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MANGROVE FOR PRODUCTION AND PROTECTION

A Changing Resource System: Case Study in Can Gio District, Southern Vietnam

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

Throughout South East Asia and many other parts of the world mangrove forests have multiple functions, which are increasingly recognized at local, national and global level. They range from conservation of biological diversity to spawning grounds for many fish and other aquatic species. Charcoal and fuelwood are also important products in particular for local people living close to the mangrove forests, both as a source of energy for domestic use and as a source of off-farm employment and income. Initially the Regional Wood Energy Development Programme in Asia, through a case study in Thailand, focused mainly on the mangroves as a source of high quality charcoal. From this study and much other research it became clear that woodfuels from mangroves should not be studied in isolation but be assessed from a broader perspective on mangrove management.

RWEDP was therefore very pleased with the offer of the Ho Chi Minh City Forest Department and Agriculture Service to prepare a study of a particular mangrove area in Southern Vietnam with this broader perspective in mind.

Mangrove forests have made considerable contributions to the socio-economic development of Vietnam, particularly of the coastal communities. Such contributions include the supply of fuelwood, charcoal, poles, construction materials, pulp, etc. Besides the direct economic value of wood and fuel, mangroves also play an important role in the sustained production of fish, prawns, cockles, crabs, etc. and are vital to the long-term stability of coastal fisheries.

However, in recent years, there has been a growing conflict in the use of mangrove lands with the conversion of mangrove forest land to aquaculture involving embanking and barricading of waterways within the forest to raise shrimp. Such activities increasingly threaten not only the stability of the mangrove ecosystem, but also the livelihood of the coastal communities who traditionally have been dependent on the mangrove resources for their income and subsistence.

The present study of Can Gio District, 65 km south of Ho Chi Minh City, South Vietnam provides information on the management of the mangrove forest with regard to forestry, fisherier, land protection and land allocation and also on the impact of development activities on the mangrove environment.

This report was prepared by Mr. Vien Ngoc Nam, HCMC Forest Department and Mr. Tran Viet My, Deputy Director, Forestry Scientific and Applications Center under the supervision of Dr. Le Van Khoi, Deputy Director of Ho Chi Minh City Agriculture Service, Mr. Nguyen Son Thuy of HCMC Forest Department and Madame Le Thi Lien, Director, and Mr. Ly Tho of Forestry Scientific and Applications Center. We are grateful to their commitment and contribution to increasing our knowledge about this important ecosystem. From the FAO - Regional Wood Energy Development Programme in Asia Ms. Margot C. Klute, APO/Participatory Forestry/Wood Energy Planning assisted in the gender study in An Nghia village, Ms. Marjukka Mahonen, APO/Agroforestry and Dr. Aroon Chomcharn, Wood Energy Conversion Specialist supervised the study, and Mr. Michael Jensen, APO/agroforestry contributed extensively to the preparation of the final report. Ms. Panpicha Issawasopon provided editorial support and prepared the document for printing.

It is hoped that this publication will be useful to research and training organizations, practitioners and policy makers interested in the sustainable management of the mangrove ecosystem and environmental protection in the region.

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SUMMARY

During the last 15 years, more than 20,000 hectares of mangrove forest have been replanted, mainly with *Rhizophora apiculata* in Can Gio District, south of Ho Chi Minh City (HCMC) following massive wartime destruction. This process has served to meet the large demand for woodfuels and construction materials in HCMC, as well as to re-establish suitable conditions for the development of various economic activities such as fishery, aquaculture, charcoal production and others.

Conflicting interests have already exerted a lot of pressure on this newly re-established resource, in particular the rapidly escalating, and up-to-now unsustainable , practice of shrimp farming, but also the growing population's need for more agricultural land. Because these activities so far have been carried out in a random, uncontrolled manner, they have caused a number of environmental problems such as water quality degradation and salt intrusion into upriver agricultural lands, both leading to reduced yields of shrimp and rice and even reduced tree growth. There is therefore an urgent need for an overall management plan for the area incorporating the different interest groups and government agencies to ensure a balanced and sustainable development.

On May 29, 1991 the Council of Ministers declared the Can Gio mangrove forest area as an Environmental Protection Forest and thereby put more emphasis on the role of mangrove forest in coastline and riverbank stabilization, as a breeding and nursery ground for marine fauna and as a habitat for wildlife. This new status however, does not exclude various sustainable productive activities, of which there appears to be particular potential for small scale charcoal production, based in the mangrove communities. Due to the favourable proximity to HCMC, many other products may have potential as well and should be explored further. This also includes the potential of the area for "ecotourism".

A number of legislative and educational measures are needed to increase the participation of local mangrove dwellers in the sustainable management of mangrove resources, including speeding-up land allocation schemes, increasing the farmers' economic benefits from the forest and increasing general awareness of the mangrove ecosystem. The latter also applies to decision makers outside the mangrove area.

In order to reduce the time spent by the mangrove families for collecting fuelwood and cooking, as well as to improve their economy, improved cook-stoves should be further promoted and tree planting around homesteads and along roads, canals etc should be supported. This would in particular benefit the women.

Because of the close proximity to HCMC and the rapid development currently going on in Vietnam, increased pressure on the Can Gio mangrove area can be expected in the near future. Thus there is an urgent need for clear policies and management plans including land zonation patterns and technical guidelines. This planning could be considerably facilitated by the establishment of a mangrove advisory committee, representing technical expertise from the fields of forestry, fishery and wildlife.

Although measures to ensure sustainability should be implemented immediately, there is still a need to gain further knowledge on the implications to the economy and the environment of different activities as well as to increase our general understanding of the mangrove ecosystem. This calls for increased research efforts and co-operation by the concerned research institutions.

1 INTRODUCTION

Because of its long coast line and its suitable environmental conditions, including a tropical climate and a large tidal range, Vietnam has a potentially large area of mangrove forests (Saenger 1983). Formerly these forests covered about 400,000 ha throughout the country, but now only about 190,000 ha remains (1986). About 57% of the original mangrove forest area was destroyed during the second Indochina war, primarily by herbicide spraying during the period between 1965-1970 in the South. Unplanned exploitation to practise agriculture and fishery activities has also contributed to the widespread destruction of mangroves. Of the remaining 190,000 ha, nearly 126,837 ha (1983) are concentrated in the South. The degradation of mangrove forests has taken place both in terms of quantity and quality. Today, most of the mangroves are newly established forest plantations, mixed secondary forests, degraded pastures and shrubs.

After 1975, Ho Chi Minh City (HCMC) planted more than 20,000 ha of *Rhizophora apiculata* in Can Gio District to restore the mangrove ecosystem and ensure that the mangrove forest would serve its dual functions of protecting the environment and providing woodfuels, construction materials and other products By declaring this area an environmental protection forest the protective function has now been given the highest priority. However, because no privately owned forests exist, the large demand for woodfuels still exerts great pressure on state forest resources, including mangroves. Furthermore, the establishment of shrimp ponds in mangrove areas has increased rapidly, often causing considerable damage to the mangrove forest ecosystem. The aims of this study are therefore:

1. To bring about an improved understanding of the mangrove forest ecosystem in Can Gio;

2. To identify a suitable way of managing mangrove forests in order to satisfy their multiple functions: Protection of the coastline against tidal waves and storms, production of wood and non-wood products for employment and income generation, as well as maintenance of the ecological balance in the estuaries, thereby protecting the breeding grounds and ensuring a sustainable catch of economically important offshore fish and shrimps;

3. To identify and propose a silvo-fishery plan for the Can Gio mangrove forest which will control the maximum surface area used for shrimp ponds and avoid damaging the environment;

4. To contribute to reducing the fuelwood deficit for Can Gio in habitants by introducing a portable improved cookstove to replace the common traditional "three stone fire". This should help reduce the illegal exploitation of mangrove forest and improve the economy of the mangrove residents;

5. To explore in further detail the socio-economic conditions of mangrove dwellers, with specific attention to gender issues.

2 MANGROVE FORESTS IN VIETNAM

Although it is not always sufficiently recognized, mangrove forests occupy a position of great importance as a natural resource with a high (potential) economic value to the country. Indeed, mangrove areas have often been regarded as wastelands to be reclaimed for economic development (Paw and Thia-Eng, 1991). As the interface between the land and the sea, coastal mangrove areas are important not only as a source of forest and aquatic products, but also play an important role in the protection of the coastal environment, in the accretion of land and as an important breeding and nursery ground for many prawns, fish and other marine animals. The products derived directly or indirectly from the mangrove forests generate many social and economic benefits to the country, and if managed more wisely than at present, such benefits could be sustainable.

2.1 Distribution

Previously, mangrove forests in Vietnam occupied an area of 400,000 hectares. They were particularly extensive in the southern part of Vietnam. From Vungtau, southeast of Ho Chi Minh City and along the coast of the Mekong delta to the tip of the Camau Peninsula, mangrove forests covered 250,000 hectares in 1943, 191,800 hectares in 1983 and 156,000 hectares in 1988. During the past war, the area of mangrove forests was seriously reduced with about 36% of the mangrove area in South Vietnam destroyed by herbicides. After 1975, many mangrove areas were over-exploited or converted to shrimp or fish ponds or for agricultural cultivation.

Four mangrove forest zones in Vietnam were distinguished by P.N. Hong (1984):

a) Zone 1: The northeast coast from Ngoc cape to Do Son cape (see map in figure 1). Mangrove forest covered an area of 39,400 hectares with highly suitable environmental conditions: An estuarine region, shore protected by islands, abundant alluvium, large tidal amplitude and saline water. The only limitation is the low temperature in winter (Northeast monsoon).

b) Zone 2: The north delta coast (from Doson cape to Lach river mouth). Mangroves covered an area of 7,000 hectares with large rivers, abundant alluvium and brackish water. But few protecting islands, and strong winds and waves.

c) Zone 3: The coast of central Vietnam (from Lach river mouth to Vung Tau cape). Mangroves occupied 14,300 hectares with less suitable conditions: Sloping seashore, short rivers, little alluvium, strong winds, waves and storms. No mangroves along the coast, only along rivers.

d) Zone 4: The south delta coast (from Vung Tau cape to Ha Tien). Mangroves covered 191,800 hectares with favourable environmental conditions: Low topography, many rivers and canals, abundant alluvial deposits, half-day tide with large amplitude, very few storms and favorable tropical climate. This is the largest and richest mangrove area of Vietnam.

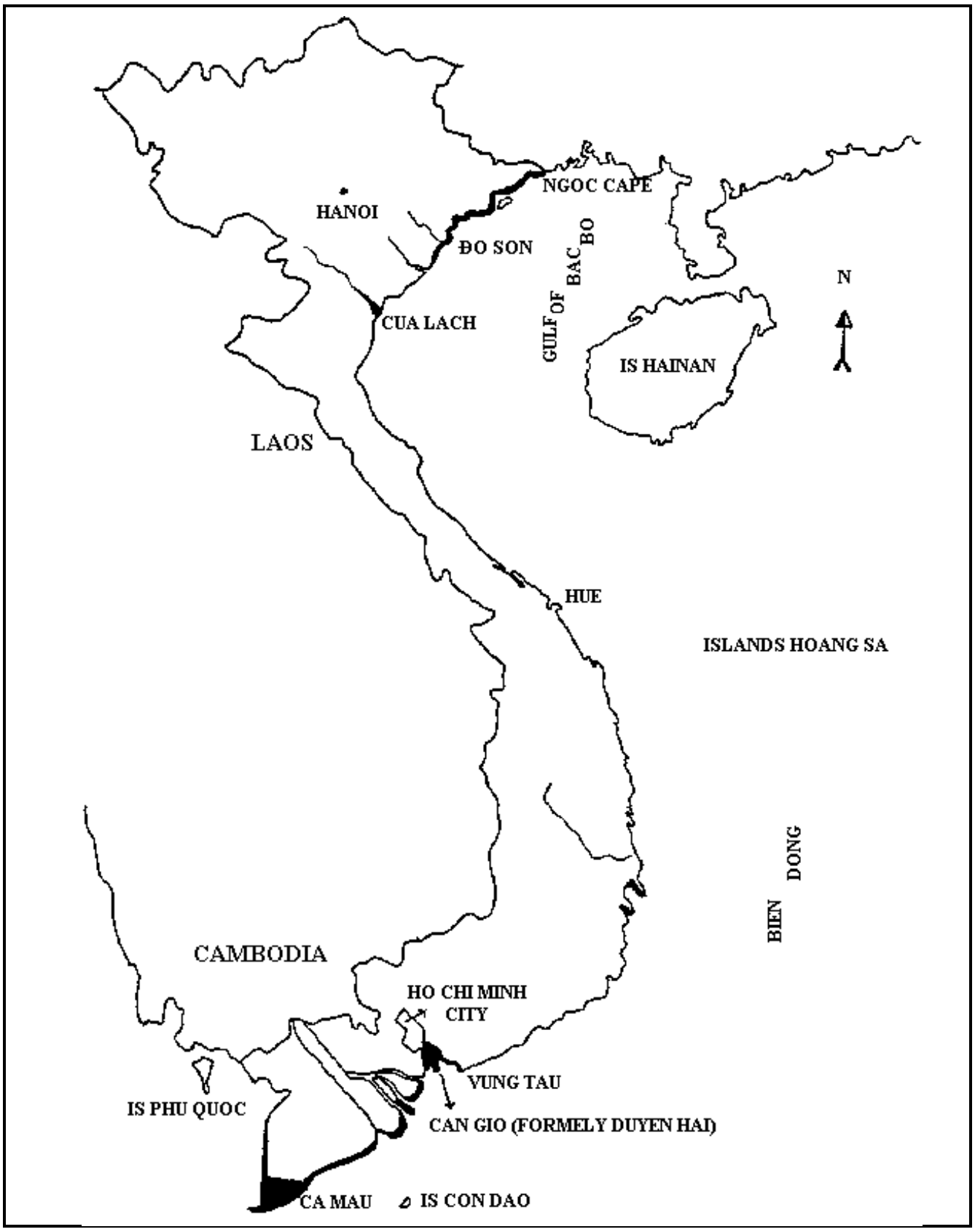

Figure 1: Distribution of Mangrove Forests (Black Coloring) in Vietnam

2.2 Flora and Fauna

Mangrove forests of Vietnam comprise about 52 known tree species belonging to 26 genera (Hong, 1986). The potential uses of mangrove tree species can be grouped as follows with many of these species having multiple uses:

* 30 species can be used for fuelwood, wood, charcoal and wood chips
* 14 species for tannins
* 24 species for green manure and soil improvement
* 14 species for fodder
* 5 species for medicines
* 21 species have nectar for bee keeping
* 1 species for alcohol, sugar, vinegar and fermented drinks.

