CHAPTER 2

SHRIMP FARM AND MANGROVE

In this chapter, ecological significance of mangrove and environmental impact of mangrove conversion from shrimp farming or other activities will be reviewed. This chapter also shows how remote sensing and simulation modeling are used as tools for impact studies.

Mangrove and Fishery Production

Mangrove is an important and productive coastal ecosystem occurring in tropical and subtropical regions of the world. It is a transitional complex ecosystem between the sea and land composed of intertidal flora and fauna.

Mangrove contributes to both terrestrial and aquatic productivity. The major processes which support the ecological significance of mangrove and nearshore fisheries are nutrient and organic fluxes. The processes begin when mangrove leaves are washed away by the incoming high and low tides and broken down by bacteria, fungi and other living microorganisms, thus entering into the food chain (Fig. 2.1). In addition, mangrove is a nursery ground for many commercially important species of finfishes and crustaceans, also the feeding ground for many species from various trophic levels. It also serves as buffer against storm surges and strong winds (Zamora, 1987)

Tide is the major process that drives nutrient input-output of mangrove ecosystem. Dissolved nutrients in incoming tidal water are generally low and tend to leach nutrients from soils rather than add to them, leading to a probable net export of dissolved nutrients from the mangrove (Boto, 1982). The study of Suphaporn Rakkhiew (1990) in mangrove at Klong Ngao, Ranong province, also confirmed that nutrients (nitrite, nitrate, total nitrogen and total phosphorus) and salt flux have seaward direction (export from Klong Ngao) in dry and wet season. These large amounts of organic matter and nutrient export from mangrove contribute to the nearshore productivity.

Relationships between mangrove and fisheries in ASEAN were reviewed by Paw and Chua (1991). In the Philippines, the logarithmic relationship between shrimp catch and mangrove area in 18 provinces was significant. In Malaysia, an analysis of 1981 fish landing showed that 32% may be associated with mangroves. However, the impact of mangrove conversion on fisheries in ASEAN region had not yet been assessed qualitatively and quantitatively.

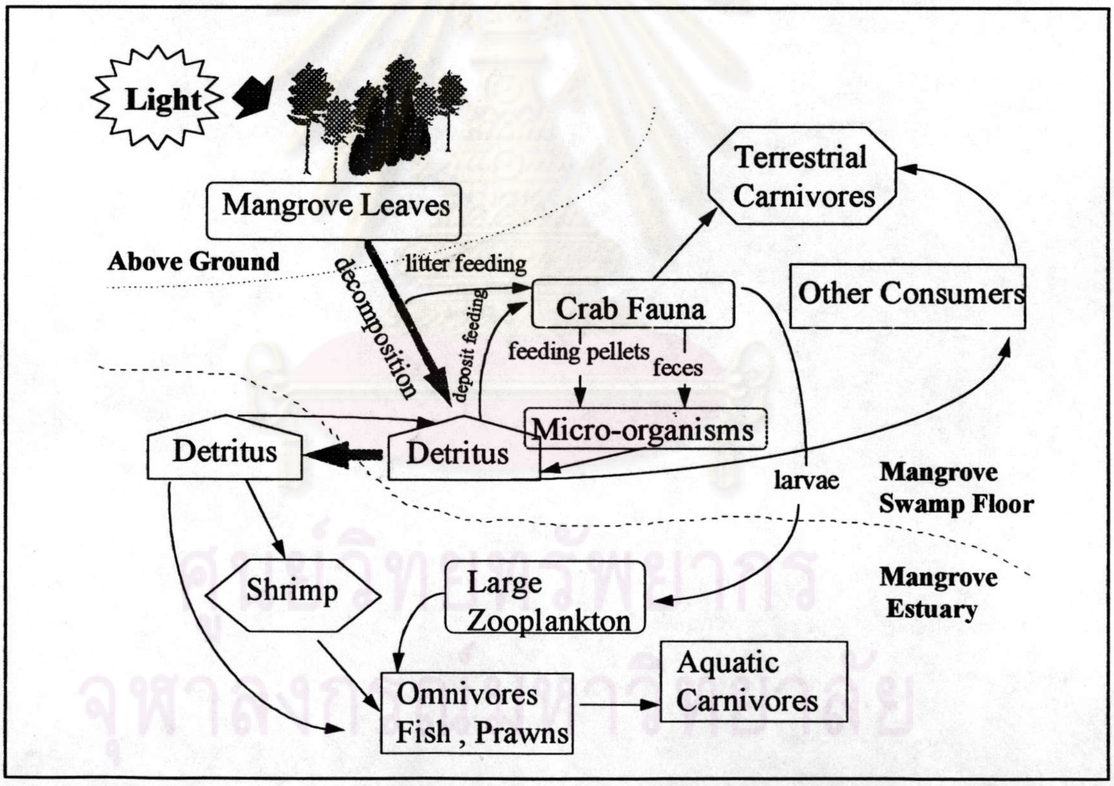

Figure 2.1. Food web in mangrove (adapted from Macintosh, 1984).

