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# ENVIRONMENTAL IMPACTS OF SHRIMP CULTURE IN THE MANGROVE AREAS OF VIETNAM

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## **Abstract**

Mangroves are an important ecosystem with high productivity.

Mangroves provide valuable forestry products and support a high diversity of marine and terrestrial life through food web interactions. They are shelters and nursery grounds for many commercially valuable species of fish, shellfish, crustaceans, waterfowls, migratory birds, and other terrestrial species. Mangrove forests also stabilize coastlines and riversides, promote coastal accretion, control saline intrusion and pollution, and defend dykes, fields and coastal inhabitants from the damage of storms and other potentially damaging natural forces (Hong (ed.), 1999).

Mangroves in Vietnam have been seriously deteriorated. Recently, the greatest threat has been shrimp culture. Hundreds of thousand hectares of mangroves have been converted to shrimp ponds. Though the government has planned to reduce environmental impacts, raging shrimp culture development along the coastline is placing intense pressure. Environment problems such as deterioration of biological resources, water and soil pollution, and salinization of soil occur daily owing to the loss of forests.

This paper will analyze the negative environment impacts of shrimp farming. Some measures for improving sustainable coastal aquaculture and conserving mangrove ecosystem will be recommended.

**Key words:** environmental impacts, mangroves, shrimp farming

## **Introduction**

The shrimp farming for export has been encouraged and promoted by the government since the early 1980s. Furthermore, high economic returns lead to the widespread practice of this lucrative activity.

The rapid expansion of shrimp farming across the coastal landscape of Vietnam can be placed firmly within the context of globalisation. Firstly it has been encouraged by the expansion of the global shrimp market and secondly the expansion of aquaculture has been enabled by the economic renovation process of doi moi which has itself been influenced by global processes (Luttrell, 2002).

However, coastal shrimp farming in Vietnam has been spontaneously developed mostly using improved extensive methods. Though the Ministry of Fisheries aims to develop aquaculture in a sustainable manner to maximize socio-economic benefits in their strategy (Vietnam coastal aquaculture sector review, 1996), much of this development has been unplanned with inadequate farm setting and practiced employing poor techniques. Moreover, most shrimp farmers have limited knowledge on the environment. As a consequence, this type of activity has placed serious impacts on valuable natural resources.

The above-mentioned situation is a very big threat to mangroves in particular and coastal environment in general. In order to cure that, the great role and potential of this essential ecosystem need to be assessed, some causes by shrimp farming leading to the deterioration of mangroves' area and quality to be analyzed, and the damaging impacts of the loss of forests on the biodiversity resources, coastal environment and life to be appraised. Based on those results, awareness of the significance of mangrove ecosystem among the coastal communities may be raised. Policies and strategies which are suitable to the Vietnamese situation

can be drawn up to both improve the knowledge and life of coastal dwellers and protect and utilize sustainably the natural resources and environment (Hong and Tuan, 1997).

### **The role of mangroves toward marine product resources**

Mangroves provide shelters and nursery grounds for many species of fish, shellfish and crustacean and microorganisms. Marine shrimp - a valuable source of foreign exchange are highly dependent upon mangrove estuarine areas during their post larval and juvenile stages (Hamilton and Snedaker, 1984).

Mangroves are also important habitats for a great diversity of reptiles, amphibians, mammals and birds. They search for food in swamps at ebb tide and live on the trees or high dunes at flow tide in mangrove area. These terrestrial animals excrete a large amount of feces everyday, which is a source of nutrition for the forest trees and also food for various aquatic creatures (Hong and Tuan, 1996).

A number of researches show that high-yield fishery is mainly carried out in the rivers, canals and estuaries with mangroves. Hamilton and Snedaker (1984) estimated that 80 percent of all marine species of commercial or recreational value in Florida USA, are dependent upon mangrove estuarine areas for at least some critical stages of their life cycles. In eastern Australia, 67 percent of the entire commercial catch is composed of species dependent upon mangrove estuarine areas. In Vietnam, the fisheries are largely dependent on the productivity of the coastal ecosystems (mangroves, seagrass beds, coral reefs). These ecosystems account for 80-90% of the total exploitation output. Another 10-20% of the output is from the deeper water area (Tang & Hong, 1999). The primary food source for aquatic organisms is plant organic matters which occur in the form of detritus, derived from the decomposition of forest litter. Litter fall of *Rhizophora apiculata* forest in Ca Mau ranges from 8,000 to 12,000 kg of leaf dry weight per ha per year (Hong & Tri, 1986).

