



## MANGROVE RESTORATION FOR ENVIRONMENTAL PROTECTION AND COASTAL LIFE IMPROVEMENT IN VIETNAM

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Received 7 October 2018; Accepted 15 November 2018

### Abstract

*Annually, the coastal zone of Viet Nam is experiencing various adverse impacts of natural disasters such as storms, floods, high tide, and northeast monsoon. For many generations, local people in Vietnam's Northern delta region have known how to plant mangroves to protect dykes, rice fields, properties and people life.*

*However, the region witnessed the conversion of mangroves into sedge fields and shrimp farming ponds for export as a result of economic development during the post-war period. The consequence is a remarkable decrease in mangrove area.*

*Since 2001, under the financial support of some NGOs from developed countries and technical supports from mangrove research institutes and centers, mangrove restoration and rehabilitation have reversed the trend of deforestation in Vietnam. The area of mangrove has increased over 15,000 hectares by 2008. Due to good protection and management work, these mangrove plantations have shown their effective role in local life improvement and sea - dyke protection from big storms. Meanwhile, places without mangrove plantations have witnessed the serious damage of solid concrete dykes. According to the World Disaster Report in 2002, the rehabilitation of mangroves in coastal provinces from Quang Ninh to Ha Tinh cost about 1.1 million USD and helped save 7.3 million USD/year used in sea-dyke maintenance.*

*On the threshold of the 21<sup>st</sup> century, Vietnam's government has taken some measures for mangrove reforestation, conservation and management. Moreover, with the supports of some NGOs, mangroves have been replanted effectively.*

*Nevertheless, challenges still exist. Therefore, urgent solutions should be worked out for protection of this valuable ecosystem. Education and communication on mangroves for local managers and communities are very important. The findings have contributed greatly to awareness rising among managers and communities about mangrove restoration and protection in response to the impacts of climate change and sea level rise.*

**Keywords:** Mangroves; Mangrove Ecosystem; Restoration; Environment; Climate change and sea level rise.

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## 1. Introduction

Mangroves are among the most important and productive ecosystems of the world. They provide food, habitats and nursery grounds for many commercially important aquatic and terrestrial animals in coastal areas. Mangrove forests stabilize coastline, sea - dykes and provide a barrier against storms, cyclones, tidal bores and other potentially damaging natural forces. Mangroves have contributed significantly to the socio - economic lives of coastal dwellers in Vietnam. Mangrove ecosystems have been traditionally exploited as building materials, charcoal, firewood, tannin, food, honey, herbal medicine, aquatic resources and other forest products.

Population and economic pressures, particularly since the second Indochina war, have led to severe depletion of Vietnam's mangrove ecosystem. The intensive use of defoliants and herbicides by US in the war (1962 - 1970) brought enormous destruction of mangrove forests in Southern Vietnam. Overexploitation, conversion of mangrove areas to agricultural land and salt pans, human settlement and particularly shrimp aquaculture along the coast have contributed to the steady decline and degradation of mangrove ecosystems. It is affirmed that shrimp farming is a major threat to mangrove ecosystem in Vietnam.

In order to cure that, in this paper, human impacts and especially shrimp culture will be analyzed. Besides, effects of reforestation on the biodiversity and environmental protection, and some issues of management and sustainable use of mangrove ecosystems will be presented. Reforested mangroves have helped improve the life of the poor and change their awareness of the role of mangroves. However, there have been some challenges to the protection and sustainable use of mangroves that need to be dealt with. This paper also proposes some recommendations for sustainable management of this highly potential - but - sensitive ecosystem.

## 2. Extent and distribution of mangrove forests in Vietnam

Vietnam's 3260 km long coast and a dense river system with abundant alluvia potentially support a substantial area of mangroves.

According to the Report "*Roots of the water: legal Frameworks for Mangrove PES in Viet Nam*" done by the Katoomba Group's legal Initiative Country study Series, Vietnam had, to the end of 2010, an estimate of 209,741 ha of mangroves, of which 152,131ha was planted and 57,610 ha was natural ones (Tab.1). Of the total mangrove area, 60% exists in the Mekong delta, with an additional 20% found in the southeast region, and almost 20% in the coastal north and Red River delta [15].

