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MITIGATION PLAN ON THE USE OF MANGROVES FOR AQUACULTURE: THAILAND

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ABSTRACT

Mangrove forest is one of the important coastal natural resources of Thailand, however, mangrove forests have deteriorated very rapidly at a rate of more than 50% of the mangrove loss during 1961–1996. The utilization and destruction of mangrove forest has been seriously discussed in many fora. Shrimp farming is one activity, which has disturbed the mangrove forests. According to the inventory and analysis of LANDSAT5 TM satellite imagery data of 1993, only 17.49% of shrimp farms are located in mangrove forests and only 7.36% in the productive area. In addition 10.10% of shrimp farms are in unproductive or upland area, which have been leased legally by the farmers. Therefore, the Royal Thai Government has been working closely with the local communities and NGOs to implement a mangrove reforestation program targeting a replanting of 24,394.64 ha. As a result, the mangrove area has increased to 252,750.88 ha in 2001.

INTRODUCTION

Thailand has 2614 km of coastline: the west coast borders the Andaman Sea while the east faces the Gulf of Thailand (South China Sea). Almost one-third of its 76 provinces border is next to the sea. The Office of Environmental Policy and Planning of Thailand (OEPP, 1992) reported that about 70% of population lives within a few kilometers landward from the coastline. Coastal areas are richly endowed with natural resources such as fertile soil, minerals, beautiful scenery, mangroves and wood forests.

The growth of GAP in Thailand was 10% or higher from 1988 through 1990, making it one of the fastest growing economies in the world (OEPP, 1992). As sizable contributing sector to this growth, the tourism and aquaculture industries have shown the fastest expansion. During periods of rapid growth, there are often conflicts between parties competing for coastal natural resources, such as the mangrove destruction for human settlement, industries, and aquaculture activities. The Royal Thai Government has several mitigation measure plans for coastal area management, especially for improving mangrove reforestation and relocation of the present aquaculture areas for the purpose of minimizing the environmental impacts.

ECOLOGICAL BENEFIT

Mangroves are communities of salt-tolerant plant species, and generally found at the boundaries between land and sea in tropical and sub-tropical areas. Aksornkoae (1993) reported that mangrove species dominate certain zones from the edge of the estuary to the inland sites. These zones are clearly demarcated. This is a unique characteristic of mangrove vegetation, and one, which distinguishes it from inland forests. Watts (1928), cited by Aksornkoae (1993) classified the distribution of mangrove plants in the western area of Thailand into five classes, whereby, class 1 is the area inundated by high tide, and class 5 the areas of tidal zone. The ecological benefit of mangrove for coastal ecosystem would be the mangroves in the normal high tides. They are important because of a wide range of functions and uses, which include the following (MIDAS, 1995):

- For the production of a wide range of forest and non-forest products;
- As a source of dissolved and suspended nutrients which are exported to adjacent areas;
- As nursery and shelter areas for juvenile fishes and crustacean species;
- As a source of fry for fish and crustacean culture;
- For protection of the shoreline from erosion by waves, currents and storms;
- As a windbreaker to crops and structures behind the mangrove forest; and
- As areas of accretion of the land through settlement of sediment in the sheltered waters inside mangrove forests.

It has been calculated (Dioxin, 1989 cited by MIDAS, 1995) that the annual value of mangrove in Thailand can reach over \$ 1000/ha/yr, including fishery and forestry benefits.

MANGROVE DETERIORATION AND DESTRUCTION

The mangrove forest in Thailand has been cleared for a number of uses such as the following:

- For construction of aquaculture ponds;
- In the creation of agriculture land;
- For construction of salt ponds;
- For mining;
- As settlement and industry, and port development;
- For charcoal production; and
- For solid waste disposal.

The Royal Forestry Department (1995) and Charupatt and Charupatt (1997) reported that the destruction of mangrove area in Thailand occurred during 1961 – 1966 (Table 1) was about 55.39 (204,865.60 ha). The average rate of mangrove destruction during 1961-1996 was 6225.6 ha/year. The mangrove area increased in 2001 at 252,750.88 ha (Marine and Coastal Resources Department 2003).

