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AGRICULTURAL DEVELOPMENT ANDNATURAL RESOURCES DEGRADATION AN ENVIRONMENTAL REVIEW

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ABSTRACT

This paper reviewed the current states and problems of sustainable use and management of forest, land use, water and agro-chemicals. The result showed that the forest cover in the MD was lowest Vietnam and they were still threaten by agricultural development, population pressure, poverty, forest fire, and lacking of knowledge and institutional arrangement. About 70% soil areas in the MD were problem soils and were reclaimed for agricultural development. Land use and management in the MD were facing with the impacts of problemed soil reclamation, soil fertile and degradation and conflict in land and water use in the MD. Water resource in the MD gave this area both the benefits and constrains. The problems of water use and management were flood, drought, water control and integrating management between land and water use. Agro-chemicals are the results of the agriculture and aquaculture development in the MD. There were figures showing that pesticides and fertilizers use increase by years in many provinces and pesticide residues were found in rivers in the delta. The impacts of agro-chemicals on human health, aquatic life, water quality and soil were reported; however, they had not understood fully. The management of agro-chemicals, especially illegal pesticides and poor farmers' practice are the most concerned in agro-chemical management.

Key word: Mekong Delta, forest, land use, water, agro-chemicals

1 INTRODUCTION

The Mekong Delta (MD) is the southernmost region of Vietnam and belongs to the lower Basin of the Mekong River. The whole area is peninsula with three sides abuting Cambodia in the North, the East Sea in the East and the South and the Thai Gulf in the South West of the MD. There are twelve provinces and one city with the natural area of 39,738.7 km^2 (12% of Vietnam area) and 17.076 million people (20% of Vietnam population) in 2004 (General Statistic Office (GSO), 2005).

It is said that the MD has comparative advantage in various agricultural products relative to other economic zones in Vietnam (SPF et al, 2006). The MD is considered as a rice bowl of the country with more than 18.5 million tons of paddy rice produced (2004) and accounted for more than 50% of paddy rice produced in the country. The rice export output of Vietnam was 4.5 million tons in 2004, of which, more than 90% of its volume came from the MD. Aquaculture was another advantage of the MD. The aquaculture area of the MD in 2004 was 650 thousand ha, increasing more than twice comparing to the year of 1995. The shrimp output of the MD was 290.2 thousand tons, accounted for 79.5% of its output of Vietnam (GSO, 2005).

According to the state of the environment of the MD in 2005, the MD were suffering with many typical environmental problems such as the environmental problems in and after flood, the degradation of water, soil and forest resources and pollution of the urban and rural areas. Of which, forest, soil and water resources and agro-chemical application were four main issues that contributed significantly to the agricultural development in the MD. Aquaculture development in recent years destroyed most of forests coastal areas and rice expansion made narrow inland forests and wetlands. Problem soils in the MD were exploited to increase agricultural land. Besides, overusing of modern inputs such as fertilizers and pesticides in the agriculture production caused types of pollution in soil and water resources. The improper exploitation of forest, land and water resource as well as agro-chemicals input are threaten the economic development, especially in agriculture, sustainable resource management and environmental protection in the MD.

The paper aims to review environmental impacts of forest, land, water resources utilization, and application of agro-chemicals (fertilizers and pesticides) to the environment in the MD. The specific objectives are:

- to evaluate the current situation and the relating problems of forest, soil, and water resources utilization and agricultural production activities;

- to evaluate the current situation and environmental impacts of applying agro-chemicals (fertilizers and pesticides) in the agricultural production; and

- to find out issues for further research in the field of environmental economic analyses.

The data used to review in this study were from three main sources such as statistics of the General Statistics Office of Vietnam (GSO), the annual reports of the state of the environment from provinces in the MD and Vietnam, and published studies related.

All relevant information collected were presented by the structure of states of the forest, land use, water utilization and agro-chemicals application (what were the situations?) how and why were they different from the past or other region of Vietnam?) and what were the impacts? From these states of each element, the most problems in utilization and management were reviewed. The causes and the effects of the problems were also discussed in this part. Finally, recommendations for sustainable use and management were found out, especially further researches in environmental economics of forest, land use and water utilization and management and the applications of agro-chemicals.