**Table 1. Current Distribution and Origin of Mangrove in Vietnam**

Location	Total Area (ha)	% of total	Natural (ha)	Planted (ha)
Quang Ninh, northern region	37,651	18	19,745	17,905
Central-northern region	1,885	1	564	1,321
Central-southern region	2	0	2	0
Southeast region	41,666	20	14,898	26,768
Meking river delta	128,537	61	22,400	100,137
All Vietnam	209,741	100	57,610	152,131

Sources: Hawkins et al, 2010

Viet Nam has lost over 80% of its mangroves since the 1950s. Spraying of defoliating agents during the Vietnam War and the rapid expansion of the aquaculture industry in the early 1980s are the most serious threats to mangrove. In response to this, mangrove restoration and rehabilitation have been ongoing since 1991, but the process of decline was only reversed in 2001 [14].

### **3. Traditional use of the mangrove ecosystem in Vietnam**

The mangrove forests of Vietnam have been widely and variously used by coastal dwellers who live in or close to them for thousands of years. The forests provide resources for the livelihood and fishery industry of the coastal communities. Commercial and traditional products of mangroves are diverse and include commodities such as timber, charcoal, fuel wood, thatching materials, herbal medicine, folder, and honey [3]. The greater part of the inhabitants here has been dependent on the wealth of fishery resources within mangrove waterways and mudflats which include many species of fish, crustacean and shellfish.

#### **3.1. Firewood**

In the most coastal communes, there are no inland forests. So, mangroves remain the main source of domestic fuel. Recently, coal has been used. Some rich households use gas in cooking.

#### **3.2. Charcoal**

*Rhizophora apiculata* and *Bruguiera parviflora* wood are converted into charcoal. Under the French domination and the old Sai Gon government, the charcoal industry was dominated by private entrepreneurs. After 1975, the forestry enterprises managed the charcoal

kilns. In recent years, there has been a sharp drop in charcoal production due to poor forests.

#### **3.3. Tannin**

Tannin from mangrove barks was used last century for the manufacture of leather, ink for dyeing fishnet, ropes, sails and textiles. In recent years, synthetic tannin has been used to replace this material.

#### **3.4. Nipa palm products**

Nipa palm is a very popular plant in the coastal area of southern Vietnam. Nipa shingles are used for houses, and poultry and piggery roofs. The fronds are used to wrap up a sticky rice coconut cake; the leaf stalks are used for floats of fishing nets and the ribs are used for making brooms. The soft endosperm of mature seeds are eaten [5].

#### **3.5. Medicine**

The sanitary condition of dwellers in the mangrove areas is often poor, so diseases are common. The traditional medicinal plants have not been studied scientifically or have been subject to experimentation [1]. Field investigation showed that there are 33 species of true and associate mangrove species that are used for treating about 44 diseases [7].

#### **3.6. Bee honey**

Along the north coast of Vietnam, beekeeping is popular. When the *Kandelia candel*, *Aegiceras corniculatum* are in bloom, the hives are placed in temporary holes along the sea-dykes or on the floor of Casuarina forests to avoid the sunlight and heat and to enable the bees to feed on the blossoms. When the blossoms finish, the hives are brought inland where there are many trees and vegetables that have nectareous flowers [5]. Several tens of metric tons of honey are produced per year.

### 3.7. Fodder and food

Mangrove foliage can be used safely as fodder, feed and meal since it contains significant quantities of all necessary minerals, vitamins, amino acid, protein, fat and crude fiber necessary for the growth and nourishment of livestock [4].

In the coastal area, many domestical animals graze on mangrove foliage.

Some kinds of mangrove plants can be consumed by human such as *Avicennia* seeds, *Kandelia candel* propagules, young leaves of *Acrosticium aureum*, *Premna integrifolia*, which are used as vegetables.

### 3.8. Other minor products

Pneumatophores of *Sonneratia* species and *Excoecania agallocha* are fashioned into bottle stoppers, net floats, and frames for sunhats. The *Xylocarpus* species with fine-textured, deep-brown wood have been used in statue carving,... [8].

