangrove resources. After the rapid depletion of mangrove forest from various anthropogenic activities in the past decades and the natural catastrophe of Tsunami 2004, the public has realized the benefits of goods and services that mangroves provide. As a result, non-governmental organizations, government agencies and the mass media have started encouraging the public to participate in mangrove restoration programs. Subsequently, seminars, articles and campaigns regarding mangroves have been produced for wider dissemination (Aksornkoe 2000).

In Prednai, there are some remaining aspects that could be implemented in regard to the community's mangrove information and education system, for example;

Although the significant amount of research has been conducted in the area since the conservation group was formed but none of the research data have been kept or is centrally managed by the community. The data is scattered among different supporting organizations and research institutes. Relevant published articles, scientific researches, regional and national environment reports or pamphlets regarding their effort and success should be stored in the village for locals and also other interests.

The learning center and mangrove walkway were built as a source of knowledge; however, there is no responsible person put on duty and no information is available in the center. The scientific name tags of mangrove species are available in both languages (Thai and English) but some information boards along the walkway are not well taken care of, for instance; posters are blown off by wind or washed out by rain, information and knowledge is not updated and words are illegible.

Lack of integration among relevant stakeholders;

Coastal zone planning in the past was a top-down approach, with decisions frequently based on inappropriate data and poor analysis. The lacks of reliable communications and cooperation among government agencies as well as a disregard for integrating local needs into management plans have contributed to the poor state of environment and economic conditions in many coastal areas. Consequently, involvement of all stakeholders is seen as an approach that has brought satisfactory results in Thailand (Sudara 1999).

Towards sustainable mangrove management

Regulation and enforcement

As a result of weak enforcement, illegal encroachment of mangrove lands is common in many areas including Prednai community. The DMCR with the assistance from the Asian Development Bank and The World Conservation Union (IUCN) has developed a legal framework to promote an integrated approach. The draft Marine and coastal Resources Management Act would provide the legal framework and institutional arrangements for an

Area-Function Participation (AFP) approach, which would identify the rights of communities to manage their own coastal and marine resources through a local organization or a co-management relationship with a local government. Moreover, greater authority would be extended to local governments working closely with key stakeholders, combined with policy guidance and law and regulation support from central government agencies such as DMCR and the Coast Guard. The monitoring and evaluation mechanism, including the collection and sharing of reliable data would also be revised.

Restoration and rehabilitation of Mangrove

There are 6 steps to successful mangrove forest restoration. Involvement of the local community where rehabilitation is taking place is essential to the long term survival of the restored forest (Royal Forestry Department 2000; Choudhury 1997; Mangrove Action Project 2006).

1. Autecology: understand both the individual species and community ecology of the naturally occurring mangrove species at the site, paying particular attention to patterns of reproduction, propagule distribution, and successful seedling establishment;
2. Hydrology: understand the normal hydrology that controls the distribution and successful establishment and growth of targeted mangrove species;
3. Eliminate Disturbances : assess the modifications of the original mangrove environment that currently prevent natural secondary succession;
4. Select an appropriate restoration site: select appropriate restoration areas through application of steps 1-3, that are both likely to succeed in rehabilitating a forest ecosystem and are cost effective. Consider the available labor to carry out the projects, including adequate monitoring of their progress toward meeting quantitative goals established prior to restoration. This step includes resolving land ownership/use issues necessary for ensuring long-term access to and conservation of the site;
5. Hydrological rehabilitation design: design the restoration program at appropriate sites selected in step 4, to restore the appropriate hydrology and utilize natural volunteer mangrove recruitment for natural plant establishment;
6. Mangrove planting: utilize actual planting of propagules or seedlings only after determining through steps 1-5.

Mangrove restoration requires a period of about 75 days of “intensive care” from the date of planting, while replacement of washed-off, eroded, crab damaged, sick and dead seedlings needs to be undertaken along with action to facilitate drainage, remove rubbish and dump brush wood to combat erosion (Choudhury 1997) but it should also be made clear that restoring mangroves is only a partial solution. Protection of those precious remaining mangrove ecosystems must become imperative for all nations, before too much is lost, and the restoration efforts are in vain.