During decomposition, mangrove litter becomes progressively enriched in protein and serves as a food source for a wide variety of filter, particulate and deposit feeders such as molluscs, crabs and polychaete worms. These primary consumers in turn form the food of a secondary consumer population (Hamilton and Snedaker, 1984).

In Can Gio District, Ho Chi Minh City, replanted mangroves have produced detritus for oyster farming sites on tidal sandy mud flats which have helped improve the life of thousands of poor people's (Tri et al., 2000).

### **Impacts of shrimp culture on mangrove environment**

#### ***Loss of mangrove area due to conversion of the land to shrimp culture***

Shrimp culture is one of the major economic sectors in the Vietnamese economy. Nevertheless, the rapid development of shrimp farming has had a very serious impact on mangrove forests. Over the last 50 years, Vietnam has lost at least 220,000 ha of mangrove forests (Vietnam News Service, 2001).

Ca Mau Province, the largest dense mangrove area, has dropped from over 150,000 ha prior to 1962 to 64,572 ha in 1999, and that almost all of this destruction has been from shrimp culture (Tan, 2001).

In Quang Ninh Province, only in 2 years 1995 and 1996, 14,837 ha of mangrove land were converted to shrimp ponds, and 8,500 ha of mangroves were devastated. The province plans to have 29,000 ha of shrimp ponds to the year 2010, 13,000 ha of which will come from existing mangroves (Hung, 2003).

In many localities such as Khanh Hoa Province, previously natural mangroves developed very well in Cam Ranh Peninsula and Ninh Hoa District. However, the development of shrimp farms and hatcheries in here has led to conversion of mangroves tiger shrimp farming purpose.

It is the same case in other coastal provinces.

Only in some coastal localities in Nam Dinh and Thai Binh Provinces where over 6,000 ha of mangroves have been planted with financial support from the Danish Red Cross and commitment of local authorities for long-term protection of this precious resource, and where education and propaganda activities on mangrove protection have been intensively undertaken, and where local people actively protest the purposes of some shrimp companies felling mangroves for shrimp pond making, mangroves have been well protected.

Table 1. Area of mangrove land, mangroves and brackish water shrimp ponds in Vietnam to the year 1999 (Source: Binh, 2003)

No.	Region	Mangrove land		Mangrove covered area		Area not covered by mangroves		Brackish shrimp pond area	
		ha	%	ha	%	ha	%	ha	%
Total		606,792	100.0	155,290	100.0	225,427	100.0	226,075	100.0
I	Northern Vietnam	153,319	25.3	46,111	29.7	76,012	33.8	31,194	13.8
II	Southern Vietnam	453,473	74.7	109,179	70.3	149,415	66.2	194,881	86.2

### *Situation of shrimp farming management in mangrove areas*

In many ways, Vietnam's government has been progressive in their protection of mangrove and other important wetland habitats, and it has called for the expansion of aquaculture to be carefully planned to protect the environment. It has encouraged diversification and integrated farming to reduce risk and preserve ecological and agricultural balance (Asia Pulse, 2002) and supported mangrove replanting program, and projects focussed on defining sustainable land-users in the brackish zone. However, it appears that government plans for significant aquaculture expansion are placing incredible pressure on coastal areas, and there may be conflict between reforestation and shrimp cultivation expansion program (Minh, 2001).

Many coastal localities have had planning for aquaculture development, however, being canceled by local people due to the invasion of land for shrimp farming. In some places, local managers or leaders, for immediate benefits, have allowed the bidding of a large area of coastal mangrove mud flats for industrial shrimp farming, depriving the poor people of their daily income source from aquatic resources collected in mangrove area. Additionally, another consequence is the damage caused by storms and floods in the absence of mangrove forests.

### *Impact of shrimp culture on coastal environment*

#### *Deterioration of the biological resources*

The loss of mangroves means the loss of habitats and food sources for a variety of marine species, and a decrease in fish catches.

The shrimp aquaculture in mangrove area has reduced or replaced the habitats of many benthos and plankton species originally abounding on muddy tidal flats. A survey showed that there are 22 species of benthos on the mudflat outside the pond of southwest Ca Mau cape, while the species remaining in the pond is only 2 (Hong, 1996).

Survey on the abandoned shrimp ponds in Nam Trieu estuary (Hai Phong City), where mangroves were destroyed shows that there was a sharp decrease in benthos biomass due to the degradation of substrate. The biomass in this area is 9 times less than that in adjacent areas (Trong and Hong, 2001).

After building a series of shrimp ponds, many economically valuable marine products and terrestrial animals such as reptiles, variants, and birds are also deprived of their habitat, breeding ground and living environment.