### 3.9. Aquatic resources

There is an evidence that mangrove forests are used as shelters and nursery grounds, as permanent habitats for some

species and breeding grounds for some coastal species [1].

The livelihood of tens of millions of poor people in the estuarine and coastal areas of Vietnam has depended on the aquatic resources in and around mangroves. Aquaculture is also widely practiced in mangroves.

## 4. Human impacts on the mangrove ecosystem

Like other Asian regional countries, mangrove forests in Vietnam are under threat of severe destruction.

The greatest impact has resulted from the intensive use of chemical herbicides and defoliant by the American forces (1962 - 1970). There is today increasing conversion of mangrove areas to other economic purposes especially shrimp farming. The rapid industrialization of coastal areas supported by Doi Moi, the renovation policy implemented in 1986, has had a major impact on the environment. Unchecked pollution of mangrove waters is another problem which contributes to the rapid degradation of mangrove ecosystem [8].

### 4.1. Chemical warfare

Table 2. Loss of forest and wood caused by chemical warfare in Southern coastal areas

Localities	Area sprayed (ha)	Loss of wood (m <sup>3</sup> )	
		High-grade wood	Low-grade wood, firewood
Eastern part of the South	35,575	1,979,640	889,350
Coasts and Mekong Delta	40,334		2,420,000
Ca Mau Peninsular	73,942	19,979,850	3,253,450
Total	149,851	21,959,490	6,562,800

Source: [3, 9].

In the southeast of Vietnam, mangrove forests served as substantial bases for military operations during French and American Resistant Wars.

For this reason, American army used napalm and herbicide defoliant at high dosage to kill mangroves while devastating war-resistant bases destroyed

an estimate of 149,850 ha [9]. The loss of wood in an area of 149,851 ha amounts to thousands of cubic meters (Table 2).

### 4.2. Overexploitation of mangrove forest wood

After the war in Southern Vietnam, repatriated people together with massive

migrations from outside sharply raised the demand of wood for construction, firewood and charcoal making. On the other hand, the annual increase of logging by forest sector also adds to the forest depletion while forest resource is getting reduced. At times villagers of Vien An Dong, Dat Mui communes of Ngoc Hien District rushed to establish thousands of charcoal - making kilns. In recent years, exploitation of mangrove forest products has been reduced as mangrove fuelwood has been replaced by coal and gas.

#### ***4.3. Conversion of mangroves to agricultural land, and salt pans***

Previously, mangroves were converted to agricultural land and salt pans, which brought about low productivity though. Therefore, this type of conversion is no longer present for the time being.

#### ***4.4. 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, dropped from over 200,000 ha before 1962 to 64,572 ha in 1999, and that almost all of this destruction has been from shrimp culture [16].

In Tra Vinh province, at Mekong delta, before the Indochina war (1943), mangroves covered 54.1% of natural area with 65,000 ha [11], decreasing to 6002 ha (approximately 5%) in 2002 (2,500 ha of which are newly planted mangroves). The forest coverage remained only 5.8% (Viet, 2003).

In Ben Tre in 1943, there were 48,000 ha and the coverage was 42.4% [11]. In 1992, the total extent was 1009 ha (0.89%) [2].

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 [10].

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 all mangroves to tiger shrimp farming purpose.

### **5. Mangrove rehabilitation and management**

After the unification of the country (1975), the central government and coastal localities in the South have paid much attention to mangrove afforestation on the land sprayed with warring herbicides. In the period 1975 - 1998, 67,637 ha of mangroves was afforested and the investment budget for reforestation in these areas is 14,784,600 US dollars [9].

Severe erosion was observed in the dead mangrove areas and along the riverbanks. Analysis of aerial photos showed that the water surface area had increased. Since 2001, mangrove restoration and rehabilitation have reversed the trend of deforestation in Vietnam, with an increase of over 15,000 hectares of mangrove forest by 2008 [15].

In the 1980s, spontaneous destruction of mangroves for economic purposes took place in many areas. Therefore, in the

early years of the 1990s, the government of Vietnam invested in reforestation of inland and coastal forests. Statistical data collected from localities showed that nearly 53,000 ha of mangroves was rehabilitated (Tab.3).