There are four sections that will be discussed in this paper. Each section describes the current situation and the problems relating to the resource exploitation. In detail, section 1 presents the current status of forests in the MD and the problems relating to forest protection and development in the MD. Section 2 describes the characteristics of soils, land use in the MD, especially land use for agriculture and aquaculture and the problems relating to soil exploitation, land use management. Section 3 presents the characteristics of water resources and their uses in the MD and the relating problems relating to water use and management in the MD. Section 4 describes the current use of agro-chemicals, the reported impacts from agro-chemicals and the problems of its management. Finally, a conclusion of four issued is drawn and further researches in environmental economics are presented in the recommendations.

This paper will focus to analysis the impacts of the MD agriculture on the forest, land and water resources and agro-chemical application. The impacts of industrial and service sectors will be limited in this paper.

2 FOREST USE AND MANAGEMENT

The first part of this section will present the current status of forest in the MD such as forest areas, forest cover, types of forest (natural and planted forests; *Melaleuca* and mangrove forests; protection, special use and production forests), forest distribution by provinces, the causes of low forest cover and unbalance distribution, the states of wetlands and their importance to forest protection in the MD and the impacts of wetland loss. The second part will elicit the three most critical problems threat the forest protection and development in the MD.

2.1 Current status of forest in the MD

Table 1: The forest area in Vietnam and the Mekong Delta in 2004

Unit: Thousand ha

Type of forest	Vietnam		Mekong Delta	
	Area	%	Area	%
Natural area (km^2)	329,314.5		39,738.7	
Forest area	12,173.3		334.8	2.8
Forest cover (%)		**36.7**		**6.0**
Natural forest	9,904.0	81,4	49.3	14,7
Planted forest	2,269.3	18,6	285.5	85,3

Source: GSO, 2005. The data was accounted to 31/12/2004

Table 1 shows that the total forest area in the MD was just 334.8 thousands hectares accounting for 2.8 % of Vietnam forest area in 2004. The percentage of forest cover in the MD was 6%, lowest in Vietnam while it was 36.7% of Vietnam area at the end of 2004. 85.3% of forest in the Mekong Delta was plantation forest (285.5 thousand ha) while it was 18.6% in the whole country (GSO, 2005). The low forest cover in the MD caused by deforestation forest during the war and the united time later, conversion to rice field, saltpans and shrimp ponds in the last decade (Tong P. H. S. et al, 2004; Miller F. et al, 1999; Hotspot Mekong Delta-soils).

There are two main forest ecosystems in the MD (*Melaleuca* and mangrove forest). *Melaleuca* forest located mainly in the Plain of Reeds, Long Xuyen Quadrangle and Ca Mau Peninsula areas and contributed to 63% of the total forest area in the MD in 2004. Mangrove forest (*Rhizophora apiculata, Avicenia spp*., etc) located in coastal wetlands and accounted for 37% of the total forest areas in the MD (Thanh N. C., 2005). The mangrove forests have important roles in coastal protection. However, its area was destroyed more than 70% comparing to the year of 1950 (about 250,000 ha mangrove forest in the MD in 1950) (Sub-FIPID cited from Miller F et al, 1999) by the war, overcutting for timber, charcoal making and fuel wood and fishery and aquaculture exploitation.

By functions, forests in the MD are divided into three categories (Protection, special use and production forest). Protection and special use forest occupied about 42 % of the total forest area of the MD (21%/each type). They located in the coastal and the last wetland areas and belonged to 10 protected sited of MD (Appendix 1). Production forest contributed to 58% of the total forest area of the MD (Binh N. N., 2003).

The plantation forest increased steady during years with the support of the 5 million ha plantation forest program for the whole country (Binh N. N; GSO, 2005). In Ca Mau, Bac Lieu, Soc Trang and Tra Vinh, the Coastal Wetland Protection and Development Project, funded by World Bank, DANDA and the Vietnamese government, supported these provinces to reestablish the forest belt for coastal areas. Appendix 2 provides more figures in forest plantation from 1995-2000 in the MD.