Indiscriminate mangrove destruction for shrimp farming has greatly reduced the seed source of marine shrimp and mud crabs. These species lay eggs at sea, their larvae and post larvae move to the river mouths and coastal line with mangroves and live there until they become mature and go to the sea again to lay eggs. When there is no longer forests, they also lose their habitat and have to leave to other places.

#### *Impacts of shrimp aquaculture on salt intrusion*

The construction of a series of large shrimp ponds along the coast, estuaries and riverbanks has considerably decreased the area of tidal water distribution. During high tides that coincide with the north-east monsoon, saline water may intrude further inland and produce saline pollution not just in the land outside the dykes, but also in the plain inside the dyke. Under dry, low humidity weather patterns, saline pollution may emerge at the surface and affect plant life. Saline pollution disrupts the ecological balance of estuarine areas as some brackish water organisms will invade further inland. Freshwater organisms will die because they cannot adapt to the salinity or they will migrate further inland (Hong, 1995).

#### *Impacts of shrimp farming on soil and water pollution*

Due to the long term holding of shrimps in the pond and weak water exchange in the extensive aquaculture system, the pond environment may become strongly polluted by the formation of  $H_2S$  and  $NH_4^+$  originating from the decomposition of the saline flooded plant debris. A common phenomenon in extensive culture ponds in the north of Vietnam as well as in the south is the presence of oscillating algae. These algae often develop into green, mucous tratum and die, rendering the pond water obnoxious with low dissolved oxygen and rapidly deteriorating pond water quality. During harvest of shrimp and fish, the effluent flow carries toxic metabolites along rivers and canals and pollutes the surrounding environment. In some cases after heavy rainfall, the saline concentration abruptly decreases which leads to massive death of shrimp in the pond, as anaerobic decomposition will form some toxicants. During pond drainage, these toxicants will be released to the environment of the marshland and affect other organisms, including seed sources and many seafood of high value (Hong (ed.), 1999).

The disordered construction of shrimp ponds had led to the consequence that lower ponds receive waste from higher ones. On the contrary, the tide usually has to pass lower ponds before flowing into the ponds on higher land at spring tide, facilitating the spread of the dirt in ponds. Toxic matters like  $Fe^{2+}$ ,  $Fe^{3+}$ ,  $NO_3$ ,  $NH_4$ , blue algae, organic wastes, disease-carrying bacteria from the ponds are brought by the tide to canals and rivulets, severely affecting the coastal and riverside flora and fauna.

In recent years, semi-intensive and intensive farming methods with a high stocking density have led to high levels of feeds, pesticides and antibiotics being used. Increase in water exchange means that chemical inputs (disinfectants, antibiotics, fertilizers, pesticides, hormones) and wastes (uneaten food, feces, ammonia, phosphorous and carbon dioxide) may reach and contaminate groundwater supplies, rivers and coastal habitats. Shrimp pond effluents high in organic matters have a high biological oxygen demand (BOD) and can cause oxygen depletion in receiving waters (EJF, 2003).

Though the Bureau of Fishery Resource Protection and Bureau of Environment Protection have provided a number of warnings on the severe consequences caused by persistent pollutants in aquatic environment and wetland degradation, illegal shrimp farming development in areas of ecological importance is continuing at a rapid rate (Hong, 2003).

#### *Impacts of shrimp farming on the spread of diseases and epidemic*

In some extensive culture ponds, due to bad water quality, disease and pests caused by bacteria or fungi begin to appear. Due to the lack of preventative measures and pathological and nutrition methods for shrimp culture, the prevalence of the diseases slowly grows and expands. This greatly affects culture yields. In many cases, the diseases spread throughout the whole area, but there are no effective measures to counteract them.

In 1994, the shrimp epidemic in the South provinces spread over an area of 84,858 ha resulting in a damage of approximately 294 billion dong (Seaprodex, 1995). There are many reasons for that, but an important reason is deforestation degenerating the environment strongly, facilitating the wide spread of epidemics.

The shrimp epidemic has left a terribly bad impact on the economy of coastal Southern Vietnam. Many shrimp breeders went bankrupt, the life of working people encountered a lot of problems, a number of freezing factories lack of materials and workers are unemployed. To meet their immediate needs of life, people continue to destroy the already exhausted or newly-planted mangroves, leading to even more serious deterioration of the resources (Hong ed., 1999).

The forest clearance for shrimp farming has enabled the development of anopheles. After the forests were destroyed, the water becomes stagnant, a species of Cyanophyta, a kind of food for anophele larvae, has enough light to develop and thus facilitates the quick growth of these mosquitoes. In the last few years, malaria has spread to some coastal areas with mangroves such as Binh Dai- Ben Tre and Ngoc Hien- Ca Mau.