From 1997 to 2010, about 38,000 ha of mangroves was planted in 6 northern provinces and mekong delta under the sponsorship from the government and NGOs.

In the framework of the program 661, the level of expenditures for reforestation and protection after planting is just U.S. \$ 500/hectare and U.S. \$ 5/hectare/year respectively, much lower than the actual cost.

Climate change scenarios and devastating impact of the Asian tsunami, international organizations have been widely promoting the protection and rehabilitation of coastal areas. The International Red Cross Disaster Risk Program has been run in eight provinces with 18,000 ha of mangroves planted along a 100 km stretch of sea dike. Mangrove for Future is a partnership-led initiative to promote investment in coastal ecosystems. The program supports local community activities in the conservation and management of coastal ecosystems.

On the threshold of the 21<sup>st</sup> century, the government of Vietnam has paid more attention to environment and resource protection. Some mangrove related strategies have been approved, namely Environmental Protection Strategy for the period of 2001 - 2010 [13], Fishery Development Strategy 2001 - 2010 (MOF, 2002). Forestry Development Strategy 2001 - 2010 [12], Strategy for Protected Areas 2002 - 2010, Strategy for Management and Conservation of Wetlands 2003 - 2010 (MONRE, 2003), Decision No. 18/2007 on Vietnam Forestry Development Strategy 2006 - 2020 and Decree No 99/2010 on the

Policy for Payments for Ecosystem Services. Program 661, planting five million hectares of forest (ended in 2010 with only 2.5 million hectares are planted within 12 years).

Under Decision 667 on May 27, 2009, a new Dike development program was approved by Vietnamese government, This program will restore and upgrade the 900 km sea dike system from Quang Ngai to Kien Giang with establishment of a protective mangrove forest situated between sea dike and the coastline.

In 2008, the MARD announced a plan of 20 trillion investment in upgrading coastal dike system and mangrove was incorporated as a protective mechanism for constructed dikes. The prominent program “Restoration and Development of Coastal Mangrove Forest (2008 - 2015)”. The key institutions implementing this program include: the MARD as the national coordinator, the MONRE, technical agencies and the People’s Committee in 29 coastal provinces as the implementing agencies [14].

Decree No 99 of 2010 on the Policy of Payments for Ecosystem Services (PES), stipulates that the consumers of some certain ecosystem services must pay the providers of ecosystem services for valuable forest ecosystem services.

MARD is responsible for overall forest management in Vietnam. The establishment of the Vietnam Administration of Seas and Islands (VASI) under MONRE in 2008 with its role is to ensure that different sectors implement a coordinated approach in terms of coastal development to initiate an Integrated Coastal Zone. However, the roles of MARD and MONRE in forest management overlap considerably, which is a potential for confusion about regulatory agencies.

**Table 3. Status of rehabilitated mangrove areas in some coastal provinces**

No	Province	Area funded by government program (ha)	Source	No	Province	Area funded by government program (ha)	Source
1	Hai Phong	234	Hong & Dao, 2002	8	Ben Tre	1,200	Sub-FIPI, 1995
2	Thai Binh	1,399	- ditto-	9	Tra Vinh	4,137	Viet, 1999
3	Nghe An	563	- ditto-	10	Soc Trang	1,404	Khem, 1998
4	Ha Tinh	46	- ditto-	11	Bac Lieu	716	Ly, 1999
5	Ba Ria - Vung Tau	3,615	Trinh, 1998	12	Ca Mau	18,500	Vinh, 1998
6	Ho Chi Minh City	20,636	Tuan, 1998	13	Total	52,913	
7	Tien Giang	463	Khang et al., 1999				

## 6. Recommendations

1. 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 all coastal provinces with mangroves through satellite photos, aerial photos and field trip done by professional staff. Survey results will be a scientific basis for the overall planning for rational use of coastal zones.

2. Research and development of other marine product farming in coastal areas such as oyster farming, shellfish 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.

3. Assessment with regard 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.

4. As an urgent matter, the proportion of space used for shrimp farming should be investigated so as to make sure that shrimp ponds occupy only 1/5 or 1/4 of the surface following agro-silvo-fishery models in mangrove areas. Wherever shrimp business proves ineffective, lands should be withdrawn for reforestation and creation of long - term habitats for sea-product keeping [6].