The forests distributed unbalance among provinces in the MD (Table 2). Ca Mau (97.2 thousand ha), Kien Giang (95.7 thousand ha) and Long An (70.1 thousand ha) occupied 78.6% forest area in the MD in 2004. The natural forests located mainly in Kien Giang with 45.7 thousand ha (92.7% of the natural forests in the MD). The plantation forests were chiefly in Ca Mau and Long An. There was no forest area in Vinh Long and Can Tho city. The unbalance of forest distribution was caused by its natural characteristics of the delta and human activities.

Table 2: Forest area by provinces in the Mekong Delta in 2004

Unit: thousand ha

Provinces/City	Total		Natural forest		Plantation forest	
	Area	%	Area	%	Area	%
Long An	70.1	20.9	0.8	1.6	69.3	24.3
Tien Giang	12.0	3.6	0.3	0.6	11.7	4.1
Ben Tre	3.8	1.1	0.9	1.8	2.9	1.0
Tra Vinh	8.4	2.5	0.9	1.8	7.5	2.6
Đong Thap	11.0	3.3	-	-	11	3.9
Vinh Long	-	-	-	-	-	-
An Giang	14.3	4.3	0.6	1.2	13.7	4.8
Kien Giang	95.7	28.6	45.7	92.7	50	17.5
Hau Giang	2.1	0.6	-	-	2.1	0.7
Soc Trang	14.4	4.3	0.1	0.2	14.3	5.0
Bac Lieu	5.8	1.7	-	-	5.8	2.0
Ca Mau	97.2	29.0	-	-	97.2	34.0
Can Tho	-	-	-	-	-	-
The Mekong Delta	334.8	100.0	49.3	100.0	285.5	100.0

Source: The General Statistics Office, 2005. The data was accounted to 31/12/2004.

Wetland had important role to protect forest in the MD; however, wetland environment has seriously degraded. According to Ni D.V, 2000 (cited by Torell M. and Salamanca A.M., 2003), two categories of wetlands in the MD observed are (1) inland wetlands and (2) coastal wetlands. The inland wetlands are founded at floodplain wet rice, seasonally flooded grassland, and *Melaleuca* forests. The coastal wetlands are founded at mangrove forest areas. The environment state of wetlands in the MD has been seriously deteriorated

by over-exploitation by human in agricultural production activities. Agricultural intensification in rice production and aquaculture are major culprits causing the environmental change of wetlands in the MD. In a WWF report (2001), Baltzer et. al. cited by Torell M. and Salamanca A.M., 2003, stated that "the wetlands of the MD were once extensive and varied. Today, much of the Delta has lost its natural habitat, although remnants of the once extensive peat swamp forests, freshwater forests and flooded grasslands are represented in these wetlands. As the last representation of these significant habitats, important for distinctive plant communities, threatened bird communities and other significant animals, conservation efforts are now highly critical and are urgent priorities."

Repeatedly, two main causes of deteriorating the environment of wetland ecosystem are agricultural intensification, mostly in rice production development and aquaculture production, mostly in shrimp aquaculture. The region pushed the rice volume through increasing cultivation area and wetlands were sources to contribute to the large number of rice field areas in the period 1990-present. Increasing the rotation of rice crops per year requires building complete irrigation system. Especially, in immense wetland areas like the Plain Reeds and Long Xuyen Quadrangle, an irrigation system to reclamation of acid sulfate soil areas has been built. Consequently, a remarkable transformation situation from broad grasslands to rice fields is completed during this period (Koji 2001, cited by Torell M. and Salamanca A.M.). Aquaculture production development caused environmental impacts such as saline intrusion of rice-shrimp fields and the neighbouring rice-monoculture fields, sedimentation in rice-shrimp fields, and disappearance of mangrove forests. Table 3 represents the environmental impacts of shrimp culturing on mangrove forests in the MD.

Table 3: Environmental impacts of extensive shrimp culture on mangrove forests in the MD

Environmental impact	Specific detail
Coastal erosion	Increased coastal erosion in Tien Giang, Ben Tre, Vinh Long, Tra Vinh, Ca Mau, and Bac Lieu provinces
Salinity intrusion	Removal of mangrove has led to increased vulnerability to storm damage and saline intrusion.
Shrimp post-larvae	Declining availability of post-larvae has resulted in decreased yields from extensive shrimp ponds.
Mud crab *Scylla serrata* abundance	Mud crabs are an important export crop, relying on mangrove habitats. The populations are reported to be declining, a combination of over-exploitation and habitat loss.