Shrimp Aquaculture in Thailand

Along Thailand's 2,600 km shoreline, there are about 1,000 km^2 of huge brackishwater areas which have potential for aquaculture (Hassanai Kongkeo, 1993). In addition, Thailand rarely has typhoons, cyclones, and un-fluctuating water temperature. The soil property is good for pond construction and broodstocks abundant. Thailand has a long tradition of work in aquaculture of banana shrimp (*Peneaus merguiensis*) and greasy shrimp (*Metapeneaus spp.*) for more than 50 years. Other localized coastal aquacultures are mussel (*Mytilus smaragdinus*), cockle (*Anadara granosa*), oyster (*Crassostrea spp.*), seabass (*Lates calcarifer*) and grouper (*Epinephelus spp.*) (Hassanai Kongkeo, 1993).

Black tiger shrimp (*P. monodon*) culture in Thailand commenced in 1974 by semi-intensive methods using hatchery produced fry but expanded very slowly because the lack of suitable feed. Until 1985, the japanease demand for shrimp was increasing, and price of shrimp from tropical countries went up to US$ 8.00-10.00 per kilogram in order to encourage the shrimp farm expansion. In connection to the success of local feed formula, shrimp aquaculture in Thailand has been increasing tremendously since 1985.

The first boom areas were along the inner part of the Gulf of Thailand including Samutsakorn, Samutsongkhram, Samutprakarn and Chacheongsao. After a few years of the serious water quality problem due to lack of proper farm management, they had to cease operations and moved to the eastern coast of the Gulf of Thailand, Chantaburi, Rayong, Trat, and also to the southern part of the country, at first along the western coast of the Gulf and recently across to the southern coast on the Andaman sea side. Table 2.1 shows details on how shrimp farming areas have changed compared to mangrove area during 1975-1991 (this is also displayed on graph in Fig 2.2).

Table 2.1 Area of shrimp farm with area of mangrove destruction in Thailand

Year	Shrimp farm area (km²)*	Mangrove area (km²)
1975	128.68	3,127 ◆
1976	122.96	
1977	124.11	
1978	241.69	
1979	246.76	2,873 ◆◆
1980	260.36	
1981	274.59	
1982	307.92	
1983	355.37	
1984	367.92	
1985	407.69	
1986	453.68	1,964◆◆◆
1987	521.49	
1988	667.31	
1989	759.28	1,806◆◆◆
1990	640.81	
1991	672.00	1,736◆◆◆

Sources : * Siri Tookvinas (1992)
◆ Suvit Vibulsresth *et al.* (1976)
◆◆ Boonchana Klankamsorn and Thongchai Charuppat (1983)
◆◆◆ Thongchai Charuppat (1993)