The mangrove fauna comprise both aquatic, semi-aquatic and terrestrial communities: 258 species of fish, 8 species of amphibians, 21 species of reptiles, 67 species of birds, 4 species of mammals, 28 species of crustaceans, 10 species of mollusc and 4 species of insects has been reported (Hong, 1992). Given the number of fauna elements reported from mangrove areas in Thailand (Chantadisai, 1989), the Vietnamese figures, especially for mammals, birds and insects are likely to increase in the future following further research.

2.3 Mangrove Deforestation

As in many other countries in Southeast Asia, mangrove forests in Vietnam have been heavily degraded, and the area under mangroves is still decreasing day by day. The 400,000 hectares of mangrove forest found in Vietnam in 1943, had been reduced by nearly 40% to 252,500 hectares in 1983. In addition, the quality of the remaining forests has also clearly decreased. Mature forests and economically productive forests are scarce and are found mainly as mixed stands, mature regeneration stands, plantations and large areas with shrubs and bushes. There are several causes for this situation:

* The herbicides sprayed by the USA in the war (1962-1971) destroyed about 104,939 hectares amounting to 36% of the total original mangrove area in South Vietnam (NAS, 1974).
* Mangrove forests have been reduced by over-exploitation for woodfuel supply or export.
* Because of population pressure and the need for more land, large tracts of mangrove forests have been converted to agricultural land.
* Because of the high potential economic returns in shrimp farming, thousands of hectares of mangrove forests have indiscriminately been converted to shrimp ponds and the natural water-ways have been barricaded. This process will continue to pose a major threat to the mangrove forest ecosystem if it is not better managed and controlled.

The change in mangrove forest area in South Vietnam is shown in Table 1 with a noticeable increase between 1975 and 1980, due to successful replanting activities. Since these replantings consist of even-aged monocultural stands they should more properly be designated plantations and distinguished from natural mangrove forests.

Table 1: Mangrove Forest Area of South Vietnam and Deforestation During 1943-1983

Year	Mangrove area, (ha)	Change, (ha)	Reduction rate, (ha/yr)
1943	250,000		
1950-1960	210,000	-40,000	-4,000
1960-1975	92,000	-118,000	-7,866
1975-1980	137,000	+45,000 *	+9,000
1983	126,837	-10,163	-3,387

* Increase by natural regeneration and plantings

In the 1980's many projects which cleared mangrove forests to establish of semi-intensive shrimp ponds in Can Gio failed because of high initial investment costs, acid sulphate soils, rapidly decreasing yields and other adverse factors. At present only about 30% of the semi-intensive shrimp pond area is in operation, the rest of the area having been abandoned after a few crops (Sung, 1992). In Indonesia, prawn production has also been reported to decline significantly in areas where mangrove vegetation has been removed (Martosubroto and Naamin, 1977, see also chapter 4).

Between 1983-1986 thousands of hectares of natural mangrove forests were converted into coconut plantations in the Do Hoa state farm in Can Gio. However, this project failed because the coconuts were planted immediately on newly raised beds without bunds to prevent salt water penetrating the beds. Subsequently, these raised beds have been changed into *Eucalyptus* plantations but the growth and yield of *Eucalyptus* has also been low, because of this genus' unsuitability for the mangrove environment.

In addition to the various causes of mangrove deforestation already mentioned, salt production is also considered a threat to the Can Gio mangroves. There are now about 1,832 hectares of salt fields in Can Gio of which 1,000 hectares have been abandoned, because the salt produced is of low quality compared to that of other places. These abandoned areas should thus most appropriately be reforested if suitable species and methods can be identified (see also chapter 7 for research needs).

2.4 Other Factors Affecting the Mangrove

There is a risk that oil pollution may affect the Can Gio mangroves in the future as the oil industry develops. An oil refinery will be built in the Thanh Tuy Ha-Tan Thuan processing zone, and the oil rigs there will pose a potential threat to the mangroves. In addition, there may be effects from the Tri An hydroelectricity dam as well as from sewage. In 1989 when a harvest failure resulted in low marine production and caused considerable financial hardship for the people in Can Gio, the Can Gio District People's Committee suggested a project to clearcut mangroves for the export of wood chips. Fortunately, for the mangroves, that project was not realized.

2.5 The Role of Mangrove Forests in the Sustained Production of Fishery Resources

As already mentioned, the mangrove ecosystem is necessary for the sustained production of fisheries. Because of the intensive nutrient circulation within the mangrove forest it provides a very rich food source for many marine animals. Moreover, as the mangrove forest provides physical protection against strong waves and larger predators it offers ideal conditions for breeding and nurturing the offspring. Unfortunately, this role is very difficult to quantify in productive and economic terms, and hence hard to include in an overall valuation of the mangrove forest area and in arguments about the most profitable use (Dixon, 1989). Studies in Australia, the Philippines and Indonesia, however, have shown a significant positive correlation between mangrove area and offshore fishery catch (Paw and Thia-Eng, 1991) especially for shrimp. Data from Can Gio District presented in Table 2 also strongly suggest this relationship.

Table 2: Area of Rhizophora Plantation and Fishery Catch in Can Gio District (Hong, 1992)

Year	Plantation area	Fish catch	Shrimp catch
1977	0	100	-
1980	6,204	3,172	150
1981	9,054	4,054	1,146
1983	11,533	10,442	1,423
1984	12,438	14,500	1,700
1989	15,650	15,870	2,430

2.6 Environmental Consequences of Mangrove Deforestation

The exact number of consequences and their seriousness is obviously dependent on specific local conditions and the intensity of the deforestation. Some of the consequences reported elsewhere can be briefly outlined:

* Reduced populations and hence reduced catches of fish, prawns and other marine products.
* Reduced protection against storm surges and floods.
* Reduced protection against coastline and riverbank erosion.
* Reduced land accretion.
* Saltwater intrusion to upriver agricultural lands.
* Exposure of acid sulphate soils.
* Disturbance of nutrient circulation patterns.
* Lost upportunities for sustained production of mangrove products.

It is unfortunate that mangrove forests up-to-now have been reclaimed indiscriminately without proper planning. Impacts of the use of mangrove land for various activities, such as agricultural development, extensive marine culture, production of firewood, poles etc. should be properly evaluated in accordance with the objectives and terms of environmental protection. This is deemed necessary because of the many reasons mentioned above and because of the unfortunate experiences of other countries in Southeast Asia following the conversion of mangrove forests. As will be discussed in chapters 4 and 7, proper planning and management, combined with further research, is the key to a sustainable development of the valuable mangrove resources of Vietnam. Such development definitely does not exclude the production of a multitude of forest and marine products, to the benefit of local communities and others.

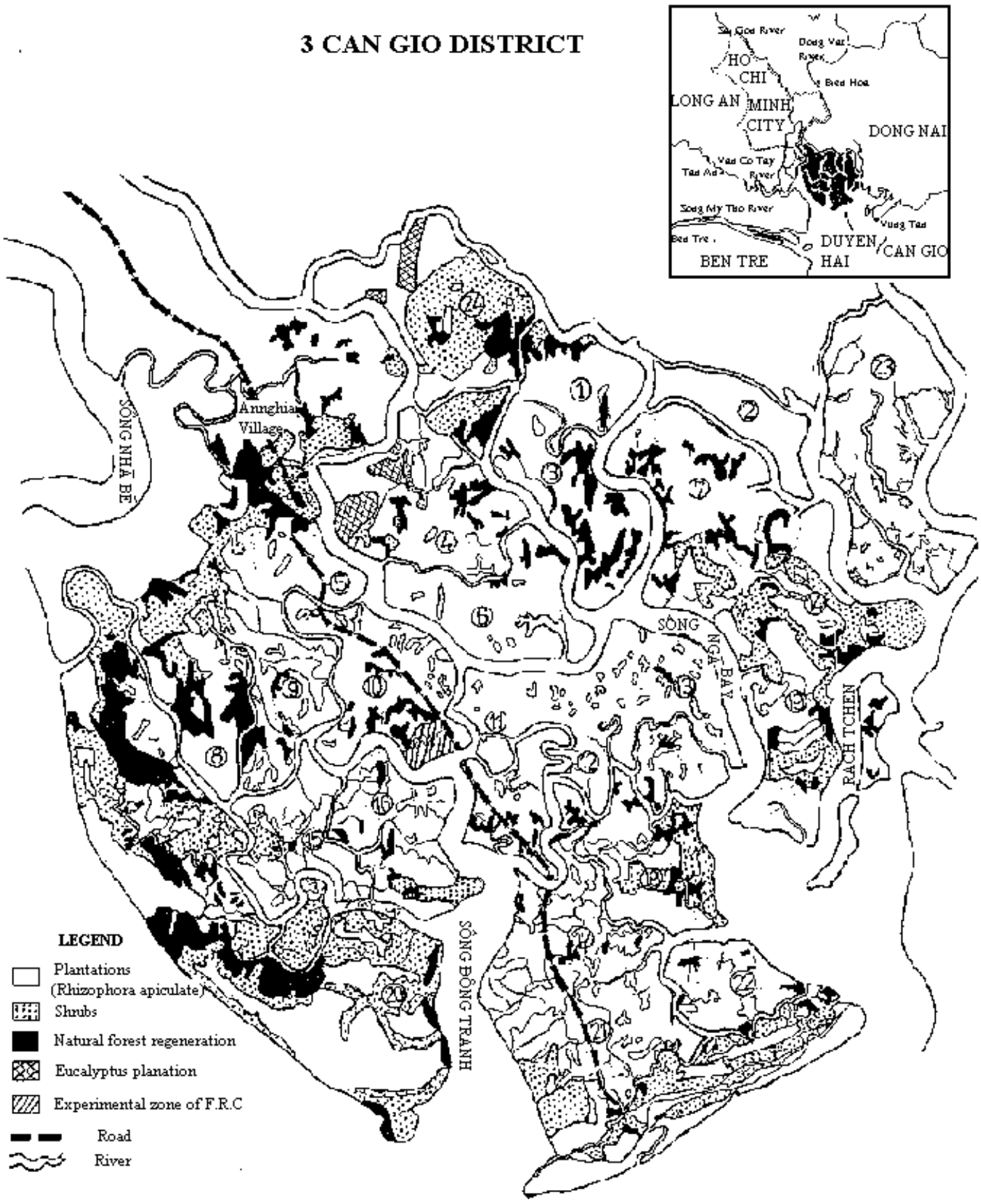

Figure 2: Forestry Map of Can Gio District

3.1 General Description

Ho Chi Minh City (formerly Saigon) is located about 1,300 km south of Hanoi and includes a mangrove area in Can Gio District. Originally the name was Can Gio, then, from 1975-1991 it was named Duyen Hai District but on December 18, 1991 it was given back its original name, Can Gio, by the Council of Ministers. Can Gio District (located at latitude 22' 14" - 40' 00" N, longitude 106^{o} - 107^{o} 00' 50" E) is about 65 km south of Ho Chi Minh City (see map in figure 2). It is one of 18 districts of Ho Chi Minh City and covers an area of 73,361 hectares. From the north to the south it covers a distance of 35 km and at the middle portion, is about 30 km wide. A network of rivers and channels traverses the delta and the main waterways leading to the port of HCMC.

From 1964-1970, Can Gio District, like many other mangrove areas, was sprayed heavily with herbicides: 665,666 gallons of Agent Orange, 343,385 gallons of Agent White and 49,200 gallons of Agent Blue. As a result, 57% of the mangrove forest in this district was destroyed (Ross, 1975). In some areas large trees of *Rhizophora, Sonneratia, and Bruguiera* were killed by the herbicide spraying and in many areas the vegetation was completely destroyed. Only *Avicennia* and nipa palm were able to survive and regenerate after the application of herbicide. And new species such as *Phoenix paludosa* and *Acrostichum aureum*, a fern which presently dominates elevated land, have expanded. Some individual trees of *Avicennia officinalis* and *Excoecaria agallocha* are now found only as shrubs. After many years of chemical spraying, the degraded land still has only scattered small trees of *Avicennia, Ceriops, Lumnitzera, Thesphesia, Pluchea,* or *Sesuvium portulacastrum* and *Paspalum vaginatum*. Since 1978, a vast programme of reforestation has been undertaken by Ho Chi Minh City Forestry Department with the main species being *Rhizophora apiculata*. Up to now, the reforestation effort has brought vast ecological improvements to the environment. Wild animals such as monkeys, otters, pythons, wild boars, crocodiles and various kinds of birds have returned to the artificially regenerated mangrove forests. Since 1991, the Can Gio mangrove forest has been declared an "Environmental Protection Forest" by the Council of Ministers (Decree No. 173 CT/H date May 29, 1991).

3.2 Climate

The climate is typically monsoonal with a pronounced dry season from November to April and a wet season starting from mid-April and lasting until late October. The average annual rainfall is about 1,336 mm with most of the rain concentrated in June and August, during the wet season. The total number of rainy days per year is about 160. The mean monthly rainfall amounts to 110 mm. Insolation is 5-9 hours per day of sunshine. Solar radiation is 300 cal/cm^{3}. Potential evapotranspiration in the area amounts to 4 mm/day, 120.4 mm/month and the highest in June (173.2 mm). The mean annual relative humidity is 80%. The winds are into the west, generally with wind speeds at about 2m/sec and typhoons are rare. The tidal regime is semi-diurnal, ranging from 2 m at mean tides to 4 m at spring tides. Alluviated soils are the principal soil type. These soils are generally slightly acidic (PH values of 4.5-6.5). Soils are predominantly saline sulphatic clay or mud with large quantities of sulfites which become oxidized to sulfates and hence acid when exposed to air.