Acidification of pond water/soils	Removal of mangroves from extensive shrimp ponds has led to declining yields of shrimp.
Declining shrimp pond yields	Related to the decrease in shrimp larval abundance and deteriorating habitat, pond yields have decreased.

Source: Phillips 1998, cited by Torell M. et al., 2003

2.2 Environmental problems of forest protection and development in the MD

According to the forest development strategy toward 2010 for the Mekong Delta, forest cover will be increased to 14% of the MD natural area (Thanh N. C., 2005). To achieve this goal and protect the existing forest, the MD confronts with three main problems in forest protection and development: 1) threats of economic development, population pressure and poverty; 2) forest fire and 3) institutional arrangement.

Table 4: Environmental problems of forest protection and development in the MD

No.	Problems	Cited source
1	The economic development, population pressure and poverty	- FAO, 2002; - Minh L. Q., 2001; - Sai Gon Economic News, vol. 40, 2005; - State of Environment of Bac Lieu, Tra Vinh and Kien Giang, 2002-2004; - Thanh N. C., 2005; - Thinh P. T., 2003; - Torell M., and Salamanca A.M., 2003.
2	Forest fire	- GSO, 1995-2004; - Nam M. V. et al, 2003.
3	Institutional arrangement	- FAO, 2002; - Minh L. Q., 2001; - Nang D., 2003; - Thien N. H., 2005; - Thanh N.C., 2003; - Thanh N. C., 2005.

The economic development, livelihood and poverty. They are the most concerned problem in forest protection and development in the MD (FAO, 2002; Thanh N. C., 2005; Thinh P. T., 2003; Torell M., and Salamanca A.M., 2003). In fact, aquaculture development is growing rapidly in the MD, especially in the coastal area. In Ca Mau and Tra Vinh, more than 60% of the mangrove forests have gone in 40 years, especially in the

last two decades for shrimp expansion. Farmers still wanted to shift from mangrove forests to shrimp ponds without being approved by the local authorities. These shifting happened mainly in Ben Tre, Tra Vinh, Soc Trang, Bac Lieu, Ca Mau and Kien Giang Provinces. It leads to pressures to the local authorities in land use planning and forest protection. According to the report of the state of environment in Bac Lieu, Kien Giang Tra Vinh, the area of aquaculture in Bac Lieu increased 33,200 ha spontaneously from 2001 to 2002. In Kien Giang, the shrimp farming area was 51,044 ha in 2003, increased 34.4% comparing to 2002. In Tra Vinh, farmers did not keep the contracts with the authorities to plant forest with 60% forest and 40% aquaculture. Nipa are still replaced by shrimp farms in many districts in Tra Vinh. These activities threaten the remaining forest areas in the coastal areas. The loss of coastal forests affected directly human and the coastal ecosystem.

In inland area, *Melaleuca* forest plantation also developed in Long An, Dong Thap, Tien Giang, An Giang and Hau Giang. The production *Melaleuca* forests are planted on acid sulphate soil and unfertile soil in these provinces. This activity contributes to the increase of the household income and forest cover in these areas. However, most of *Melaleuca* forests in Long An, Dong Thap, Tien Giang belong production forests and farmers who plant the forests have right to cut or harvest *Melaleuca* forests. As a result, farmers in these provinces cut thousands of ha *Melaleuca* forests in 2005 because of *Melaleuca* price went down. Many scientists and government staff of these provinces tried to convince farmers to stop cutting forest to maintain forest areas in these areas (Sai Gon Economic News, vol. 40, 2005).

The percentage of the poor in the MD was 30% in 2004 and most of them living surrounding forest areas. They mainly rely on the resources of the forests (firewood, fish, wild animal and vegetation, ect.) (Thanh M. C., 2005; FAO, 2002). It leads to challenging to the local authorities to protect forest and upgrade the livelihood for the poor.