Education, Training and Awareness

The purpose of raising awareness is to provide knowledge and understanding about the importance of mangroves with an aim of instilling in people affection and desire to protect natural resources, with a vision and a will to participate in the resource management (The Thai Pattana Foundation Journal 1996). Awareness needs to be raised at all levels from decision makers in government to community leaders.

Educational programs should emphasize the ecological and economic value of mangrove ecosystems as a national resource. Also, education should help to generate support for,

compliance with, an enforcement of regulations protecting the mangroves. Education and trainings are required especially in communities that depend upon mangrove resources for their livelihood.

In Prednai, the members of conservation group are trained to monitor resources and conduct experiments (e.g. using GPS, monitoring salinity and tree growth, self-action research in observing their mud crabs in the crab bank) so that they can take care of the local resources and report to the local responsible agencies in the case of uncommon.

The education center in Prednai should be harmoniously designed with respect to the building, parking area and a jetty for boat trips. The center should provide information to visitors regarding significance of mangrove ecosystems and their community-based management. In the long-term, the center should act as a focal point for local community links.

Figure 7 shows an example of a well-designed walkway which the information is gathered in a beautiful and easy-to-read form. The boards are designed to protect posters from wind and rain. The information is provided in dual language (Thai and English) and updated from time to time. The visitors can take a study tour to obtain knowledge on nature and mangrove management, observe the wildlife and mangrove species. In addition, they can also relax and exercise among the refreshing natural landscape.



Figure 7 The well-designed walkways and information boards.

Integrated approach and participation of all stakeholders

Successful resource management options must be economically viable, environmentally sustainable and socially equitable. Such integrated approaches should result in more sustainable coastal zone management. Sudara (1999) suggests that coastal management plans must be revised from time to time in order to reflect the needs of all stakeholders as a result of the condition and situation dynamics in coastal areas: with new problems arising, or simply with the changes over time.

Opportunities to manage mangrove forest should be provided for greater interaction between local communities, scientists, managers and policy makers to foster valuable interdisciplinary exchange of ideas on the management of mangrove ecosystems. This can be achieved by

field visits, consultations, workshops, symposia, newsletters and use of the internet. All levels of government agencies need to support the village organization movement and provide them the right to care for the resources on which their livelihood are dependent on. Universities are also the important supporting stakeholders involving in research, education, awareness building and resources planning according to Plathong (2000).

An integrated approach to coastal area and river basin/watershed management through coherent policy development and concerted action is increasingly being regarded as the best way to achieve conservation and sustainable use of mangrove and other coastal resources (UNEP-WCMC 2006; World Bank, ISME, Center Aarhus 2003). However, to decide on the utilization, conservation and management of mangrove resources in accordance with national laws and regulations, traditional practices, needs and interests of local communities who are highly dependent on mangrove resources for their livelihood are necessary to take into account.

Lessons learned and concluding remarks

The Prednai conservation group has demonstrated that the participatory process in natural resource management is an appropriate way for them to manage their forests. The grassroots origin and ongoing strong community support are one of its important strengths. Strong leadership appears to be a key to the success of Prednai conservation group. In the in-depth interviews, the most common answer to why Prednai has been successful in their conservation and management endeavors was given to the strong leadership in the community. The strong leaders can act to increase community participation, unify force within the community and serve as focal points for networking with government, NGOs, and other communities.

The success of Prednai community can be an example of people empowering themselves through local initiative and organization, demonstrating that confidence can be gained through small successes and that it can help improve livelihoods and alleviate poverty.

However, mangrove rehabilitation and management cannot be sustainable in the long run by community themselves. All related parties should step in to participate and to ensure that the community can continue their current efforts effectively and can replicate their activities into other communities (Chotthong and Aksornkoae 2006; Plathong 2000; Sudara 1999). The current management of mangroves in Thailand, including education, training, public awareness and participation of coastal communities show an overall positive trend (World Bank, 2007). It now remains to be seen if the present progress and awareness will result in the sustainable management of this valuable ecosystem.

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