3.3 Flora and Fauna of Can Gio Mangrove Area

About 105 plant species, belonging to 48 genera (Nam et.al. 1990) are found in Can Gio mangrove forest, including *Rhizophora apiculata, Bruguiera gymnorrhiza, Bruguiera parviflora, Ceriops sp, Kandelia candel, Rhizophora mucronata*, *Sonneratia alba*, *Sonneratia ovata*, *Sonneratia casedar*, *Avicennia alba*, *A. officinalis*, *A. lanata* (stunted trees in abandoned salt fields), *Aegiceras majus*, *Thespesia populnea*, *Hibiscus tiliaceus*, *Lumnitzera racemose*, *Xylocarpus granatum*, and *Excoecaria agallocha*.

There are about 150 known species of aquatic fauna. The fish fauna is very abundant since mangrove forests serve as nurseries as well as sources of foods for many species of fish like *Lates calcarifer* and *Mugil affinis*, prawns such as *Pangasius spp, Penaeus spp., Metapenaeus spp.,* and mudcrabs: *Scylla serrata*.

Within the area, there is a variety of wildlife such as wild pig (*Sus scrofa*), monkey (*Macaca fascicularis*), otter (*Lutra lutra*), saltwater crocodile (*Crocodylus porosus*), many species of snakes etc., which are now endangered or have dissapeared due to human interference. There are also many birds, including migratory species, some of which are very rare and should be protected.

3.4 Social Information

According to the population census in April 1985, the population of Can Gio District was 49,328 with a growth rate of 2%. Information on the population census of Can Gio in 1985 is summarised in Table 3.

An-Nghia Village

To obtain a more specific picture of the living conditions in Can Gio District a case study was carried out in the An-Nghia village, located in An Thoi Dong Subdistrict in the northern part of Can Gio District. The district is located south of Ho Chi Minh City and An-Nghia lies at a distance of about 35 km south from the centre of Ho Chi Minh City. It is situated near the main road that connects Nha Be with Can Gio town. This is an area between mangroves and paddy fields. It covers a surface of 922.5 ha and comprises a population of 1,538 inhabitants divided among 200 households. It is also the poorest village of Can Gio District. The study which focused on gender issues was carried out in May 1992, and is further described in the appendix.

Table 3: Census Abstract of Can Gio District, HCMC (1985)

Subdistrict Particulars	Thanh An	Binh Khanh	An Thoi Dong	Tam Thon Hiep	Long Hoa	Can Thanh	Ly Nhon
1. Households	545	2,322	1,468	767	1,357	1,705	589
2. Population total	3,443	12,779	8,810	4,785	7,334	8,793	3,384
- Male	1,708	6,287	4,570	2,633	3,636	4,344	1,748
- Female	1,735	6,492	4,240	2,152	3,698	4,449	1,636

* Average family size : 5.6 persons
* Illiteracy rate of about 50 %
* Fresh water is bought from merchants who transport it to Nha Be District from HCMC on their boats. The price is about US$ 15-17 per cubic meter to the consumers who store it in big jars placed around their houses. In the rainy season, rain water is collected and stored in jars or tanks and no fresh water is bought.
* Livestock raising is limited because of lack of food and fresh water.
* Main protein sources are fish and crustaceans. Rice is very important for the people, and appears to be their main staple food.
* Energy for cooking derives completely from mangrove wood or nipa leaves, paddy husk and paddy residues.
* Houses are mainly built with *Rhizophora* poles and nipa leaves for roof thatching and wall partitioning.
* The proportion of workers engaged in agriculture, mangrove fishery activities and allied activities is high in Can Gio.

3.5 Land Use

The northern part of Can Gio District is a paddy producing region, but the rice yields are very low because of the acid sulphate soils or failure to prevent salty water intrusion. The southern part of the district is the most suitable area for *Rhizophora* species. The forest resource of the district covers an area of 26,225 ha or 36,7% of the total area. About 3,640 ha of shrimp ponds within the mangrove forest is operated by local people and state farms. With traditional harvest methods, 360 ha of semi-intensive shrimp ponds were established on abandoned salt pens, along the Nha-Be-Can Gio road, south of the district near the coast and on *Phoenix paludosa* land (grown on stiffer elevated sites). Now only 120 ha is in operation with an average yield of 350 kg/ha/year.

Three major types of monoculture plantations are found in Can Gio: *Rhizophora, Eucalyptus* and *Nypa* of which *Rhizophora* is the most important.

Rhizophora Plantation

Following the massive deforestation of mangrove areas during the war, large tracts of degraded land in Can Gio have been reforested with plantations of *Rhizophora apiculata* in the southern part of the district. Between 1978-1991 Ho Chi Minh City Forestry Department reforested about 17,298 ha. These plantations have been established to improve the mangrove ecosystem and provide a sustainable source of wood products for local domestic and industrial demands for energy and construction material.

Table 4: Land Use in Can Gio District

Category	Forest type	Area, ha	Percent
1. Forested area		**26,225**	**36.7**
	a. Naturally established	**7,516**	**10.5**
	- Phoenix paludosa	5,235	7.3
	- Acrostichum aureum	465	0.7
	- Avicennia spp.	566	0.8
	- Ceriops tagal	82	0.01
	- Mixed forests	1,168	1.6
	b. Man-made forest	**18,709**	**26.2**
	- Rhizophora	17,298	24.3
	- Nypa fruticans	813	1.1
	- Eucalyptus spp.	598	0.8
2. Non-forested area		**45,136**	**63.3**
	- Wasteland	4,501	6.3
	- Water ways	22,667	31.8
	- Mud flat	3,532	4.9
	- Salt field	1,832	2.6
	- Paddy field	3,841	5.4
	- Coconut	50	0.01
	- Shrimp pond	4,000	5.6
	- Other land uses	4,763	6.6
Total		**71,361**	**100.0**

Rhizophora apiculata is the sole commercial mangrove tree species that is extensively planted. In Can Gio, planting is done using propagules purchased from Minh Hai province, about 300 km south of Can Gio. Local plantations are now producing sufficient quantities of propagules for future establishment of new plantations by transforming 200 ha of mature *Rhizophora* into seed stands at compartments 8, 10, 11, 12 and 13 (see map in figure 2).

Table 5: *R. apiculata* Plantations Established Between 1978 - 1991 in Can Gio

Year	Extent (ha)	Year	Extent (ha)
1978	1,920	1984	905
1979	2,017	1985	1,075
1980	2,267	1986	1,998
1981	2,850	1987	120
1982	1,589	1988	22
1983	890	1991	1,465
Total			17,298

Eucalyptus Plantations

In the northern part of Can Gio District where the land was invaded by species of no economic value (*Phoenix paludosa* or *Acrostichum aureum)* trees were burnt and on abandoned raised beds for coconuts at Do Hoa *Eucalyptus spp.* were planted. In the mangrove environment *Eucalyptus* would normally require a high initial capital investment to construct the raised beds on which they are grown (about 500 - 700 US$ per ha). About 50% of the land was used to plant *Eucalyptus*, whereas *R. apiculata* was planted on bed slopes and *Nypa fruticans* within the canals (Figure 5). The growth of *Eucalyptus* in Can Gio district was good during the first three years until the roots met the soil layer of the pyrite class. Then the root system couldn't go down but instead distributed laterally so that the growth of *Eucalyptus* slowed down. Since the *Eucalyptus* plantations in Can Gio apparently are ill-suited to the mangrove environment, it may be questioned whether the normally high costs of establishing raised beds is justified, as opposed to the much lower costs for establishing natural indigenous mangrove species (see chapter 4).

Figure 3: Two Year Rhizophora mucronata Plantation in Can Gio (Mangrove Experiment Station)

Figure 4: Eucalyptus Plantation on Raised Beds

Nypa fruticans Plantation

The total area of 813 hectares of *Nypa fruticans* in Can Gio district is distributed along riverbanks, around homesteads (by local people) and within canals between the raised beds of *Eucalyptus* (by Do Hoa and Thanh Nien Brigade). Nipa commonly occurs in the northern part of Can Gio District in brackish water (area with a water salinity below 1.8%). The lands where the planting of rice failed were the most suitable to transform into nipa plantations. Nipa leaves are used for roof thatching, wall partitioning and cooking by people living in the northern districts as in Binh Khanh and An Ngia village. It is also used to make mud skipper (a semi-aquatic fish) traps, and brooms.

Figure 5: Nypa fruticans Plantation in Can Gio

4 MANAGEMENT AND PRODUCTION OF CAN GIO MANGROVE AREA

Traditionally, the local and the Ho Chi Minh City populations have utilized the Can Gio mangrove forest area as a resource for woodfuels, nipa leaves for roof thatching and salt produced from seawater, as well as a place to catch various aquatic products like fish, shrimp, mussels and crabs and a place for hunting wildlife like wild boar. However, between 1962-1971 more than half of the Can Gio mangrove forest was defoliated by herbicide spraying, and although some trees survived they were stunted in growth and of poor quality.

4.1 Management of Forest Plantations

The management of the Can Gio mangrove forest area began in 1978 with the reforestation of *Rhizophora apiculata* plantations to counter the extensive deforestation and it is probably the best controlled and managed mangrove forest in Vietnam at present. Previously, the Can Gio mangrove forest was divided into 24 compartments (figure 2), each supervised by one management unit (either agricultural state farm, forest enterprise, brigade or a production unit). Now, these management units have been reduced to 12 and all are involved in the extraction of fishery as well as forestry products. These units are responsible for management, control, protection and for undertaking any improvements.

4.1.1 Management objectives

The reforestation carried out from 1978-1991 was aimed at sustained yield management with the production of fuelwood, charcoal and poles as the primary activities. But in May 1991 the Can Gio mangrove forest was changed into environmental protection forest land, with the following objectives:

* To conserve and protect the shore and riverbanks from erosion and damage by strong winds and waves in support of inland fisheries and agricultural production.

* To protect and preserve all available mangrove forest through maintaining and ensuring its continuous role as a productive ecosystem and as a breeding and feeding ground for sea fauna and other wildlife.

* To maximize production of prime poles and leaves for roof thatching to maintain a steady supply of good quality and cheap building material for the housing industry and to meet other construction needs of local communities as well as rural people in suburban districts of HCMC.

* To provide woodfuels for local consumption, HCMC and other areas.

* To provide livelihood and employment as well as to improve the living standard of people dwelling in the mangrove area and the forest workers.

* To preserve sufficient areas for research, seed sources, recreation and training, particularly in mangrove forestry.

* To promote social forestry, through people's participation in improved utilization and management of the forest by providing training and field practices.

* To regulate the use of waterways within the mangroves so that their navigational value will not be impaired.

Although the new status of the forest area, as illustrated by the above objectives, put some limitations to the kind and intensity of forestry activities in the area, it should however not conflict seriously with the previous aims of sustained yield management. But all management decisions will have to pay due attention to the protective and nurturing role of mangrove trees.

4.1.2 Plantatation establishment

Choice of Tree Species

In the Can Gio Mangrove Forest *Rhizophora apiculata* is the species most commonly planted in suitable sites. 8 ha of *Rhizophora mucronata* was afforested in a *Phoenix paludosa - Acrostichum aureum* infested area in 1989 as a trial. Though the latter species had disappeared in Can Gio after wartime chemical spraying, the rehabilitation of *R. mucronata* species is now going on using seeds bought from Ben Tre province 150 km from Can Gio District. An increase in the use of this species has been recommended by Chan (1990) because of its superior growth characteristics and general hardiness. *Avicennia officinalis*, and *Kandelia candel* are also planted in trials at elevated sites. In the choice of suitable species the different salt concentrations of the water that the various species are naturally adapted to should be borne in mind (e.g. *R. apiculata* prefers 1-3%)

Site Preparation

In the open swampy wastelands site preparation prior to planting is not necessary, whereas in areas with scattered shrubs and bushes, site preparation prior to planting is carried out by clearing and heaping in rows. Since 1991, in the degraded interior and elevated forests of predominantly *Acrostichum* and mixed stands of species of no economic value, heavy clearing has been carried out, requiring 24 man-days per hectare. The suggested use of *R. mucronata* rather than *R. apiculata* would be an advantage in this case, because its propagules are longer and more competitive towards *Achrosticum* ferns and will overtop and start to shade out these within two years, rendering clearing unnecessary (Chan, 1990). In the *Phoenix paludosa* infested areas the site preparation is the most difficult requiring burning in the dry season (from February-April) and then cutting of the stems in August. Despite its high cost, this method is not effective, because the coppices will resprout again in the rainy season. The proper methods of treatment for this kind of site need to be studied in the future.

Planting Material, Techniques, Costs and Limitations

Planting *Rhizophora* using propagules has long been practiced in Vietnam and other countries throughout Southeast Asia. Its timing largely depends on the availability of propagules and hence it is carried out during the season when propagules are abundant. The season of mature propagules for *R. apiculata* occurs from September to October in Can Gio and of *R. mucronata* from December to January in Ben Tre province. The propagules are collected from the forest floor, at the water front where the propagules are floating and also from the trees. Mature propagules on the tree can be recognized by the distinct abscission collar between the fruit and the hypocotyle (Nam, 1991). The planting operation is done simply by inserting the propagules into the mud, 5-6 cm deep. When the mud is hard, a stick has to be used to make planting holes. Planting of *R. apiculata* is carried out at 1 m x 1 m spacing (10,000 seedlings per hectare), although for fuelwood plantations a wider spacing of 1.5 x 1.5 m has been recommended (Chan,1990). The operation is usually carried out between August and November. One year after planting a survey is normally carried out to determine seedling survival. Areas with less than 75% survival are replanted during the following planting season. Planting using potted seedlings have never been used but wildlings were used in planting trials near the coast aimed at preventing erosion by wind and wave (Nam, 1991). An estimate of the establishment costs for *R. apiculata* and *R. mucronata* plantations, is presented in table 5, showing *R. mucronata* to have a markedly higher cost. This difference is however due to the fact that *R. mucronata* propagules at present must be bought from the Minh Hai area. As soon as sufficient seed producing stands have been established in Can Gio this cost will be markedly reduced.