Forest fire. This was another problem in forest protection and development in the MD. In 2002, a big forest fire in U Minh Thuong (Upper U Minh) National Park, Kien Giang Province destroyed more than 4,000 ha Melaleuca forests (accounting for 40% of the total areas of U Minh Thuong) and 194 ha of peat land. In addition, over 2,100 hectares of peat soils were also partially burned, leaving only about 600 ha unaffected (Nam M. V. et al, 2003). Another big fire in U Minh Ha (Lower U Minh), Ca Mau Province burned 4,423 ha forest in 2002 (17% of the total forest area of U Minh Ha) by fire.

Many solutions to prevent forest fire in the MD have been launched such as forest forecast, water management mechanism change in the forest areas, upgrading people awareness of forest fire. However, the forest fire management created other problems involving in water management, forest and wetland habitat, etc. Until now forest fire is

still a big problem in protection of *Melaleuca* forests. More figures in forest fire in the MD from 1995 to 2004 are presented in Appendix 3.

Institutional arrangement. Finally, insufficient institutional arrangement also a problem of forest protection and development in the MD. Much information relating to forest uses and management, especially wetlands are still missing and limited such as the composition, structure, and processes, such as hydrological, soil chemistry, flora and fauna, and fire processes are not well understood. For example, the hydrology and fire ecology of U Minh Thuong peatland and those at Tram Chim are very different, even more different than those in upland areas. These should be better understood for appropriate management. Further more, socio-economic and biodiversity values of wetlands are not well understood and not yet recognized in development policies, especially total value of forest wetland ecosystem in the MD, how the poor rely on the forest resource and wetland, which policies support the forest and wetland protection and management (Thien N. H., 2005). There are investment scarcity in forest industries and forest product processing (FAO, 2002). There is a need of having an wetlands institution in wetlands management and upgrading knowledge of the authorities about forest and wetland protection (Nang D., 2003; Thanh N. C., 2005). They could help the MD to find a proper way in forest conservation and development.

3 LAND USE AND MANAGEMENT

The first part of this section will present the current status of land use in the MD such as the characteristics of soils, sub-regions division by the geological structure and surface landscape, types of ecosystems in the MD base on human, settlements, agriculture, land used and types of natural resources, land use types of rice production, and the changes of agricultural land in rice and shrimp development in the MD. The second part will elicit the most three problems threat the sustainable use and management of land resource in the MD.

3.1 Current status of land use in the MD

3.1.1 Types of soils and land uses in the Mekong Delta

There are three main types of soils in the MD (alluvial, acid sulphate and saline soils) (Torell M. and Salamanca A.M., year, 2003). Alluvial soils, usually located along main rivers, cover 31% of the total area in the delta and are agriculturally productive. Acid sulphate soils are highly acidic and have low fertility, cover around 41% of the total area in the delta, located in the Plain of Reeds, Long Xuyen Quadrangle and Ca Mau Peninsula. Saline soils due to salt-water intrusion from December to May when the water table is low, rainfall is less and the tidal regimes from the Gulf of Thailand and the South China Sea push saltwater upstream. It covers 19% of the total area in the delta and located

along coastal areas and have limited uses. However, in the past 30 years, saline and acid sulphate soils have been exploited for agricultural development.

Basing on the geological structures and surface landscape feature, the MD is divided by five sub regions (the Plain of Reeds, Long Xuyen Quadrangle, the Central Area, the Eastern Coastal Area and Ca Mau Peninsula) (Torell M, and Salamanca A.M., 2003). The Plain of Reeds located on the northern bank of the lowest depressions in the hinterland, consisting of three provinces Long An, Dong Thap and Tien Giang. Of which 50% of its area located in Long An province. This region is commonly flooded in the wet season. Long Xuyen Quadrangle located on the northwestern bank of the Bassac River comprsing An Giang, Kien Giang, a part of Can Tho City, together with the archipelagoes of Phu Quoc, and Nam Du. This is the region of acid sulphate soil and salty acid sulphate soil. In the wet season, this region is flooded to a large extent for 1.5-2 months. The Central area located in the central part of the MD. This is the largest sub-region of alluvial soil growing rice and fruit garden and it has the most developed economy in the MD. 4) The Eastern Coastal Area located broadly in the coastal plain from Go Cong, Ben Tre, Vinh Long, Soc Trang and Bac Lieu. This region has many sand dunes in the coastline. 5) Ca Mau Peninsula located in the southern part of the delta consisting Kien Giang, Ca Mau.