5. With salt fellow lands that are rarely flooded in tidal water, native species naturally growing around, such as *Xylocarpus moluccensis*, *Spondias cytherea*, *Tamarindus indicus*, *Excoecaria agallocha*, *Heritiera littoralis*, *Thespesia populnea*, *Ceiba pentandra* and *Leguminosae* species should be planted for the dual purpose of preventing lands from marginalization and firewood supply.

6. Solving socio-economic problems and planning residential zones in mangrove areas:

Pressing problems need to be solved are:

- Introduction of an educational program for mangroves and sea-product protection as a part of the software program taught at all school levels.

- Training key local officials and selected cadres from forestry and fishery departments on the role of mangrove ecosystems in economic growth and natural conservation.

- Formulation of transparent policy tools and regulations on using a part of earning from selling frozen shrimp products (through tax tariff) for reforestation.

- Application of enforceable policies to restrict population growth and formulate population planning for each mangrove area.

- Speeding up the allocation of forests and forestry lands to people for planting and protecting mangroves.

- Long-term plans for utilization of coastal mud flats should be made available so that improper bidding of these lands could be eliminated and the lands are secured for the poor.

- A national action strategy on mangrove management and relevant institutions and applicable policies for sustainable management of mangrove forests should be promulgated as soon as possible.

### 7. Some recommendations for strengthening responses of mangroves to sea level rise and climate change

Causes of climate change are diverse and complex, including both natural and human induced ones. However, men have had adverse impacts (through activities of greenhouse gas emission from industrial sectors, transportation, indiscriminate forest felling in riverhead areas,...); moreover, protection mangrove forests along the coast have been cut down for shrimp ponds, and other activities for immediate benefits, facilitating attack by natural disasters; as a consequence of this, large damage to the community has been observed (Hong et al., 2006, Tuan et al., 2009). Therefore, in order to minimize the impacts, the government, managers, scientists and communities need to work together to define and protect mangrove forests for well adapting to climate change (Tab. 5).

**Table 5. Applicable measures to mangrove in response to climate change**

No	Activity	Responsible	Note
1	Define and protect mangrove areas of strategic significance to response to climate change. Special attention should be paid to the protection of mangrove areas that tend to move seaward as they are easily vulnerable to human impacts. Monitor human impacts on mangrove forests <sup>f</sup>	Managers	Mangrove forests rich in sediments, freshwater, with abundance of grown - up trees for supply of a good seed source. Human activities threatening mangroves are predicted to increase when sea level rises because people may build sea - dykes or wave - buffering walls to prevent soil erosion
2	Protect and propagate typical mangrove species or ecosystems for prevention once natural hazards occur. The best samples should be kept in natural reserve/protected area system	The government	Classification based on diversity level or ecological function of mangrove areas

3	Restore mangrove areas that have been deteriorated, generate livelihoods for local communities, reduce pressures on adjacent mangrove areas	The government, scientists	Planting of various types of trees for mangrove restoration, increasing diversity and response ability of mangroves
4	Establish greenbelts and buffer zones, facilitating mangrove movement inland when sea level rises, mitigating impacts of adjacent land- use activities	Managers	The greenbelt should range from 200 m to 1.5 km wide for open coast and 30 - 50 m for riverside areas
5	Study plant structure, density, abundance and diversity of mangrove plant species and molluscs in mangrove areas, primary production, hydrological regime, sedimentation and rising sea level	The government, scientists	Study, evaluate sensitiveness of mangroves to climate change; study and forecast change in species composition in mangrove ecosystems
6	Develop cooperation with stakeholders to generate budget for response to climate change.	The government, scientists, managers	Encourage development of alternative livelihood sources for communities living on mangrove forests, honey making, seagrass culture, algal culture...

## 8. International cooperation

Rehabilitation and development of mangrove productivity is imperative not only for individual countries but also worldwide. Attempts should be made to carry out studies that may facilitate international cooperation in utilization and sustainable management of this ecosystem.

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