Table 5: Estimated Establishment Cost of Mangroves in Can Gio (Nam, 1991b)

Activity	Cost US$ per hectare	
	R. apiculata	***R. mucronata***
I) Direct cost	62.07	90.22
1. Labor cost	18.26	15.22
2. Seedlings (propagules)	43.75	75.00
II) Overheads	13.64	19.85
III) Design cost	1.62	1.62
IV) Office running expenditure	0.76	1.1
V) Contingencies	3.90	5.64
VI) Total	**81.93**	**118.43**

Note: exchange rate: US$ 1 = 8,000 Dong (May, 1991)

Figure 7: Three Months Old Rhizophora apiculata Plantation

Sesarmid crabs may cause scattered damage to new propagules of *Rhizophora* in plantations, especially, in the area cleared a few months before the planting season. The crabs feed on the propagules by nibbling their collar, often completely, and/or biting right through the hypocotyle. Attacks can occur above or below the mud surface.

The beetle, *Poelilips fallax* has been observed to attack propagules of *Rhizophora apiculata* bought from Minh Hai province. Barnacles were observed on young seedlings and trees of *Rhizophora* and *Avicennia* in low-lying seafront areas. Their attachment to young seedlings suppresses photosynthetic and respiratory processes and hence retards growth.

In the low area where flooding occurs twice daily, the degree of damage to the propagule is very high because clearing of mangroves leads to a higher degree of anaerobiosis (anaerobic = without oxygen) in sediments, low redox potential and high concentrations of sulphide (Shamsudin,1990).

4.1.3 Silvicultural activities

Rotation

The rotational age of *Rhizophora apiculata* plantations in Can Gio is recommended as 20 years (Chan, 1990). At present the age of the oldest plantations is 14 years. Within these 14 years two thinning and pruning operations have already been carried out.

At this point, it has not been fully established whether thinning truly has beneficial effects on the overall growth of mangrove forests. However, thinning operations have shown that mean annual diameter increment is greater and survival better, compared to without thinning.

Intermediate Felling (Thinning)

The first thinning is carried out after 6-7 years. Actually, this is a pruning operation to reduce the number of multi-stems, leaving behind 1 or 2 main stems depending on the density of the plantation; usually the number of stems removed is about 50-65% but with no reduction in the number of trees. The yield varies from 4.27 to 6.06 m^3/ha (7-10 steres/ha) of firewood. Prior to thinnings 1, 2 and 3, a 0.03% inventory, using random 10 x 10 m plot sampling, is undertaken by forest inventory brigades and approved by HCMC Forestry Department.

The second thinning is carried out in the plantations which have reached 9-10 years of age. A yield of 9-15 m^3/ha (15-25 steres/ha) is usually obtained which leaves a residual stand of trees with a mean spacing of 1.3-1.4 m. Prior to the 2nd thinning, all trees are marked and checked by the District Forest Ranger and HCMC Forestry Department based on visual appraisal of crown, root competition and distance between trees. A third thinning will be carried out for the stands of 14-15 years of age. The mean spacing of residual trees will be 2.0-2.3 m or 1,900-2,500 trees/ha. A yield of 20-25 m^3/ha (33-41.2 steres/ha) of firewood is expected.

Final Felling

The 20 years rotation of *Rhizophora* plantations in Can Gio is now not certain anymore because of the change in status of these plantations into environmental protection forests, but silviculturally sound felling systems could be applied, including the alternate strip felling for plantations located less than 100 m from the riverbank. For inland plantations located more than 100 m from the riverbank the two-stage selective felling system, as recommended by Chan (1990) could be carried out. To benefit the wildlife the "bicyclical" strip felling system described by Hung-Tuck (1987), harvesting alternate strips every 15 years, could be applied thereby ensuring a more continous forest cover. In any case strips along the seashore about 300m wide and strips along riverbanks about 20-30m wide should be left permanently covered, preferably by natural vegetation, in order to prevent erosion (Quynh & The, 1992).

4.2 Forestry Products

4.2.1 Plantation productivity

The oldest plantation in Can Gio is 14 years. In 1989, an inventory was carried out (Nam, 1990) to assess the growth and yield of the plantation at different sites and age classes. The results of this inventory are presented in tables 6 and 7.

The mean annual increments of diameter at breast height and height over the period are 0.61 cm and 0.81 m respectively but increases differ among the 3 classes of soils that can be distinguished according to their degree of inundation by tides.

Table 6: Annual Growth of *R. apiculata* on Different Soil Classes

Soil class	Diameter (cm)	Height (m)
Soil class I	0.74 cm/year	1.05 m/year
Soil class II	0.60 cm/year	0.90 m/year
Soil class III	0.50 cm/year	0.72 m/year

1) - Soil class I is inundated by medium-high tides and most suitable for planting *R. apiculata*.
- Soil class II is inundated by normal high tides and suitable for planting *R. apiculata*.
- Soil class III is inundated by spring tides only and is not suitable for planting *R. apiculata*.

Rhizophora apiculata in Can Gio has multi-stems[1], the biggest stem is considered as the main stem and the remainder as sub-stems.

As seen from table 7 a final volume at 20 years age of about 100-110m^3/ha can be expected. The majority of this will be used for poles and construction timber and the remainder as woodfuels. Together with the products from the three thinning operations reported later, amounting to about 33-46m^3, the total wood production can be estimated at approximately 140-150m^3/ha or about 7m^3/ha annually on average. A longer rotation may be considered for some stands in order to obtain timber of bigger size and to increase the average annual production. Stockings of 283m^3/ha for plantations 25 years old has been reported from Minh Hai Province (Binh, 1992).

Table 7: Growth and Yield of *Rhizophora apiculata* Plantations in Can Gio

Age year	Stand density (No. stems/ha)		Total stems (stem/ ha)	Diameter (dhb) cm		Height (m)		Diameter of		MAI m^3/ha/ year	Total volume m^3/ha
	Main stem	Sub stem		Main stem	Sub stem	Main stem	Sub stem	Crown (cm)	Prop root (cm)		
3	7,616		7,616	1.86		2.44		143	140	0.87	2.61
4	6,900	7,033	13,933	2.44	2.05	3.32	2.70	163	159	2.20	8.82
5	7,668	5,691	13,359	3.03	2.35	4.09	3.50	148	166	3.23	16.16
*6	7,966	6,383	14,349	3.53	2.55	4.57	3.93	142	167	4.17	25.04
*7	7,200	6,050	13,250	4.59	3.09	5.84	4.89	162	186	6.29	44.05
*8	6,450	3,303	9,753	5.39	4.26	7.24	6.00	153	181	8.06	64.49
**9	5,877	1,166	7,043	5.87	4.95	8.11	6.40	163	171	7.48	67.35
**10	5,200	1,210	6,410	6.33	5.56	8.46	6.93	181	216	7.39	73.97
**11	4,955	1,466	6,421	6.51	6.00	9.02	7.43	147	220	7.48	82.28
*15	3,950		3,950	7.45		10.10		155	185	5.05	75.86

Note: * After first thinning already prescribed.
** After second thinning already prescribed.

[1] There has been some doubt raised as to whether multi-stemmed *Rhizophora* really is *R. apiculata*. Some observers suggest it may be *R. conjugata*. There are no reports of *R. apiculata* forming multiple stems in the mangroves of Thailand, Malaysia, Indonesia or Myanmar.

4.2.2 *Rhizophora* thinning products

The first thinning in Can Gio was carried out in 1986 and the second thinning applied in 1989. Between 1986-1991 a total of 220,968 steres of firewood was obtained from thinning practice and mainly supplied to Ho Chi Minh City and people in the suburban districts.

Table 8: Thinning Products in Can Gio 1986 - 1991

Year	Billet of 1m length (stere)	Billet of 0.3m length (stere)	Total (stere)
1986	30,327	7,581	37,908
1987	81,022	20,255	101,277
1988	18,740	4,685	23,425
1989	30,937	6,888	37,825
1990	11,101	3,294	14,395
1991	4,078	2,060	6,138
Total	**176,205**	**44,763**	**220,968**

Note: One stere = one stacked cubic meter = 0.65 solid m^3 (about 585 kg for mangrove wood)

The product from the first and second thinning is mainly used for firewood. The trunks with diameters over 3cm are cut into billets of 1m length and stacked 1m high and sold at about US$ 7.08-8.85 per stere in Can Gio. The top of trunks less than 3cm in diameter are cut into billets of 0.3m length with a price of US$4.77 per stere. Prop roots and stilt roots are also cut into 0.3m length and are sold at US$ 3.98 per stere at the forest gate. The price in HCMC will be about 50-80% higher than that in the Can Gio District market.

About 15% of second thinning products can be used as poles of 3.5m length and 8cm in diameter which can fetch US$ 0.35 each. They are used as construction material for houses, jetties, bridges and fishing stakes. Poles of 2m length with diameter over 6cm are used mainly as pulp material. A chipping mill that has just been installed in Thu Dyc District has created a high demand for the Can Gio mangrove wood. Those who want to purchase *Rhizophora* woods have to obtain permission from HCMC Forest Ranger Branch and HCMC Forest Department in order to avoid excess cutting.

Figure 8: Production of Poles from Thinned Wood in Can Gio

4.2.3 *Eucalyptus* and nipa production

Five years after planting, *Eucalyptus camaldulensis* is harvested and cut into billets of 2.0 m or processed into wood chips for export. The remaining wood is used for domestic firewood. It is difficult to obtain *Eucalyptus* wood and *Nypa* leaves production figures from individual trees. The data presented in table 9 is obtained from Do Hoa Brigade (Compartments 4 and 24) which has concentrated on *Nypa* and *Eucalyptus* plantations.

Table 9: *Eucalyptus* Wood and *Nypa* Leaves Production Figures by Do Hoa Brigade from

1989-1991 (Total area 2178 ha)

Year	*Eucalyptus* wood (Ton)	*Nypa* leaves (no. of fronds)
1989	300	300,000
1990	400	186,000
1991	-	321,000

Figure 9: Stacks of Eucalyptus Pulp Wood for Export at Do Hoa Brigade, Can Gio District

4.2.4 Charcoal production

In Can Gio, the manufacturing of charcoal from mangrove wood is a rather new activty. Although mangrove wood (*R. apiculata*) makes excellent charcoal, a high demand for firewood and poles in Ho Chi Minh City leaves very little thinned products behind for further processing into charcoal. *R. apiculata* charcoal is of high quality; it does not emit smoke, ignites easily and produces an even heat that lasts long. Mangrove charcoal is used for domestic cooking, tea drying, in chemical and metal industries and by street food vendors etc.

At present, there are 6 charcoal kilns in operation in Ho Chi Minh City. Three of these kilns which are located in HCMC belong to the Can Gio Forest Enterprise and the other 3 belong to Phu Nhuan State Farm, located in Can Gio (Compartment 4). Charcoal making is not a common activity in the mangrove swamps, because kilns have to be built above the high water level, and such areas are not abundant. Charcoal production statistics of Can Gio from 1988-1991 are summarized in table 10 below, which shows that even at present the kilns are not operating at their maximum capacity (about 360 tons annually).

Table 10: Charcoal Production in Can Gio District 1988-1991 (6 kilns)

Year	Charcoal quantity, kg.
1988	18,200
1989 *	69,813
1990	21,300
1991 *	79,892

Note: * Thinning operations carried out

Description of the Kiln

The type of kiln used is a brick beehive with a circular base 6 m in diameter and 3 m in height. The kiln is made from clay bricks plastered together by a mortar mixture of sand and clay. The wall is 20-25 cm thick. There are four equidistant smoke vents (10 x 10 cm) from the base of the kiln to the outside for a flue exit. An arched door (2 m wide at the base and 0.4 m wide at the top and 2 m high) is built at one side of the kiln wall for loading fuelwood and unloading charcoal.

Each kiln built requires the following materials and labor:

- Fired clay bricks 15,000-17,000
- Clay 5 m^3
- Sand 3 m^3
- Cement 150 kg
- Labor 30-36 man days.

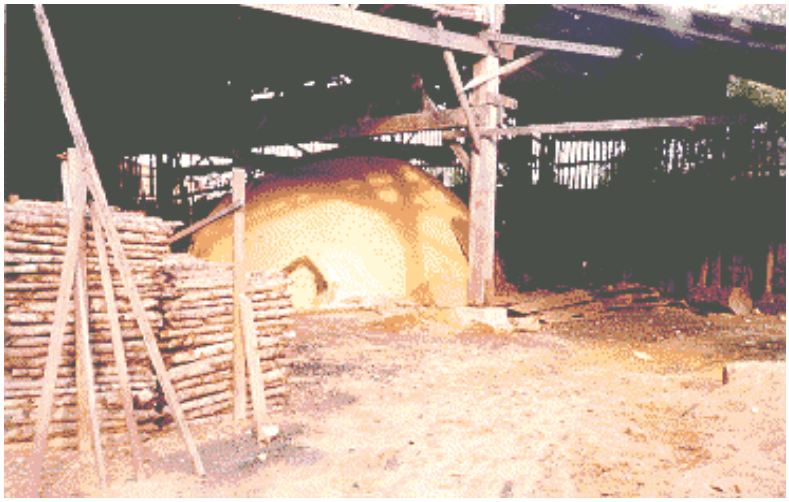

Figure 12: Brick Beehive Charcoal Kiln, HCMC

The life span of a kiln is expected to be about 15-20 years with maintenance and minor repair undertaken every year. The loading capacity of a kiln is about 27 tons (45 steres) of fresh wood. Only fuelwood from the second and third thinning can be used for charcoal making. Stems are cut into 1 m long billets and transported to the kiln by boat.

Kiln Loading

The charge consists of unbarked billets 1 m long and 6-10 cm in diameter. Billets are stacked vertically over a layer of horizontally placed billets in order to ensure complete carbonization at the floor level. Only lower portions of the kiln are packed, leaving some area between the dome and the standing logs empty. When loading has been completed, the door is partially sealed with bricks and clay. A small aperture of the kiln is left open above the ground load for the purpose of firing.