Basing on human, settlements, agriculture, land used and the types of natural resource, there are three main types of ecosystems in the Delta: Towns and cites; agricultural lands and natural or semi-natural wetland. Towns and cites covered 7% of the total land areas. Agricultural land constitute 83% of the areas and hold 79% of the population while urban areas occupy 10% of the areas and hold 30% of the population (Ni D. V. cited by Torell M, and Salamanca A.M., 2003).

There are three land use types for rice production in the Mekong Delta. These are rice cultivated with fresh water irrigation with three crops per year, rice cultivated in relatively dry areas with one crop per year, and rice cultivated in the wet areas with two crops per year. The main part of rice grown in the MD observed now is the first land use type. Meanwhile, the second land use type is practiced with traditional rice varieties. Since the economic reforms time, agricultural practices along with cropping pattern have changed rapidly. Environmental factors such as flooding and salinity prevented rice production. With the help of the artificial constructions such as dams, dykes and canal systems helped to introduce the irritated rice to increase the number of rice crop per year to the delta.

3.1.2 Trend of change in land uses

Table 5: Agricultural land changes from 1977 to 2003

Unit: Thousand ha

	1977	1980	1985	1990	1995	2003*
Total area of the MD	4,013.6	3,987.6	3,965.8	3,957.2	3,955.5	3,973.9
Agricultural land	2,239.4	2,541.0	2,435.3	2,462.3	2,612.2	2,960.5
% Agricultural land/Total area (%)	55.8	63.7	61.4	62.2	66.0	74.5

*Source: Xuan V. T. and Matsui S., 1998; * GSO, 2005*

The intensification, reclamation and irrigation of agriculture lead rapid change in land use. Table 5 shows that the agricultural land increased from 2,239.4 thousand ha (55.8%) to 2,960.5 thousand ha of the total area of the delta. The reclamation and irrigation works shifted forest, bare and uncultivated land to the agriculture land.

In agricultural land, rice land has increased by 100 thousand hectares per year in the period of 1990-1999. In 2004, the total rice field area was 2.1 million ha (3.8 million ha cultivated area), accounting for 50% of the rice field of the country (GSO, 2005). Increase in land use for agricultural production helped the delta to become the most important food producing region in Vietnam. The triple rice in the Delta increased significantly in 1985-2000 (Appendix 7) and will still increase in the flood areas with the dyke construction.

Moreover, the conversion from rice fields to shrimp ponds happened in the coastline (Ben Tre, Tra Vinh, Soc Trang, Kien Giang and Ca Mau (2.2.2), especially in the period of 2000-2004. The aquaculture areas increase more than two times from 1995 to 2004. In 2004 there were approximately 650 thousands hectares of aquaculture production in the MD (GSO, 2005). The change of land use from rice to shrimp require the change of water use from fresh water to brackish water (Appendix 8).

Fish raising developed dramatically in the MD from 1995-2004, especially from 1998-2002 in An Giang, Tien Giang, Can Tho, Dong Thap and Vinh Long. The fish output of the Mekong Delta in 2004 was 433,617 tons, accounted for 62% of Vietnam. Of which, An Giang, Can Tho and Tien Giang produced the highest output for the MD in 2004 (GSO, 2005). The development of fish production, especially *Pangasius sp*. required big volume of water, foodstuff and chemicals, caused diseases and pollution partly in these provinces (Appendix 9).

3.2 Environmental problems of land use and management in the Mekong Delta

The most problems concern land use and management were impacts of exploitation of problem soils (acid and saline soils), the threats of soil fertile and management and lacking of integration in land and water uses.