Table 1. Destruction of mangrove area between 1961 - 1993¹

Unit: ha

<i>Year Rate</i>	<i>Mangrove Area</i>	<i>Destroyed Area</i>	<i>%</i>	<i>Average Destruction (ha/year)</i>
Before 1961	372,448.00	-	-	-
1961	367,900.00	4,548.00	1.23	-
1975	312,700.00	55,200.00	14.81	3,942.86
1979	287,308.00	25,392.00	6.82	6,348.00
1983	196,435.84	90,872.16	24.38	22,718.04
1989	180,559.04	15,876.80	4.27	2,646.13
1991	173,820.26	6,738.08	1.82	3,369.04
1993	168,682.56	5,138.40	1.39	2,569.20
1996	167,582.40	1,100.16	0.67	366.72
2001 ²	252,750.88	-	-	-
Total/average		204,865.60	55.9	5,853.30

Source : 1. Royal Forestry Department (1995)
2. Marine and Coastal Resources Department (2003)

MITIGATION PLAN AND UTILIZATION

The Cabinet Resolution

A number of approaches have been proposed in order to prevent further mangrove forest destruction. In late 1987, a Cabinet Decision introduced three zones for mangrove forests based on surveyed data in 1961 shown in the order of their allocating uses in Table 2.

Table 2. Definition and uses of mangrove zones (MIDAS, 1995)

Conservation Zone	Economic A Zone	Economic B Zone
Strongly protected from any impact for its natural environmental values	To be used for forest utilization on sustainable yield basis	To be used for other developments with consideration given to the impacts on the environment
1. Economic flora and fauna preservation, fishery and salt production	1. Forest concession area	1. Agriculture uses: agriculture animal farming
2. Economic flora reproduction and fauna breeding	2. Public forest and non-concession area for local uses	2. Industrial uses: mining industrial plant urban and residential commercial area and seaboard area - other
3. Area for accretion and deposition: beaches and sand bars, mud flats island, caves & coral reefs	3. State and public economic forest plantation	
4. Historical and archaeological purposes A		
5. Local symbol		
6. National park, wildlife sanctuary		
7. Environmental and ecosystem preservation		
8. Area within 20 m of natural riversides and 75 m of coasts		

Conservation Zone:	226,373 rai (42,678 ha)	=	1.46%
Economic A Zone:	1,248,056 rai (199,689 ha)	=	53.61%
Economic B Zone:	813,600 rai (813,006)	=	34.93%

The utilization of the mangrove areas in Thailand was analyzed in 1993 by a Joint Working Committee comprising the Royal Forestry Department (RFD), Department of Fisheries (DOF), Land Development Department (LDD), Office of Environment Policy and Planning (OEPP), and National Research Council of Thailand (NRCT). The results are briefly shown in Table 3 and Table 4.

Remaining mangrove	168,682.56 ha (45.28%)
Destruction due to:	203,765.44 ha (54.76%)
Shrimp farms	64,991.76 ha (17.46%)
Settlement and others	138,773.68 ha (37.30%)

Table 3. Utilization of mangrove area in 1993

Unit: ha

	Conservation Zone	Economic A Zone	Economic B Zone	Total
Remaining mangrove	23,205.52	130,577.12	14,880.00	168,682.56
Shrimp farm	4,471.76	22,939.68	37,580.20	64,991.76
Settlement	271.92	560.76	4,128.44	4,961.12
Other uses	14,728.80	45,591.32	73,492.36	133,812.56
Total	42,678.00	199,688.80	130,081.00	372,448.00

Source: Joint Working Committee of Royal Forestry Department, Department of Fisheries, Land Development Department, office of Environmental Policy and Planning and National Research Council of Thailand (Charupatt and Ongsomwang, 1995)

Table 4. Utilization of mangrove area in 1993 (by region of country)

Unit: ha

	Shrimp Farm		Community		Other		Remaining		Total Area	
	Area	%	Area	%	Area	%	Area	%	Area	%
Eastern	25,983.84	6.97	2,485.72	0.67	13,327.76	3.38	13,047.68	3.61	54,846	14.73
Central	14,157	3.80	1,749.08	0.47	45,712.88	12.26	5,363.04	1.45	66,982	17.98
Southern (Gulf of Thailand)	20,902	5.61	571.64	0.15	18,550.72	4.98	16,424.64	4.42	56,449	15.16
Southern (Andaman Sea)	3,948.92	1.08	154.68	0.06	66,221.12	15.09	133,847.20	35.90	194,172	52.13
Total	64,991.76	17.46	4,961.12	1.35	133,812.76	35.81	168,882.56	45.28	372,448	100

Source: Joint Working Committee of Royal Forestry Department; Department of Fisheries, Land Development Department, Office of Environmental Policy And Planning and National Research Council of Thailand. (Charupatt and Ongsomwang, 1995).