Firing and Carbonization

Carbonization of mangrove wood in a brick kiln may involve two methods:

Direct Firing: This traditional method is used for mangrove billets obtained from natural grown forests where larger size and wet logs are normally encountered. The fire is ignited inside the kiln firing port using dried mangrove wood and/or prop-roots as fuel. Since part of the wood load would also get burnt to provide heat energy to first dry the wood and later initiate the carbonization process, charcoal yield is lower and charcoal recovered around the firing zone is slightly over-burnt (light weight and friable).

Indirect Firing: This method primarily utilizes heat from fuelwood combusted in the firing port extended about 1-1.2 m. from the base of the kiln wall. The combustion heat will get drawn inside the kiln through a natural draft. With good control of firewood combustion at the firing port and the air inlet into the kiln, firewood consumption will be less and charcoal yield will be higher. This method may require a longer firing period.

Two major stages in charcoal making can be observed: a) **Drying Stage** for which high firing of firewood is needed to drive out the moisture. This stage continues for about 10-15 days until a dense, pungent grey smoke starts to come out from all four vents. b) **Carbonization stage** which takes place once the fuelwood load is dried and reaches a temperature of about 275 deg. Celcius. After starting, the carbonization process carries on at about 350 deg. Celcius average temperature till complete. This may take another 8-10 days and firing intensity is kept very low (just enough to control the heat balance in carbonization). During these two stages the opening of the four vent holes are reduced according to the following schedule:

1/3 of the opening sealed after 6 days of firing,
1/2 of the opening sealed after 10 days of firing,
Complete sealing of each vent when clear smoke exits from the vent.
(This should take place about 20-25 days after firing.)

The kiln worker will normally apply mud to completely seal the kiln leakages (from cracks) and allow it to cool down for about a week. The control of the carbonization process is totally dependent on the experience of the charcoal kiln operator and his skills to interpret the smoke odor and color.

Table 11: Burning Schedule for Charcoal Making

Kiln Loading	1 -2 days
Initial Stage of Drying & Carbonization	10 - 15 days
Final Stage of Carbonization	8 - 10 days
Cooling	6 - 7 days
Kiln Unloading	2 - 3 days
Total	**27 - 37 days**

Production per kiln charge is about 6 metric tons of charcoal with a conversion efficiency of 21.5% and 24.7% for direct and indirect firing, respectively. The proximate contents analysis of produced charcoal is as follows:

Volatile matter content	33.%
Ash content	2.8%
Moisture content	4.6%
Fixed carbon content	59.4%
Calorific value	6,603.3 cal/g.

Production Cost and Revenue Per Burn

The production cost per kiln charge can be estimated as follows:

*	Raw material 45 steres x US$ 7.7/stere		347.7
*	Cost of 10 steres fuelwood for firing		77.2
*	Manpower cost		54.6
*	Kiln depreciation (US$ 453.6 for kiln construction, 30 days/cycle and life span 20 years)		1.9
*	Kiln maintenance		0.5
*	Tax on charcoal produced		10.3
	Total costs	US$	492.2

Selling price of charcoal products:

*	Stick and lump charcoal 4.8 tons x US$ 136.4/ton (HCMC)		654.7
*	Charcoal pieces 0.8 tons x US$ 54.54/ton		43.6
*	*Rhizophora* bark charcoal 0.25 ton x US$ 27.27/ton		6.8
	Total	US$	705.1

Apparent net profit from each kiln charge is US$ 212.9 or about 43% of the investment (Parallel exchange rate US$ = 11,000 dong)

Most of the charcoal is sold in HCMC where there is a good demand for charcoal at the market and where three of the present 6 kilns are located. At present about 8% of energy use in HCMC is supplied by charcoal. Because the cost of transport is high it would be more favourable to have all the kilns located close to the place of woodfuel harvest, since the processing reduces the weight to about 1/4 that of fresh wood.

Uncontrolled development of the charcoal making industry could hasten the ecological destruction and depletion of the Can Gio mangrove forest, but at present, even if working at maximum capacity (about 360 tons charcoal annually), the 6 kilns can only process about 8% of the present average wood production from thinnings (table 8). As table 10 shows, maximum capacity is far from being reached, even in the years of thinning operations, with for instance only 22% of maximum capacity used in 1991. The construction of new kilns in Can Gio has presently been stopped, but there appears to be plenty of room for the development of this small scale industry. Any expansion should obviously be monitored and regulated by the HCMC Forest Department. But if properly managed charcoal could become an important source of energy not only for domestic and industrial applications in HCMC but possibly also for export, as well as generating employment opportunities for mangrove residents and others. In terms of price per energy unit released from charcoal, the efficiency is equal to electricity and is cheaper than wood and kerosene use (Min. of Forestry, 1992). It can also be considered as an important alternative energy resource that does not add to environmental pollution produced by a big industrial city like HCMC.

4.3 Non-Forestry Activities in the Mangrove Area

4.3.1 Capture fisheries

Traditionally, fishery activities have been a main source of income for the people of Can Gio, but due to the limited resources it is difficult to sustain these unless better ways of exploitation and a more rational use are adopted. In 1991, as shown in table 12, about 11,500 tonnes of fish and shrimp were captured in Can Gio, of which 986 tonnes were shrimps. The local people often capture fish and crabs with simple tools, e.g. hooks, fishing poles and cast nets, hence there is a low catch per person. Generally, the fishermen of Can Gio District are poor and have a low standard of living.

Table 12: Fishery Catch in Can Gio District from 1986 - 1991

Year	Fish (Tonnes)	Shrimp (Tonnes)	Total (Tonnes)
1986	8,910.8	682.2	9,593
1987	9,894.5	617.5	10,512
1988	10,870.1	782.9	11,653
1989	15,870.0	2,430.0	18,300
1990	13,673.0	1,357.0	15,030
1991	10,514.0	986.0	11,500
TOTAL	**69,732.4**	**6,855.6**	**76,588**

Source: (Dinh et al, 1990)

4.3.2 Shrimp farming

Can Gio district has a 20,418 ha open water area, of which 7,000 - 8,000 ha has potential for shrimp breeding. The traditional shrimp culture, using trapping ponds, covers about 3,640 ha and is practiced by local people and state farms. It involves the barricading of natural waterways within the forest, allowing shrimp juveniles to come into the pond during high tide to feed on micro-organisms and later harvesting them once or twice a month. One "pond" will usually cover 5-10 ha of mangrove area. Production is low (about 50-150 kg/ha/year). Although this traditional method is the least damaging to the mangrove forest, it may threaten the surrounding mangroves, because it often involves illegal logging of *Rhizophora* wood for use as poles, piling foundations in the ponds, etc.

Most private ponds are semi-extensive with dikes established around the pond and sluices made of a light material such as wooden planks or poles. Additional post-larvae are supplied as well as supplemental feed. The average yield is 150-250 kg/ha/year (Can Gio People's Committee, 1992).

Semi-intensive shrimp ponds occupied an area of 360 ha in 1991, an increase of 110 ha over 1990. These ponds are generally smaller, about 0.5-1 ha, with mechanical pumping of water, nursery- raised larvae, feeding, and require high investments. An area of 120 ha is operating with a production of 42 tons shrimp; i.e., an average yield of only 0.3 ton/ha/year. The ponds were established either on *Phoenix paludosa* land, which is elevated land that could not be planted with *Rhizophora*, or on abandoned salt fields with stunted *Avicennia lanata* growing on it.

Table 13: Example of Production Cost and Income (US $/ ha) from Semi-Intensive Shrimp Farming (Dinh et al, 1990)

Pond construction:			
- Dikes	600	C) Income earned/crop 500 kg	636
- Two sluices	100		
	-----	Profit/crop	254
Total	700	(C-A-B)	
A) Construction cost/crop[1]	118	Profit/year (3 crops)	762
Production cost of one shrimp crop:		(If production falls below 300 kg per crop -	
Larvae, 150 kg	48	equalling 382 US$, net income will be	
Feed, 2100 kg	134	negative)	
Salaries of laborers	27		
Bank interest	49		
Other costs	6		

B) Total	264		

Note: [1] Ponds must be repaired/rebuilt approximately every 2 years, i.e. 6 crops could be considered during the period.

In Can Gio three shrimp nursery farms have been established to produce post-larvae of *Penaeus merguiensis* (Banana prawn) with a capacity of 90 millions larvae but the actual production in 1991 was only 40 million larvae. So in practise a large amount of larvae must still be supplied from natural populations, hence contributing to the depletion of this resource.

Shrimp Export

Japan, Singapore and Australia are currently the biggest consumers of Vietnamese shrimp. Hongkong, South Korea, Thailand and Sri Lanka are also important consumers and the EEC, United States and Canada are promising markets for the export of shrimp in the near future. Vietnam exported 15,000 metric tons of frozen shrimp in 1985, mainly captured shrimps. For the period between 1992-1995, the estimated exported quantity of shrimp has been forecasted to be about 20,000 tons/year, with an estimated earnings of about US$ 180 million (9,260 US$/ton) (Seaprodex, 1989).

Shrimp Farm Experimental Area of the Forest Research Center (F.R.C.)

The experimental area in Can Gio covers 165 ha in the intermediate zone between brackish and salty water, which is only flooded by high and medium tides and is mainly planted with *Rhizophora* and *Avicennia*. Semi-extensive and semi-intensive shrimp farming systems were chosen for the experiments here.

With semi-extensive farming systems there is less need to construct ponds and to establish dikes around these. The ponds used have sluices made of wooden planks and poles in order to supply water as well as to drain it out. Shrimp post-larvae are mainly obtained from natural populations via the sluice system. Additional post-larvae are also provided and the harvesting method is selective and allows separation of the undersized shrimp in good physical condition for returning to the pond for further growth. Their major, and natural, food source is the mangrove litter, which during decomposition, together with the multiple micro-organisms involved in the breakdown process, becomes a very good feed. Additional feed such as grilled bran and mixed fish is also provided. Some advanced techniques in feeding, harvesting, environmental improvement and reducing the number of predatory fish have been tried. However, because the ponds are too large compared to the number of sluices to ensure sufficient water circulation, the environment becomes unfavourable both for shrimps and *Rhizophora apiculata*. There are now 4 semi-extensive shrimp ponds within this experimental area. The average area is 30-50 ha/pond of which 5-10 ha is open water area. During the first period, the yield was 150-250 kg/ha/year of which about 40-50% consisted of *Penaeus indicus* (Tom The) and *P. merguensis* (Tom bac The), but has now declined to about 100 kg/ha/year.

F.R.C. is currently collaborating with the Ecological Division (Integrated University HCMC) on research on shrimp culture. The research programme includes a trial of the semi-intensive model, covering 6,000 m^2 (figure 11). Shrimp post-larvae (*P. merguiensis* and *P. monodon*) have been collected from natural and/or artificial cultures and introduced at a density of 7 - 10 post-larvae/m^2. Feed consists of both industrial and freshly prepared items, such as *Acetes* shrimp (Ruoc), and fresh water crab (Ba Khia). No production results are available yet, but the yield is expected to be 800 - 1,250 kg/ha/year.

Figure 10: Traditional Shrimp Farming by Barricading Natural Waterways Within the Forest

Figure 11: Semi-Intensive Shrimp Pond of Forest Research Center

Decline of Shrimp Productivity

During the past ten years (1982-1992) Can Gio has gained a lot of experience in shrimp breeding both in the private and state sectors. Although the area for shrimp breeding has been increasing rapidly, the average yield has been decreasing dramatically.

For state-owned ponds, the total water area reserved for shrimp breeding (for 25 state farms and production units) is 2,586 ha, of which only 120 ha are in use for semi-intensive and intensive farming (Can Gio People's Committee, 1992) with a yield of 300 - 450 kg/ha/year. The remaining area consists of semi-extensive ponds with dikes established around them. The yield before was 150 -250 kg/ha/year but has declined to only about 50 kg/ha/year at present (Dinh et al, 1990).

The causes for this widespread decline in shrimp productivity can basically be ascribed to two main causes: Insufficient inputs of (natural) feed and larvae and detoriating water quality. More specifically this is due to:

* Lack of scientific and technical expertise in design and management
* Random unplanned and uncontrolled establishment of ponds
* Unsuitable pond sites selected e.g. acid sulphate soils which acidify pond water
* Alluvial sediments depositing in ponds and channels, further reducing water circulation
* Removal of shading trees causing excessive water temperatures (up to 36-37°C)
* Many ponds are too large to ensure sufficient water circulation
* Use of natural stocks of post-larvae which are diminishing due to over-exploitation.
* Reduced supply of natural food (no litterfall input)
* Reduced dissolved oxygen in water caused by high temperatures, high shrimp density, high algae production nourished by abundant organic matter, and water resource diminished by sediment deposits and high evaporation.
* The production of "artificial" post-larvae is very complicated (hence many people are reluctant to risk it).

As mentioned earlier, these problems are not unique to Vietnam but have been experienced also in most surrounding countries where the boom in shrimp breeding took place some years ago and was accompanied by extensive removal of the original mangrove forest. A number of the problems may not be very surprising when compared with the nutrient circulation patterns in natural mangroves since the falling leaves from mangrove trees and the organisms involved in their decomposition normally forms the major food source for shrimp. Annual litterfall in mangrove forests may amount to 17 tons dry matter per hectare (Sukardjo, 1989). Therefore, removal of the trees requires considerable feed input in substitution. In addition, the trees have other beneficial effects like temperature regulation. Furthermore, the water is constantly renewed under natural conditions ensuring constant levels of oxygen, salt, nutrients etc. This water circulation pattern is obviously impeded by a large number of ponds and dikes.

There is therefore still an urgent need for further research on suitable techniques and management.

Alternative Models for Shrimp Breeding

As indicated above there is an urgent need for systems that integrate shrimp farming with tree growing in order to achieve a more sustainable land use. For these systems, as well as for the mangrove area as a whole, a ratio of 80% forest to 20% shrimp farms and other land uses is recommended (Quynh & The, 1992) and with alternating areas of shrimp farms and forest. Such systems have already been practised for some time in Indonesia and have also been introduced in Minh Hai province, south of Can Gio with initial promising results (Liem, 1992). There are three principally different systems applied in Minh Hai:

I Mangrove plantation forest (on 20 year rotation) where fish and shrimp are caught within natural canals. No ponds or dikes are constructed.