Table 6: Environmental problems of land use adn management in the MD

No.	Problems	Cited source
1	The impacts of exploitation of problem soils (acid and saline soils)	- Ecoagriculture Partners- Department of Soil Science, College of Agriculture, Cantho Univeristy, 2004; - White I. et al, 2000; - Minh L. Q., 2001; - Estellès P. et al, 2002
2	Threats of soil fertile and management	- Department of Soil Science, College of Agriculture, Cantho Univeristy, 2004; - Khoa L. V, 2002; - Khoa L. V, 2003; - Estellès P. et al, 2002
3	Integration management between land and water use	- CAULES, 2005; - Department of Soil Science, College of Agriculture, Cantho Univeristy, 2004; - GSO, 2005 - Minh L. Q., 2001; - Populus J. et al, 2002; - Tuyen N. Q., 2004;

The impacts of exploitation of problems soils were not simple. The mechanism was fresh water in the flood used to flush the acid soil and build dams to prevent saline intrusion. All of these activities happened with the main purpose of rice expansion. As a result, many problems occurred such as changing the ecological features of wetlands, soils and aquatic organisms. These impacts at the moment have not understood fully.

Further more, the changes in agriculture threat the soil fertile and the speed of soil degradation in the MD. Intensification was introduced to the MD at the decade of 1980s. It helps the MD solve the food security and become the largest rice production and export in Vietnam. As a result, there is an increase in soil rotation, inputs, agro- chemicals and the reclamation of problem soils (acid and salty soils) to increase cultivation areas. Those activities have threatened the soil fertile and speed up the soil degradation and desertification. According to Khoa L.V., 2002 and 2003 soil compact was a physical characteristics of soil degradation, especially in rice monoculture.

The integration of land and water uses is the most important in land use in the MD. The spontaneous conversion in land use especially rice-shrimp (Ca Mau, Bac Lieu, Soc Trang, Tra Vinh, Kien Giang, Ben Tre), rice - pond (An Giang, can Tho, Tien Giang, Dong

Thap, Vinh Long) are suffering with the ecosystem destruction, saline intrusion, salty soil, water shortage in irrigation, aquaculture and pollution (Populus J. et al, 2002). The impacts of saline intrusion on rice production and shortage of fresh water supply in the dry season become more critical in the floodgates areas of the MD (Tuyen N.Q., 2004; CAULES, 2005). This problem will be discussed more in 4.2.

4 WATER USE MANAGEMENT

4.1 The current status of water resources in the MD

The MD has a water reserve of 550 km^3. It is considered as the most potential region in the country in terms of water resources with many rivers and a canal network. However, the situation of water supply differs betweemn the rain season and the dry season. In the rain season, the rivers are recharged with the fresh water from the upper part of Mekong River outside the country inaddition to a large volume of rainwater. As a result, the volum of water received is much more than the volume of water disrecharged to the sea. The abundance of fresh water in the rain season facilitates agricultural production and more than adequately satisfies water demand in general. Alternanatively, in the dry season there is a shortage of water for agricultural, aquacultural, industrial production and domestic use. Furthermore, it is said that if only 20% of surface water is extracted from the rivers, which is equal to 400 m^3/second, the water volume taken out is much more than the water volume supplied by the Mekong river. Consequently, the salt intrusion happens and becomes a problem for the water-supply system in the MD.

Total reserve of groundwater is estimated at 92,128,000 m^3/day in which the static reserve is 82,710,000 m^3/day and the elastic reserve is about 8,349,000 m^3/day. Almost groundwater is found at the shallow layers from 80-100 m. The safe yield is estimated at 1,069,000 m^3/day. Overpumping has caused a decreases in the groundwater table in recent years. Surveys showed that in the Southwest region of the MRD the groundwater table is continuously reduced from 0.2 to 0.5 m/year (Truong et al., 2004). In the central area of Soc Trang province, the groundwater table is reduced from 0.5 to 1.0 m/year. In Bac Lieu province, the groundwater table is reduced from 1.0 to 1.5 m/year within ten years. In Ca Mau province, the groundwater table is reduced from 1.0 to 2.0 m/year within six years.

Although the water resource in the MD is relatively rich for agricultural production activities, in recent years there has been a trend of unforeseeable change of the flooding situation. Rice production in the Spring-Autumn crop is faced with a shortage of irrigated water. In the future, it is said that the water allocation for competitive crops needs to be more attention. The advantage on the abundant water source would be disappeared.