Charupatt and Charupatt (1996) reported the remaining mangrove area in the country in 1996 using Sattelite map Landsat-5 TM Geoclded (1: 50,000). The results are as follows:

<i>Remaining mangrove area:</i>	<i>167,582.40 ha (44.99%)</i>
<i>Shrimp farming in mangrove area</i>	<i>66,997.88 ha (17.98%)</i>
<i>Human settlement:</i>	<i>8,800.40 ha (2.36%)</i>
<i>Others:</i>	<i>129,067.32 ha (34.65%)</i>

After the Cabinet resolution on mangrove zonation in December 1987, the Cabinet has also issued some more mangrove resolutions disallowing the lease of mangrove areas by both government agencies and the private sector. However, the most important one was on 19 November 1996 when the cancellation of mangrove concessions all over the country was approved. This means that there will be no more Economic A Zone under the mangrove zonation policy in December 1987.

Shrimp Farms in Mangrove Area

Mangrove forests in Thailand always contain very high content of acid sulfate soil with very low pH when exposed to the air. The low pH in bottom soil is directly toxic to the cultured shrimps. Mud is very soft which make the cost of pond construction and maintenance high during culture period. Therefore, it was recommended that farmers should not construct their shrimp ponds in mangrove forests (Tookwinas, 1993).

In Table 3, shrimp farms in mangrove areas (17.46%) were divided into 4471.76 ha of conservation zone (1.20%), 22,939.68 ha of economic A zone (6.16%) and 37,580.20 ha of economic B zone (10.10%) and were leased to the farmers. Therefore, only shrimp farm areas in mangrove conservation zone (4471.76 ha; 1.20%) and economic A zone (22,939.668 ha; 6.16%) (total of 27,441.44 ha; 7.36%) were illegally constructed. The government has also proposed mitigation measures to transfer these shrimp farm areas in order to promote reforestation.

Mangrove destruction from 1975 to 2001 vs. the shrimp farming area and production (Table 5) showed that mangrove area sharply decreased during 1979-1989. The highest destruction rate was in 1986 (Table 2), which was 12,951.76 ha/year. The intensive marine shrimp farming areas increased from 1989 to 1991 (Table 5). This means that most mangrove areas were destroyed before the boom or expansion of shrimp farm areas. The shrimp farm areas have increased only since 1998.

Table 5. Marine Shrimp Farming: Number of Farm, Area and Production 1985 – 1995

Year	Number of Farms	Area (ha)	Yield (mt)
1985	4,939	40,769	15,841
1986	5,524	45,368	17,886
1987	5,899	44,770	23,566
1988	10,246	54,778	55,633
1989	12,545	71,165	93,494
1990	15,072	64,606	118,227
1991	18,998	75,332	162,070
1992	19,303	72,796	184,884
1993	20,027	71,887	225,514
1994	22,198	73,246	263,446
1995	26,145	75,495	259,541
1996	23,413	72,663	239,508
1997	23,723	73,200	227,560
1998	25,977	76,019	252,730
1999	28,012	73,120	275,544
2000	31,513	68,365	300,000
2001	-	-	280,000

Source: Fisheries Statistics (2002)

MANGROVE REFORESTATION POLICY AND ACTION PLAN***National Plan***

The National Mangrove Rehabilitation Project has been funded by the Royal Thai Government for many years. Seedlings are raised in large nurseries run by government staff using seeds bought from villagers. Coastal communities are directly involved in growing the seedlings and the communities have been involved in raising the seedlings and in extending the program. Local people could now initiate and run their own rehabilitation project. The project has set a target of planting 50,000 rai (8000 ha) per year since 1906. The total mangrove rehabilitation is around 24,394.64 ha during 1906-2001 (Table 6).