II Each household manages 8 ha of forest area on a 12 year rotation surrounding 2 ha of permanent shrimp ponds. The farmer gets all shrimp products and shares forestry products with the government enterprise.

III Forest established within dikes where shrimp can be raised for about 5 years until canopy closure. Hereafter a new area must be used for shrimp breeding. This system can be regarded as equivalent to the well-known "taungya" system, originally developed for teak plantation establishment.

Given a sufficiently large area the third system does not necessarily require the farmers to be moved around every five years, but could be designed as a rotation system with the farm centrally located.

Topographically Can Gio District can be divided into 3 types of areas:

* An area with an elevation of up to 0.5 m that is flooded every day by the tide. This area is not suitable for (semi-intensive) shrimp farming.
* An area with an elevation of 0.5 - 1.0 m that is flooded every month by the tide, and suitable for extensive and semi-extensive shrimp farming.
* An area with an elevation of 1.5-2.0 m that is flooded once a year by the tide and is suitable for semi-intensive and intensive farming (Dinh et.al. 1990).

Choice of the most suitable system will thus depend on the specific local situation in terms of topography, tidal regime and socio-economic conditions. These precautions should be incorporated into the overall mangrove management plan.

Shrimp farming, may appear to be very lucrative. However, as shown, a number of serious problems remain to be solved in order to obtain sustainable yields. It may very well be that reported initial high and "promising" yields are obtained on the credit of natural resources "saved up" in the system but quickly depleted, and hence at the cost of long term sustainability. The actual costs may thus be higher and the profit lower than calculations like that presented earlier indicate. More realistic long-term economic calculations are therefore needed to provide a realistic basis for decisions on land use development policies and investment needs. Such a development scheme would require a well-developed management plan for the mangrove area in order to avoid negative environmental effects. In particular, a land use zonation plan should be developed to ensure the proper distribution and balance between shrimp ponds and forest.

4.3.3 Other types of aquaculture

Apart from shrimp culture, crab culture in ponds and floating cages is also becoming more common among people in Can Gio. In 1991, 140 households raised soft shell crabs and 78 households raised red pancreas and other crabs in about 180 floating cages. Nine households raised spiny lobsters in 15 cages. As indicated by the initial results, floating cage culture can bring high economic return if a number of problems can be solved, including planning of breeding, culture techniques, environmental protection, marketing and financial support for investments. One advantage of the cage culture is that it does not require the conversion of mangrove forest as pond culture does. It may thus serve as a more environment-friendly production system which can act either as an alternative or a supplement to shrimp farming.

4.3.4 Salt production

Besides agricultural and forestry production, salt production also plays an economic role in the district. But in the past few years, the production of salt has failed because excessive rain and low water salinity has resulted in a poor quality product, and hence lower prices than elsewhere. The total area of salt pans is 1,800 ha, but at present there are only about 750 ha in operation. The remaining area is unused with stunted bushes of *Avicennia lanata* and *Ceriops tagal*.

In addition to the non-forestry outputs (described above) already being extracted in the Can Gio District, various other possible products to supplement the income of the mangrove population could be developed, like palm sugar (from nipa palm), bee-keeping and crocodile farming. With its present status as an environmental protection forest and its close vicinity to HCMC, a promising new source of income could be "eco-tourism", provided wildlife are ensured good conditions for re-establishment.

5 SAVING WOODFUELS USING IMPROVED COOKSTOVES

One way of alleviating the pressure on mangrove forest resources, thereby contributing to sustainable land use, is to reduce the need for fuelwood by promoting more energy efficient cookstoves. The incentives for this would be the reduced time spent on fuelwood collection and cooking and/or improved economy.

According to the findings of the gender study reported in the appendix, half of the households (100 households) in An Nghia village can be classified as poor or very poor. More than half of these used the "three stone" type of fire for cooking. The rest had better cookstoves constructed of clay and some had metal stoves. Most households, except for the poorest ones possessed more than one type of cookstove. Some people use commercial, but poorly built cook stoves. The ones they can afford cost 10,000 to 15,000 Dong (about 1 US$). Unfortunately, this type is less durable and sometimes lasts just a few days, although more usually they last a few months. When asked about using more durable ones, villagers immediately recognized the improved types with metal buckets, but said they could not afford these more expensive models costing 25,000 to 45,000 Dong (about 3-4 US$). Also, these models were not yet available in An Nghia or Binh Khanh market.

Most cookstoves are installed inside the kitchen. But in some cases, such as when cooking for a large number of people, roasting cake for selling, etc. the cookstoves are placed outside. In most houses the stove is typically used for cooking rice, soup, fish with sauce and to boil drinking water or water for washing children and sick people. Depending on income and category of household, most people in the village have 2-3 meals per day. However, when working in the paddy field or fishing, all households take 3 meals per day. During the holidays, most households only take 2 meals per day, except high income and average income households.

Figure 12: The First Model of Improved Cookstove Introduced in An Nghia

Fuelwood consists mainly of branches, twigs and roots of *Rhizophora apiculata*, and branches, twigs and stems of *Avicennia* and *Bruguiera*. Moreover, nipa palm leaves have also been used for cooking. Some households collect fuelwood around their houses, once every 2-5 days, but most households collect it far from An Nghia village and therefore fetch it only once every 2-3 weeks.

After being introduced to 5 promising cookstove models available at the Ho Chi Minh City market, An Nghia villagers selected two models (figures 12 & 13). According to their experience, the 3 remaining types of cookstoves break too easily, usually with a lifespan of less than one month, and sometimes only a week.

Figure 13: The Second, and the Smallest, Model of Improved Cookstove Introduced.

200 improved cookstoves of the models selected, in 3 different sizes, have been installed in the village: The biggest one in households which have more than 11 members; the average one in households which have 7-10 members (both sizes being of the first type of cookstove); and the smallest one (of the second type) in households which have 6 members or less. These types of cookstoves, while designed primarily for fuelwood, are less suitable for charcoal and cannot use nipa palm leaves, rice husk or other residues. However, all households in An Nghia mainly use fuelwood. The market price of the large and average sized stove is 2.3 US$ and the small one is sold for 2 US$. Both prices were considered too expensive by at least half of the villagers. Some preliminary experiences after the introduction of the new cookstoves are as follows:

1. Less smoke than the traditional "3-stone fire".

2. Their lifespan presumably longer than the traditional one, since their structures are quite solid and they are clad by a metal bucket.

3. More convenient to use if cooking with fuelwood or charcoal.

4. Time saving. It usually take 60-65 minutes to cook a meal (commonly consisting of soup, cooked rice, fish cooked with sauce and boiled water). Depending on the household this has been reduced by 15-20 minutes compared to the traditional 3-stone open fire.

5. Fuelwood saving because of good heat retention. The 3-stone fire and cookstove available in An Nghia, usually require 0.13 - 0.18 stere for cooking 2-3 meals per day during a week, while the new cookstoves only need 0.08-0.12 stere for cooking the same amount. This could mean an annual saving of about 500 steres of fuelwood for An Nghia village or about 17,000 steres per year for Can Gio District, assuming that 80% of the households uses fuelwood for cooking.

Unfortunately the higher price of the improved cookstoves limits their availability, in particular to the poor households. Since most people at present do not buy their fuelwood, there is no real economic incentive for them to invest in more efficient cookstoves. The time saved on fuelwood collection could, however, be spent on other productive activities instead or the surplus fuelwood, if still collected, could be sold, providing additional income.

6 ENVIRONMENTAL PROTECTION FOREST

As discussed in previous chapters, the importance of a mangrove forest is much wider than just being a site for wood production. The mangrove resources are numerous and of great importance to the socio-economy of the Can Gio District, providing both forestry and marine products. In addition, they also have an important role in coastline protection and accretion of land, improvement of the microclimate as well as being an important nursery ground and habitat for many marine prawns, fish and other animals. With its new status as an environmental protection forest specific priority is now given to the more indirect roles of the mangrove forest.

This change of emphasis on objectives should have a considerable impact on the management of the mangrove forests.

6.1 Activities in Environmental Protection Forest

Following a study to determine the feasibility of converting a production forest into an environmental protection forest the Council of Ministers approved the conversion in Decree No. 173 CT/HDBT, dated May 29, 1991.

At the total cost of 500 million Dong (from the HCMC budget) 1,465 ha of *Rhizophora apiculata*, 101 ha of *Nypa fruticans* and 94 ha of *Eucalyptus camaldulensis* were planted and manpower and building support provided.

About 86 households were allocated a total of 7,173 ha of land and forest land to maintain, protect and afforest. They were allowed to plant trees on their land and gather all products. To establish the forest, a contract period of 30 years was agreed between volunteer households and the Can Gio Forest Enterprise. The forest produce is shared between the Forest Enterprise (35%) and the households (65%). People can also make shrimp ponds within the forest, under the control of, and with technical support from, the Forest Enterprise and with the approval of the HCMC Forest Department.

In order to preserve the mangrove ecosystem, the HCMC Forest Department is now controlling all the *Avicennia alba* grown on mud flats. The riverbanks must be retained as a buffer area, 5-10 m wide. People can still collect dry wood from within these forests for their own use.

Figure 15: A Villager's Residence: Built Largely Using the Products of the Surrounding Forest

6.2 Laws and Regulations for Mangrove Forest Protection

Until recently there were few laws, guidelines or regulations for the preservation of the mangrove forests, but on 19 August 1991, the Council of State issued a Forest Protection and Development Law concerning the establishment, use and management of environmental protection forests.

Regulations for first and second thinning operations were also issued in 1984 and 1989 respectively, while the regulation for a third thinning is still being compiled.

The hunting of wild animals and birds in the mangrove area is now prohibited, according to official rules No. 1222/NN-LN dated 15 November 1991, issued by the HCMC Agriculture Service.

To manage shrimp ponds within the forest, the HCMC Agricultural Service issued a communique on management and establishment of shrimp ponds within the mangroves of Can Gio District. In the past, many state farms, forest enterprises and individuals in Can Gio cut trees, and barricaded and embanked land indiscriminately for shrimp ponds in the traditional way thus affecting the growth and development of *Rhizophora*. To avoid this, the establishment of shrimp ponds is now strictly controlled by forest rangers and the Forest Enterprise.

A temporary regulation (No. 178/LN-QD) dated 7 March 1992 of the HCMC Agriculture Service concerns contracts for hiring of households and management units for individual plots for forest protection. Based on these contracts, the money for paying forest guards and households will be made available from the HCMC budget every year.

In the future, many regulations and guidelines for the use of the environmental and protection forests for wood production, marine culture and wildlife conservation will be compiled to further contribute to the preservation and rehabilitation of the mangrove ecosystem in Can Gio District.

7 POLICY AND DEVELOPMENT ISSUES

Now that the mangrove forests in Can Gio have been declared an environmental protection forest a particularly thorough management plan is necessary for the area encompassing the use of appropriate extraction techniques. Being located so close to a major and rapidly developing city like HCMC this should be considered urgent, since pressure on the mangroves is likely to increase in the near future. During the last few years, the Forest Department of HCMC has implemented various measures to tackle some of these issues. In order to further improve the interactions between all sectors and to enable the development of more successful strategies, the following policy and development issues should be addressed:

7.1 Promoting Public Awareness

The protection and use of the mangrove ecosystem requires an intimate understanding of the forest and environment that people live in. In the past, extension programmes, training activities, seminars, workshops and exhibitions on the mangrove ecosystem have received low priorities. The lack of awareness of the importance of the mangrove forests coupled with the poor state of the economy has led to damage of the forest. To win public acceptance and support on a national and local level for forestry programmes, social and community forestry projects should be carried out to promote awareness of conservation issues and mobilize the local people to participate in mangrove forest protection. Public campaigns and educational activities should be undertaken to make people more aware of the direct and indirect importance of mangrove forests, and of laws and regulations for the forest, and to provide guidance on forestry and fishery techniques, including aquaculture. This awareness campaign should also be directed towards decisionmakers outside the mangrove area.

7.2 Land Allocation

In the past, land and forest land was allocated only to state organizations, not to local people or individuals. Hence, conflicts of interest arose frequently between state organizations and authorities such as state farms or the Forest Enterprise and the local people. Mangrove forests were damaged, illegal cutting was common and the state farms were not able to protect the forest. The local people, who lived in or nearby the forests had no legal benefits from the forest, not even firewood for cooking. The HCMC Forest Department has initiated a change in policy by allocating land and forest land to local people for forest protection, maintenance and afforestation. For example in 1990, Can Gio' Forest Enterprise allocated forest and forest land in compartments 4 and 6 to 10 poor households in Tam Thon Hiep sub-district. Besides allocating land, other support is also provided such as financial support for house construction, to purchase boats and rice during the first 6 months as well as tree seeds and assistance and supervision of their forest-related activities. This has resulted in better protection of the forest. The forestry activities provide jobs for people through forest protection, thinning and afforestation. If they plant trees on the allocated land, they become the real owners of these trees and hence behave more responsibly. For various reasons, such as limited economic resources to support households in the initial period after the land has been allocated to them, land allocation is presently carried out slowly.

Based on these initial experiences from both the Duyen Hai Forest Enterprise and Can Gio People's Committee it is clear that forest land allocation to local residents has considerable benefits and efforts should be made to find the ways and means to continue with this programme. However, it is necessary to identify the overall benefits and ensure that both sides (receivers as well as the government) benefit equally. The effective duration of the land allocation contract should also be considered.

7.3 Land Use Planning

In order to ensure the overall sustainability of the mangrove area, including permanent and productive forest lands, agricultural land, shrimp ponds, fish farms, rivers etc. a land use plan specifying zones for each land use category should be drawn up. This will aid in creating harmony among economic interest groups within Can Gio District as well as ensure economic and environmental stability. This plan should form the basis of the land allocation programme. In order to ensure a sustainable system the government should naturally include privately owned lands as well.