## **Recommendations**

It is urgent and practical to make an overall plan of production on the areas with mangroves, and to conduct investigations and surveys of the exact current status of mangroves, shrimp farming land, agricultural land, eroded land, accretion land in coastal provinces with mangroves through satellite photos, aerial photos and field trips done by professional staff. Survey results will be a scientific basis for the overall planning for rational use of coastal zones.

Assessments with regards to the economic resources and environmental impacts of some models in the silvo-fishery should be carried out in order to evaluate achievements to be replicated and problems to be solved. It is necessary to continue to build other shrimp-mangrove integrated farming systems to determine actual comparative advantages and find the most sustainable pattern.

Training courses should be provided for forestry and fishery extension staff, leaders and officials of forestry and fishery and planning and investment sectors about the significant roles of mangroves, the close relationship between mangroves and marine resources and techniques of shrimp farming so that they will become active information disseminators guiding local people to rationally use mangroves and not to cut down the forests for shrimp farming.

The Ministry of Fisheries and local authorities are recommended to have planning of shrimp farming outside mangrove areas such as in low productivity rice fields inside seadykes; investment in adequate water supply and drainage systems should be made to create a favorable condition for raised shrimps.

Research on and development of other marine product farming in coastal areas such as oyster farming, snail farming or high economic value fish farming should be conducted which are suggested to gradually replace shrimp farming in mangrove areas. It is also necessary to promote poly - culture and diversification of aquaculture to protect against unfavorable market conditions and reduce risks of diseases.

Forest land allocation should be further promoted in coastal areas. On allocated forest land, farmers are required to protect 70-75% of forests and allowed to use 30-25% of the land for aquaculture. Besides, they have the right to use properly thinned forest products.

Propagation and educational activities for local population on the protection of natural resources and mangrove environment combined with family planning education should be enhanced. The specific activities are to propagate on the national and local mass media, to publish and distribute mangrove books for coastal teachers, schoolchildren and dwellers in order to avoid and limit the increasing damage caused by natural disasters.

There needs to be a state project or programs to evaluate the use of mangroves for shrimp and other aquatic animal farming and to compare the long-term environmental and resource impacts in areas that mangrove are cleared for other economic purposes, to mangrove protection

It is suggested that sponsors should support Vietnam in addressing the environmental and social issues arising from the rapid development of shrimp aquaculture, and in implementing habitat restoration schemes, including mangrove planting and restoration of lands abandoned, polluted or salinized by aquaculture activities.

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## THE RELATIONSHIP BETWEEN MANGROVES AND AQUATIC RESOURCES



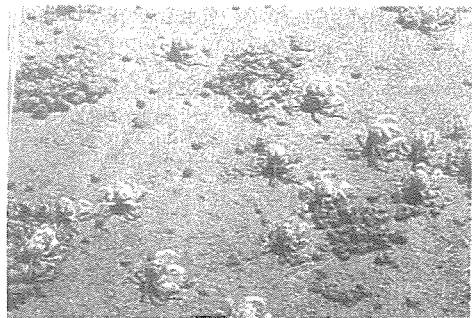
The rehabilitated mangroves in Can Gio  
- Ho Chi Minh City



The litter fall of mangroves are decomposed into food  
for many aquatic resources by micro organisms



Mud flat flooded by tides with a high volume  
of mangrove phytodetritus offers a diversified food  
source for many marine species



Many of *Uca* and *Secerma* living on mud flats form  
a link to the important food chain



Mangrove forests are places for many fishermen with  
nets and lights to earn their living

Happy fisherman at Thai Thuong Commune  
- Thai Thuy District after catching a very valuable fish  
(*Sciena sp.*) near the mangrove areas. The air bladder  
of this is used to make special thread in surgery  
operation with the price 10,000 to 20,000 USD/bladder



## IMPACTS OF SHRIMP CULTURE ON MANGROVES



Tens of thousand hectares of dense mangrove forests in Ca Mau cape have been converted to extensive shrimp culture system



Indiscriminate deforestation for making shrimp ponds has turned mangrove area into fallow land



All *Bruguiera gymnorrhiza* trees and other mangrove species died after being inundated for a long time in shrimp ponds of Dong Rui Island, Quang Ninh Province



All mangrove areas in Cam Ranh District, Khanh Hoa Province have been converted to tiger shrimp nurseries and shrimp ponds



Due to weak water exchange, the pond environment is strongly polluted



Conversion of natural mangroves forest to shrimp culture in Ninh Ich - Ninh Hoa - Khanh Hoa Province