Table 6. Progress of Mangrove Replanting Record from 1906

Unit: ha

Province	1906 - 1990	1991 - 1996	1997 - 2001	Total
Pattani	758.4	32.0	57.6	848.0
Trang	9.6	1,512.0	304.0	1,825.6
Satun	-	1,293.6	400.0	1,693.6
Nakhorn Si Thammarat	3,087.04	1,686.4	96.0	4,869.44
Phangnga	-	1,726.4	520.0	2,246.4
Krabi	1,324.8	533.6	544.0	2,402.4
Phuket	-	235.2	32.0	267.2
Suratthani	-	926.8	478.4	1,405.2
Chumphon	-	732.8	438.4	1,171.2
Ranong	-	1,269.6	1,331.2	2,600.8
Phetchburi	-	656.0	80.0	736.0
Prachuap Khirikhan	—	256.0	-	256.0
Rayong	-	896.0	48.0	944.0
Chanthaburi	840.4	416.0	864.0	2,120.8
Trat	-	848.0	160.0	1,008.0
Total	6,020.64	13,020.4	5,353.6	2,439.64

Source: Marine and Coastal Resources Department (2003)

A number of mangrove rehabilitation projects have been undertaken by NGOs and the local communities (MIDAS, 1995). One project in Klong Khone Sub-district, Samut Songkhram Province, was originally an idea of the provincial government and in the first two years planting was done by volunteer labor from the local community of the province and NGOs from Bangkok. In two years, around 500 rai (80 ha) were planted per year in a comparatively short time. In the first year the mangrove used was exclusively *Rhizophora* but there was nearly 100% mortality due to barnacle spat settling on the seedlings that later broke under the weight of the developing barnacles, and the seedlings being eaten by crabs. In the second year, the species used were *Rhizophora* and *Avicennia* in the 1:1 ratio. On the third year (1994), around 1000 rai (160 ha) were planted, but this time the species was all *Avicennia* and seedlings were grown and planted by local people who were paid for this purpose. In 1995, the local people from a neighboring sub-district agreed to join the planting program.

Another mangrove rehabilitation project was at Khao Sam Roi Yod National Park, where the seedlings were grown by the staff of the Park in its mangrove seedling nursery for *Rhizophora* sp. and *Ceriops* sp. Seed stocks are collected locally, and community groups, particularly school groups visiting the park are encouraged to plant mangrove, thus, several hectares have been planted over the past two years.

Reforestation Program under the Royal Project

Some mangrove reforestation projects have been done under the Royal Project. The mangrove replanting at Kung Krabaen Bay has been implemented under The Kung Krabaen Bay Royal Development Study Center since 1987. Around 264 ha of productive mangrove area has been declared reserved and approximately 166.4 ha were replanted. Another mangrove reforestation project was also done under the Royal Princess Sirinthorn Project since 1995 in Petchburi about 160 km south of Bangkok. The area of around 17 ha was reforested. Many scientists have carried out research programs under this Royal Reforestation Project.

Research on Mangrove Replanting in Abandoned Shrimp Farms

Some research activities have also been conducted to rehabilitate abandoned shrimp farms in mangrove areas. Macintosh (1996) mentioned the result of experiment in Ranong Province, southern Thailand under the joint research Project of Stirling University U.K., Aarhus University, Denmark and the Royal Forestry Department. Results indicated that mangrove trees could be planted successfully in shrimp waste sediments. The growth of young mangroves in shrimp waste sediments was four times faster than the growth in the natural habitat. An observation was also made in Chanthaburi Province, Eastern Thailand, which showed that the abandoned shrimp farms in Tha-Mai district, Chanthaburi can be naturally grown with wild seeds of mangroves. Their growth rate was found similar to the growth rate in the natural habitat.

DISCUSSION AND CONCLUSION

Hambrey (1996) proposed a method of classifying suitable area and unsuitable area for shrimp farms. Basic information on soil, land suitability and other existing data would be needed especially in areas where the potential for shrimp farming is high. Shrimp farming in such areas should be encouraged because of its economic importance. However, as has been recommended by the Department of Fisheries, farmers should construct their shrimp farms away from mangrove forests. Mangrove forests can serve as protection area from erosion and wetland treatment for shrimp farms effluents (Tookwinas. 1991).

For effective environmental production, coastal areas should be zoned. Shrimp farms should not be located in productive mangrove areas (Tookwinas, 1996). As for the suitable location for shrimp farm with respect to mangrove forests, the following concerns should be considered:

- 1) Mangrove areas are not be suitable for shrimp farms due to many problems as earlier discussed.
- 2) Mangrove destruction in Thailand has been mainly done by human settlement and illegal occupation, and for this reason the Royal Thai Government has tried many mitigation programs to solve this problem.

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Mangrove replanting carried by representatives from NGOs and students (left) at Kung Krabeau Bay



Mangrove conversion in Thailand