7.4 Improving Standard of Living

Most people who live in the Can Gio mangrove area are poor and live under harsh conditions such as lack of fresh water, education and communication, with few job opportunities and the risk of malaria. As a means of raising the standard of living in the mangrove forest areas, the government should give a high priority to the provision of infrastructure like roads, hospitals, schools, electricity, and so on. In addition, the government should try to provide opportunities for job generating activities, for instance by offering low interest loans for investments in charcoal kilns, aquaculture, livestock breeding, agriculture and tree planting. In particular, there appears to be ample room for a sustainable expansion of the local charcoal industry. The prospects for the development of other products like those mentioned in chapter 4, should also be further explored. With its close proximity to HCMC, market opportunities should be favourable for a number of products. In the allocation of jobs or forest land, priority ought to be given to Can Gio mangrove population over outsiders.

7.5 Shrimp Breeding

A thorough evaluation should be made of all semi-intensive and intensive shrimp ponds already present in Can Gio. This is considered necessary in order to draw up policies and guidelines to support the spread of these models. Clear cutting of mangrove forests for conversion into shrimp ponds is now strictly forbidden and this rule may have to be amended. Although semi-intensive farming appears to be the best model, many improvements in management and techniques still have to be introduced to prevent further damage to the mangrove forest ecosystem. The Indonesian models which integrate trees in the shrimp ponds (described in chapter 4) have now been introduced in Minh Hai province with promising results. These models should seriously be considered for introduction into Can Gio District. The "taungya" system (p. 34) would be especially suitable where new forest is to be established.

7.6 Energy Policies

Although they live in the mangrove area, people often lack firewood for domestic use. This is because most forests already have owners or because the area has been designated an environmental protection forest, hence with restricted access. People are only permitted to collect dry wood and, because this amount is limited, this often leads to illegal cutting. This calls for a solution to the energy problems facing the people. This can be done through the promotion of afforestation, by planting trees in homesteads, around schools, along roads and riverbanks. This may increase the local supply and, together with the promotion of fuelwood-saving cooking stoves, would reduce illegal cutting.

Besides providing support through the provision of tree seeds and/or saplings, rules and regulations may have to be amended to ensure that the benefits reach the people. Ways and means should be found so that wood from thinning operations can be supplied at a low price to villages and sub-districts by the sub-district People's Committee and forest rangers. In order to determine the present and future demand for firewood of Can Gio District, a more detailed survey of fuelwood demand and supply needs to be carried out.

7.7 Scientific Research

As an environmental protection forest, HCMC's mangroves have a number of problems which need to be solved to satisfy both the demands for protection and production. Unfortunately, research on mangrove forests has until now been given low priority by the authorities due to the small size of the areas involved. Even though some research has been carried out during the past 10 years, e.g. in the fields of species survey, thinning operations, charcoal processing and silvofishery, this has often been done in isolation and with little sharing of the results among all concerned. Furthermore, many issues remain, such as: species choice for replanting on elevated land and on abandoned salt fields; planting trials with measurement of erosion along riverbanks and the coastline; relations between mangrove forest and fishery; primary and secondary productivity; surveying wild fauna to set up a wildlife conservation scheme; possible environmental impacts of ecotourism; economic prospect of alternative mangrove products, etc. There is therefore a need for close and conscious collaboration between the concerned research agencies, to ensure that these activities will collectively produce the optimum benefits and avoid waste of scarce resources.

The establishment of a National Mangrove Committee should be considered in order to formulate policy guidelines on mangrove resource management at a national level. This committee should be multidiciplinary, representing forestry, fishery and wildlife expertise and should actively coordinate between the central, local and international mangrove research institutions.

In order to facilitate research and development activities related to the mangrove ecosystem, the government should offer incentives to scientific and technical cadres and create a good working environment in the mangrove area.

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ANNEX
Socio-Economic Conditions in An Nghia Village with Particular Emphasis on Gender Issues

1 An Nghia Village At Present

An Nghia village is characterized by houses constructed of nipa palm leaves. The houses are built on clay bodies. These "islands" can be established only after the (sub) district's authorization has been obtained. The village consists of seven housing clusters. These clusters are connected by clay roads that serve as dams and boundaries between village forest plantations, open water surfaces, shrimp ponds and paddy fields.

Villagers mostly originate from provinces adjacent to Ho Chi Minh City, like Can Gio District, Long An province, Tien Giang province and Nha Be District of Ho Chi Minh City. But some have come to An Nghia from more remote areas, like Ben Tre province, mainly forced out by wartime destruction.

There are 1,538 inhabitants, of which 760 are male and 778 are female. The average household size is 7.7 persons and there are exactly 200 households, of which 19 are headed by women. One of those is a woman living on her own, forming a separate household.

Though the average household has nearly eight members, most of the couples would prefer a family with four children. For many reasons, families often reach up to 10 children. The smallest household consists of one lady and the biggest one is a fisher family with 21 people. A quarter of all households has less than 6 persons. A majority of 58 percent has 6-10 household members.

There is no strong awareness among the villagers of An Nghia being a community. Religious, cultural and ethnic differences have until now prevented occurrence of communal celebrations and construction of communal meeting places. The villagers can best be regarded as pioneer families that have come to try their luck, colonizing the land and trying to make a living. They have arrived there before, during and after the war, which finished in 1975. So, it is still very much a "floating" population that lives both in the district as a whole and specifically in this village.

The village is led by a village committee, that comprises a headman and a deputy headman. They have been nominated for the posts by the district authorities. They receive a financial complement for executing the task. It is said to be an unpopular job demanding a lot of time, with many obligations and only a few gains. The village headman is equipped with a megaphone system, that works on a battery as electricity has not yet been provided by the district. However electricity supply is expected to be available in the future as electricity poles has already been erected (fig. 1). The megaphone serves to make public announcements and to provide the villagers with certain radio programs that are broadcast by the state radio.

The public services available in the village are otherwise limited. There is one primary school with 280 pupils, 10 teachers and 2 assistants. Among the teachers are seven males and three females. There is a pharmacy and a first aid station with two male physicians and a female nurse. The nurse also acts as the mid-wife.

There are three village associations: A women's-, a youth's- and a farmers' association. The latter is the most active and tries, for example, to borrow money from the European Community (EC) The EC has an anti-salinity project in Binh Khanh sub-district (see map). The women's association depends on the district's initiatives for the organization of activities. The main fields of interest are care for sick children and the elderly, prevention of malaria and family planning. The literacy rate is higher among men than among women, but is generally low, at about 50%.

The Nha Be-Can Gio road goes through An Nghia village and complements the extensive river-stream transportation network. The main means of transportation from An Nghia to other places are the bus, motorcycle, bicycle or passenger cars. Most of the households only possess a bicycle, but about ten households own a motorcycle. One motorcycle owner uses his motorcycle as a taxi. When men are going to the Agricultural Bank in An Thoi Dong, Binh Khanh or Ho Chi Minh City they often form a group of four or five members and go by motorcycle. Children that go in secondary school go by bicycle to Binh Khanh or An Thoi Dong. Some male household heads own a boat.

Figure 1. Provision of electricity is expected in the near future, as electricity poles have already been erected.

Fresh water is supplied by a water boat that charges 18,000 Dong per cubic meter or 700 Dong per 40 liter. Compared with the price of tap water provided in Ho Chi Minh City, which is 500 Dong per cubic meter, this is 36 times more expensive.

The government promotes fisheries as the main potential for economic development in Can Gio District. It has supported infrastructure works for that purpose.

A road connecting Binh Khanh in the North with Can Gio town in the South was constructed by the Ministry of Communication in 1985. An Nghia is situated near to that road. The main advantages of this infrastructure is fast transportation of fish products to Ho Chi Minh City and a possibility to conserve these perishable products in cold storage units.

Along with the road, electricity has been provided to Can Gio town since 1989. Also, the provision of electricity for other villages along the road will be a reality in due time. In An Nghia, electricity poles have been erected already.

2 Resources Profile

The natural resources available to An Nghia households comprise roughly four categories: a) agricultural land, b) surface water, c) natural forest and d) forest plantations.

An Nghia village belongs to An Thoi Dong sub-district, which is a sub-district of Can Gio District. Nearly 50% of the land in An Thoi Dong sub-district is occupied by the four state farms and the forestry enterprise. The remainder of the land is inhabited by the rural dwellers. The size of their plots varies between 0.5 and 2.0 hectares of paddy fields and 200-300 square meters of homestead per family. This is not enough to produce a reasonable amount of paddy to survive throughout the year. Nevertheless, about 55% of the heads of household mention paddy farming as their first occupation. As it is the main food crop they are producing, they regard it as their main source of living. Because of the low yield of 500-600 kilograms per hectare, a lack of rice during several months over the year is inevitable. With some families this may last for six months of the year.

The *Rhizophora* plantations that have been planted near the village do not belong to the village; all of them are controlled by the state farms or the forest enterprise. The villagers only control the nipa palm plantations which were planted two-three years ago within the homesteads and on paddy lands which had become less productive as a consequence of the rising salinity caused by Tri An hydro-electricity dam on Dong Nai river. The total surface area planted with nipa palm is about 250 hectares. The lands on which they were planted belong to An Nghia villagers, so they have the legal right to use them, but the location is far away from the village.

Nipa palm is very suitable for construction of houses: trussing of walls, roof thatching etc. It can also serve as firewood, though An Nghia villagers prefer *Rhizophora* as it heats longer and turns into charcoal, after which it can be used one more time. Without negating the advantages of growing nipa, some farmers appear to be switching back to paddy now that the salinity of their fields has reduced again. Within the settlement area of An Nghia, some other tree species such as *Eucalyptus* and *Avicennia* have also been distributed and planted. But the real large scale plantations are further away.

Due to the wide river and stream network surrounding An Nghia village, fishery activities, including aqua catching (the capture of various aqua fauna on the mudflats at low tide), are quite popular. Twenty percent of all households is involved in fishery activities and 1.5% in aqua catching, excluding sub-labor and children. Only about 50% of fishing households have fishing nets or boats with engines. Most boats are old, with small engines, only suitable for sailing on the river, not on the sea.

Labor resources are quite abundant but most people have no education. Casual labor covers about 16.5 percent of all household heads. Making raised beds for planting, house building, making dikes and roads, are the main jobs of the casual laborers. They don't like planting and thinning activities, because of the heavy work and because the payment is made only after finishing the whole plot which sometimes takes three or four weeks. People prefer to receive money at the end of a working day.

Up to now there have been no training courses in fishery, forestry, agriculture or rearing of livestock in An Nghia. All production is mainly based on traditional experience. No branch of the Agricultural Development Bank or Saving Fund is here, except for a system of saving money

implemented among the villagers themselves. However, it is not popular because of a general lack of cash income. As half of all households are poor or very poor, they lack cash almost continuously throughout the year. The cash income collected by them after a working day is just enough to buy rice, food, fresh water and other necessities for daily life.

3 Socio-Economic Characteristics of An Nghia Villagers

An Nghia is a village near a mangrove forest, where agriculture and fishery activities are the main sources of income. In An Nghia village the division of economic activities among the total of 200 heads of households is as follows:

Table 1: Main Activities of Household Heads in An Ngia

	Heads of Households	Percentage
Farming	111	55.5 %
Fisheries	40	20.0 %
Casual labor	33	16.5 %
Trading	13	6.5 %
Aqua catching	3	1.5 %

These figures relate to the household heads and cover "productive" activities. Activities of household members other than the household head are not revealed. Also, the necessary but non-economic activities like child care, cooking and washing are not included. These activities, that traditionally are recognized as "women's work" are defined as reproductive activities[1]. Normally, "reproductive" activities are not identified in statistical data. Since they are relevant for evaluating the impact of project interventions, they will be discussed separately (see later in 3.2). In relation to the "productive" activities no significant differences between female and male heads of households could be found.

The categories rich, average and poor refers to their ownership of land and equipment, and the fact of a felt lack of cash over the year. Rich and average-rich families are mainly paddy farmers owning a rice field. They may also own a motorcycle, a boat and several water jars (up to eight). Generally, poor and very-poor families do not own property, they sometimes experience difficulties to maintain their own house and they often have just one water jar, or even none (fig. 2). At present, there is a Unicef project providing a square concrete water jar to each family classified "very poor".

[1] Reproductive activities are activities carried out to reproduce and care for the household and the community, including food preparation, child care, education, health care, home maintenance, fuel and water collection, etc. are reproductive activities. These activities are often viewed as non-economic, generally carry no pecuniary remuneration, and usually are excluded from the national income accounts.

Figure 2: The wealth of a family can be "read" from the number of water jars beside the house

Table 2: The Socio-Economic Status of Households in An Nghia

	General (N=200)		Female Headed (N=19)	
1. Rich	29 hhs	14.5%	2	11%
2. Average rich	71 hhs	35.5%	4	21%
3. Poor	57 hhs	28.5%	4	21%
4. Very poor	43 hhs	21.5%	9	47%

Poor and very poor families suffer a lack of cash temporarily or permanently over the year. This results in a shortage of food, since fruit, vegetables, water, rice and meat have to be purchased. Poor families eat pig meat only once in two or three months. The shortage is periodical in the households that are classified "poor", but is permanent with the ones classified "very poor".

Nearly half of the female headed households is classified "very poor". While the division rich-poor over all households is fifty-fifty, for households with a woman as head it is one-third against two-thirds. This does not absolutely prove that women heading a household have to confront a greater life struggle than males heading a household. But it confirms that it is less easy for women to "remarry" after a divorce or widowhood, and it also gives an indication of the probability of becoming poor when a woman leads a household on her own.

The rich households are mainly active in fisheries and trading. People express their preference for activities like the capture of crustaceans and fishery activities, which "pay off" on the same day.

In general, the poor and very poor do not own land or technical equipment. They usually hire out their labor on a casual basis. They form the majority of participants in the planting and thinning activities organized by the Forestry Department (FD). For the poor and very poor households the most difficult period is the beginning of the wet season (September-October). In that period, the rice has been planted, investments have been made, but the rice is not yet mature and the sea tide is high, which prevents fishing activities. This results in a lack of cash for family activities.