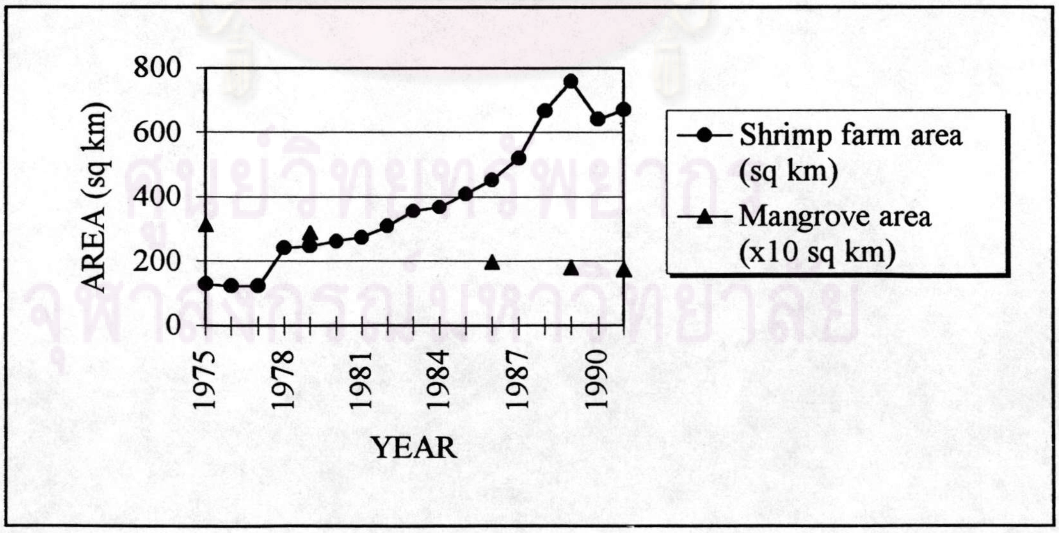

Fig. 2.2 Area of shrimp farm and area of mangrove destruction in Thailand

Mangrove and Shrimp Farming

Impact of Shrimp Farm on the Environment

The underestimation of mangrove importance to the environment might partly resulte in contributing to the rapid conversion of mangrove to shrimp farms. Furthermore, mangrove used to be regarded as wasteland which could be reclaimed for development and be economically valuable (Hamilton and Snedaker, 1984). Several studies have been carried out to review the impact of human activities on mangrove ecosystems emphasized on the effects from shrimp farming.

Taweesak Piyakarnchana *et al.* (1979) conducted a comparative study on mangrove along the bank of Mae Klong River, Samutsongkhram province. The study revealed that benthic community on the east bank, where the mangrove was still in good condition, was richer in term of species and abundance than the west bank, where the mangrove was partly cleared for shrimp farms. Jirakorn Gajasenie and Suthasanee Boonkong (1982) conducted a comparative ecological study of the fauna of natural mangrove and converted areas for shrimp farm as well as mangrove plantations in Chantaburi province. The study showed that natural mangrove maintain a higher number of species, biomass and species diversity index than the converted areas.

Abundance and composition of zooplankton are good indicators of the degree of biological productivity of the area. Sarin Tantipokanon and Nittharatana Paphavasit (1991) studied the zooplankton in the mangrove area where most have been converted to shrimp farms (in Ang Sila Area, Chonburi province) and found that zooplankton abundance was lower as compared to other nearshores which still have pristine mangrove. They finally concluded that conversion of mangrove area to shrimp farm has negative impact on aquatic productivity of coastal water. Phaibul Naiyanetr (1991) also found that shrimp farms decreased the number of crustaceans which people use for their food.

Impact of shrimp farm on mangrove soil properties were studied by Pramuk Kawneum (1990) and Chada Narongrit (1992). In general, the fertility status of shrimp pond soil was found to be lower than the mangrove soil.

On community based land-use and social impacts, Sebastiani *et al* (1994) reported that large-scale shrimp farming in Venesuela which began in the 1980s triggered a land-use conflict, and then lead to public protest based on the impacts which were related to direct removal of wetlands, interruption of natural patterns of surface flow, and alteration of feeding grounds of some bird species with migratory status. In Thailand, conflict of social benefit groups resulting from the drawing of seawater from shrimp farm into planting area was also evidenced at Khung Kraben Bay, Chantaburi province (Somvipha Yothaphant, 1990) and at Pak Phanang area, Nakhon Sri Thammarat province (Coastal Resource Institute, 1991).

Simulation Modeling and Remote Sensing Technique for Impact Study

The development of simulation modeling and remote sensing are an emerging area of environmental problem solving and management. The simulation modeling would allow the understanding of ecological process or complex problem in a short time with low cost. Together with remote sensing, which can provide past and current spatial and temporal data on landscape properties, the model can give a great advantage to researchers or resource managers.

Browder *et al*. (1984,1985) created a spatial model to explore the dynamic relationship between land-water interface and wetland disintegation in Louisiana., and found a parabolic relationship between them at most study sites. So they can demonstrate modeling future trends in wetland loss and brown shrimp production based on positive linear relationship between brown shrimp catch and total interface length over the past 28 years.

In Thailand, many studies were carried out on the distribution, classification of mangrove, extent and change of mangrove, including landuse mapping, by using remote sensed data (Suvit Vibulsresth *et al*., 1985, 1988; Absornsuda Siripong *et al*., 1991; Apichart Pongsrihadulchai, 1993). Other countries which have problems with shrimp farm expansion also used remote sensing as a tool for landuse mapping and monitoring the change of mangrove area (Terchunian et al., 1986; Shanid and Pramanik, 1986; Eng and Bao, 1993).