3.1 Gender[2] differences in productive activities

The productive activities[3] in An Nghia consist of subsistence crop production, fishery, capture of crustaceans, feeding livestock (chicken) and some handicraft makings like sewing. The subsistence crop production includes cultivation of paddy, vegetables and fruit crops. A single crop of paddy is grown during the monsoon rains (June - November) and is the prominent crop. Paddy fields are located in the low area and small fruit fields are located in the higher area.

Farming:

Site preparation for paddy cultivation is exclusively done by men. About a month is spent on the whole process, including preparation of seed beds and sowing. Transplanting is done by women in July. If family labor is not sufficient, they can ask casual labor or groups of women to assist them based on a system of reciprocal exchange. In August and September, weeding and spraying of pesticides and fertilizers are done by women and men. During the harvest from November to December, work is done in a complementary manner. Beside being paddy farmers, An Nghia villagers spread their income over other farm activities, of which sugarcane, small apple and sweet

[2] There are differences between women and men that are biological and social. "Sex" refers to the biological differences that are universal and unchanging. "Gender" refers to the social differences that are learned, are changeable over time, and have wide variations within and between cultures. Gender is a socio-economic variable to analyze roles, responsibilities, constraints and opportunities of the people involved; it considers both women and men.

[3] Productive activities include all tasks that provide the household and the community economically, e.g. crop and livestock production, handicrafts, marketing and wage employment.

potatoes are the main species of fruit and vegetable crops, but are only grown on a small scale. Small apples can be harvested during the year by men and women. Sweet potatoes are only grown around the houses in the rainy season to solve partly the need for vegetables. They are mainly grown by the women. Some people keep small livestock like ducks and chickens. Breeding chickens commercially is limited to one household in An Nghia. Chickens are fed in the homestead. Collection of fodder is done by the man (the head of household), whereas children and women are only sub-laborers. The village headman owns two pigs.

Fishery Activities:

Fishery activities are carried out all year round, but in September - October fish and shrimp yields are low because of higher tides. For some farming families, fishery is an additional job and is done outside the paddy cultivation schedule. Men form the main labor force, while women and children help to repair the fishing nets. The capturing of crustaceans is done by men, women and children all year but less intensively during the wet season (November - April) where it as difficult to catch fish, crab and shrimp because their tracks are washed out. The yields of fish and crustaceans at present amount to 300 kilograms per hectare of water surface per year. Through extension workers who could train farmers intensively on the job, yields may be raised substantially. This, combined with other innovations could make it possible to harvest average fish yields of 1,000 kilograms per hectare annually.

Crafts and Trading:

This category mainly covers the large scale trading in fish, that is done every day by (middle) men who sell it on Binh Thanh and Ho Chi Minh City markets. Small scale trading by women is carried out in the homestead or near the house in the village. Small scale trading is done by women in the homestead where cakes, fruit, vegetables, sugar, fish sauce and so on are sold. The investment capital is small and the interest is low. The practice of traditional crafts and the making of handicrafts are not widespread. There are roof thatching, furniture making and renovation and repair activities which are mainly men's jobs (fig.3). Some activities related to fisheries like net sowing, mudskipper trap- and broom making are both women's and men's jobs. Finally, some crafts are exclusively carried out by women like sewing and basket weaving. Sewing is limited to 10 households. It is done by women on a small scale, with one sewing machine per household.

Figure 3: Repairs on motorcycles and other technical equipment are exclusively done by men.

Figure 4: Though heavy work is generally known as a man's job, women can be recognized among the casual laborers.

Casual Labor:

Generally casual labor concerns physical work related to house building, fish pond construction, planting, thinning, digging, etc. Normally, the duration varies from a day to a month. Casual laborers can be hired by a private person, an enterprise, the forestry department, etc. Because of the heavy work of dike construction, making raised beds and shrimp pond digging it is mostly known as a man's job. However, women can be found among the workers (fig. 4). The daily wage for this kind of work is about 15,000 Dong for men, whereas women earn about 10,000 Dong per day as casual laborers.

It seems to be very common that capital intensive technological innovations are controlled by men, for example boats, motorcycles, radios, accumulator batteries and heavy fishery equipment.

As stated above, the villagers of An Nghia are characterized by earning multiple incomes from different sources. Despite this, poverty continues. Factors contributing to this are the limited resources for rice production, such as small size of plots, and low productivity, and the relatively low yields obtained from fishery activities. Therefore, the amount of cash gained over the year is by far not enough to buy all household necessities. In fact half of the population suffers periodically, mainly in the wet season from May to November, from a lack of food. If a particularly bad season occurs, famine is likely.

3.2 Reproductive activities

To understand better the roles of women and men within a given context, gender roles can be divided between productive and reproductive activities. Reproductive activities are those carried out to reproduce and care for the household and community, including fuel and water collection, food preparation, etc. Sometimes they are called human resources maintenance activities.

Men are mainly responsible for building the houses and repairing them. Most houses in An Nghia are built with nipa leaves for thatching and walls, so every 2-3 years they have to be repaired. Women and children in the family will also help, and if family labor is not sufficient, then groups of men work on a system of reciprocal exchange.

Women are mainly responsible for cooking and taking care of children and elderly people. However, in one household (breeding chickens), the wife is an accountant and works all day in the primary school, so taking care of the children is the man's (head of household) task.

Collection of fuelwood is a daily activity mainly done by women, when there is sufficient wood available in the homestead. Similarly in households that have their own plantations of nipa palm and some trees of *Rhizophora*, *Eucalyptus* or *Avicennia*, women are mainly responsible for fuelwood collection. In the case of longer distances, at the site of thinning activities for example, collection is done by men, women and children together. As they have to go far away (within Can Gio District) to collect it, women and children cannot go on their own. The quantity of fuelwood collected for cooking each time is normally enough for about 2-3 weeks.

Collection of fresh water is easier. Some private boats carry fresh water to each household, therefore men, women, children have equal opportunities to collect water (fig. 5). Though, in general it is the head of household who has to provide the money to pay. The various household tasks, including washing clothes, feeding some livestock such as pigs and chickens are women's tasks. In fact, one can conclude that women's tasks are more demanding than men's tasks. Despite that, the average income of a woman is less than that of a man. Women work all day, but equal sharing of decisions and responsibilities between men and women is still far away.

Figure 5: A young woman collecting water from the water boat.

4 Constraints to Development

Firstly, the limited natural resources available in An Nghia is one of the largest constraints to increasing the villagers' standard of living. The land reserved for cultivation is not large (0.5 - 2.0 hectares paddy field/household and 200 - 300 m^2 of homestead). What is more, due to unsuitable soil and climatic conditions, rice productivity is low. Although some households want to enlarge paddy cultivation no more land is available, and often the local People's Committee does not reply to their letters requesting permission to cultivate more land.

Secondly, the illiteracy rate in An Nghia is quite high with nearly 50% of the inhabitants being illiterate. Illiterates include the people who never went to school and the people who went to primary school but now forget most of what they learned after not using it for many years. There is only one household head who graduated from secondary school and most of his children are in primary and secondary school now. The heads of most households have had primary education (1-5 years) or no education at all. The illiteracy rate among females is higher than among males. Although there is a primary school in An Nghia and a literacy drive is implemented every year the number of illiterates is still high. In particular, the re-training of the elderly who once were literate and members of poor and very poor households is difficult. This is one of the negative factors limiting the acceptance of new technical achievements related to possible economic activities in the mangrove ecosystem and of social improvements. Besides the low rate of literacy, there is a lack of budget,

skills, and training courses related to breeding of fish, shrimp and crabs, cage culture and livestock. Some households are willing to borrow money from the Agricultural Development Bank or other national organizations but the borrowing procedures are too complicated, requiring house property, land certificate etc. as security. The central and HCM City governments should provide legal land certificates to peasants as soon as possible, and at the same time the Agricultural Development Bank should also simplify loan procedures, especially so that poor and very poor peasants are able to implement successfully the "Crossing out Hunger, Reducing Poverty" programme which has just been initiated by the HCM City government.

Thirdly, the limited availability of fresh water and fuelwood are major constraints. Due to the need to transport water from Nha Be District or Dong Nai province to An Nghia, the price of fresh water in An Nghia is 36 times the price in urban areas. The provision of fresh water is completely carried out by the private sector. Though the water price is high, it is very convenient because private boats carry fresh water to each household. A water supply network implemented by the state (water supply facility in HCM City) is necessary to reduce the price in the short term, and in the long term, a stable, durable water supply strategy based on investments of the Central and HCM City governments as well as international subsidies should be drawn up. Most households do not have to buy fuelwood, but they must go far from An Nghia village, within Can Gio District to collect it and since not all *Rhizophora* plantations belong to An Nghia, illegal cutting of *Rhizophora* for fuelwood is inevitable. To partly solve the fuelwood shortage, HCM City government (Financial Service, Agricultural Service, and so on) and Can Gio People's Committee need to support/subsidize the commercialization and distribution of mangrove wood so that villagers can afford it, and at the same time help to develop their own trees/plantation for fuelwood in the homestead as well as introducing, step-by-step, more solid, improved cookstoves.

Fourthly, as long as life remains a struggle for at least a half of the population in Can Gio district, a big part of the population continues to consider resettlement elsewhere. Living in An Nghia and Can Gio District seems for many people to be a temporary solution. The inhabitants of An Nghia village can be characterized as a "floating" population: only some live here permanently. This phenomena may also contribute to a lack of a community spirit, and may prevent initiatives for community organization and again, this may create constraints to developing knowledge and experience for the community management of natural resources.

Finally, some bad traditional habits like the fact that people only want to do something which pays off on the same day act as constraints. For example, some works such as thinning and planting that are offered by the government are not acceptable to them because they are not paid before the job is finished. The government can not help them increase their income, if they refuse to accept the work available. These habits have contributed to the lack of support programs to improve the standard of living in An Nghia village.

5 The Potentials of An Nghia Village

The natural resources available to households in An Nghia vary with their economic status. In general, the households that are rich own land, a fishpond, materials, a boat and/or a motorcycle. The poor and very poor households only have their house and homestead, and for some even their house appears to have collapsed, which has forced them to live with their parents. As a gender consideration it has to be remarked that the division between rich and poor is more pronounced

among the 19 female headed households than among all households in An Nghia (200). Nearly fifty percent (47%) of the households headed by women are very poor, while this category is only 22 percent of all household heads.

It has to be taken into consideration that all households in An Nghia are relatively poor. This is relevant, when reflecting on the possibilities and potentials to develop this village and the surrounding area. As the physical circumstances are severe, only the potentials for economic development are elaborated. This is not to ignore the need for cultural and social development also, but it can come after the real struggle for life has been overcome.

The government and specifically the Agriculture Service of Ho Chi Minh City could become a stabilizing factor for the "floating" population in Can Gio District and specifically An Nghia village, by carrying out several facilitating activities for the local population. These activities should differ relative to the natural resource it concerns.

South of An Nghia there is a forest farm with natural forest where villagers can legally collect dry dead firewood. It requires a boat and high tide to reach this area. The potentials of the natural forest can be used by cultivating certain species of animals or plants. There may be a possibility to keep and breed crocodiles and snakes, both for their skins and their meat. Bee keeping and honey production can also be developed. Since 1991 when the forest formally became an environmental protection forest, settling within the forest and hunting of wild animals has not been allowed. The forest ranger can fine people who break the law.

The paddy land has been partly converted into nipa palm plantations and only a part is giving rice yields once a year. Potential areas for development are:

1. Supply of fresh water to increase the crop productivity through the reduction of salinity.
2. Introduction of salt resistant rice varieties.
3. Application of technical knowledge on fertilizer and irrigation techniques, to increase the yields and number of harvests per year.
4. Cultivation of crops other than rice on salty soils, and the possibility to market these within Vietnam e.g. millet, wheat, barley or other cereals.
5. Reduction of rice pests and other crop diseases.
6. Providing agricultural extension services related to paddy as mentioned above.
7. Increasing the pace at which legal land certificates are provided to the peasants that have developed land.

The homesteads could be used more intensively, which would improve the income of women. Possibilities lie in:

1. Livestock production. At present ducks, chickens and pigs are bred in An Ngia. The agricultural development agency in charge of livestock could promote a higher intensity of this and other kinds of animal husbandry e.g. goats or sheep through extension services related to feeding techniques and alternative ways of making small cattle products e.g. meat, leather, dairy products (egg, cheese, yoghurt, milk).
2. Fruit trees, nut trees and other multipurpose trees suitable for this ecological environment.

3. Vegetable beds, if these are resistant to salt water, or if they can be irrigated with fresh water.

To upgrade women's kitchen environments the following initiatives can be promoted:

1. Support/subsidize commercialization and distribution of *Rhizophora* wood so that villagers can afford to (legally) obtain it.
2. Introduce, step-by-step, the metal bucket cookstove as it can be used one or two years against 3-4 months on average for the fragile ones that people use nowadays, and examine ways to keep its price low/affordable for An Nghia's peasant population.
3. Facilitate the provision of fresh water (substantially used for drinking water) to Can Gio District, as An Nghia villagers are now paying 36 times the price that Ho Chi Minh City dwellers pay.
4. Provide extension services to improve livestock feeding techniques, foremost for small livestock like ducks and chickens, as those are affordable for An Nghia villagers.

It has become clear from the plans of the Department of Fisheries and the People's Council of Ho Chi Minh City, that most economic growth is expected from aquatic productions. If this is to be promoted, much effort should be made to avoid further economic marginalization of women, as women are only involved in the capture of crustaceans and hardly in fishery activities itself.

The cultivation of fish, crab, shrimps, snails, mussels, oysters, sea plants, jelly fish, frogs, lobsters, squids, eels, prawns and octopus is known from other countries and can achieve yields of 1,000 kilograms per hectare of water surface. With loans and cash money to invest in the construction of fish ponds and technical support, it should be possible to increase the yields that nowadays are low. The Ho Chi Minh City Agriculture Service, the Department of Marine Products, can provide facilities to build fish ponds, use higher fodder quality and teach innovative feeding techniques.