4.2 Environmental problems of water resource use and management in the MD

In this subjection, we will discuss the main problems of water resource use and management in the MD. As shown in table 7, these problems includes flood and drought, the conflict between water control and water use conflict and integrated water management.

Table 7: Environmental problems of water resource use and management in the MD

No.	Problems	Cited source
1	The impacts and management problems of drought and flood	- White I. et al, 2000; - Minh L. Q., 2001; - Estellès P. et al, 2002
2	Water control and quality	- CAULES, 2005; - DOSTE of Tra Vinh, Soc Trang, Kien Giang and Bac Lieu, 2000-2004 and Can Tho, 2005; - Minh L. Q., 2001; - White I. et al, 2000; - Tuyen N. Q., 2004
3	Integrated management	- Minh L. Q., 2001; - Populus J. et al, 2002; - Tuyen N. Q., 2004;

It is important to note that the conflict between flood and drought in water resource is a typical problem in water management in the MD. Water resource brings great value to the MD; however, there are many disasters relating to water resources. The MD residents have to suffer from flood in rain season while there is a shortage of fresh water supply for agriculture in the dry season, especially in Summer-Autumn rice crop and domestic in dry season. To restrain the flood, the government built a dyke system and a flood drainage system to the West Sea, etc. However these activities have created impacts the ecological changes such as water regime, soil fertile and the socio-economics.

Another problem of water resource in the MD lies at water quality and pollution. A huge amount of water comes from outside the delta. Moreover, all water uses from agriculture, industry and domestic discharge to the rivers. According to the report of the state of the environment of the department of Environment and Natural Resources in different provinces in the MD, the surface water is partially polluted in some areas such as residents' clusters, industrial areas, agricultural and aquaculture areas. There is a complicated trend in water quality in rivers, ditches and canals in recent year. Water quality has started to exceed the permission levels of the Vietnamese standards, especially regarding the organic pollution. This problem will be more serious if there is no action to

prevent the sources of pollution. The rivers become sewages for all kinds of wastewater. Surface water is polluted by organic substances, residues of agri-chemicals, heavy metals and epidemic actors. The sources of pollution of water in the coastal areas in Ca Mau, Kien Giang, Bac Lieu, Tra Vinh, Soc Trang are from interior rivers, ditches and canals, water transportation, aquaculture, especially shrimp farming, agricultural activities (fertilizer residues, overuse agro-chemicals, etc.), wastewater from urban areas, resident clusters, and tourism activities along the coastal lines.

The conflict between water use and integrated water management will be more critical in the MD in the future. Acid water is a big problem of the Mekong Delta in general and the Mekong Delta of Vietnam in particular. Acid water affects water quality and subsequently affects agricultural and aquacultural production and people's lives. Acid water has been found mainly in acid sulphate soil areas. In addition, saline intrusion is one of the water problems in the MD, especially in Ca Mau, Tra Vinh, Kien Giang during the dry season (DOSTE of Tra Vinh, Soc Trang, Kien Giang and Bac Lieu in 2000-2004). At the mouths of Tien River (Tien Giang province), the salty level is about 4‰ and salt water goes into the inland 40-60 km. At Can Tho City, in April 2003 it is measured that the salt water went into the inland far from the central City 62 km. On April 2004 it was 30 km from the City. However, in February 2005 it was only 10 km. The situation of salt intrusion in the MD during the dry season affects agricultural production activities and livelihood of its residents. Some crops, ei.g. the Spring-Summer rice production, do not receive enough water to produce. Consequently, the paddy rice areas are decreased in the dry season. Almost all rivers in the MD face with the problem of salt water intrusion. Approximately, more than 70% residents in the MD are affected by this problem.

The integration management of water resource in the MD covers the management between provinces in the MD areas and other upstream areas as well as the management between water uses (agriculture, aquaculture, domestic and industrial use).

Water management in flood and dry season, fresh, brackish and saline water and among provinces and up and down stream of the Mekong Basin is a big challenge for the authorities of MD provinces and countries of Mekong River.

5 AGRO-CHEMICAL USE MANAGEMENT

5.1 The status of agro-chemical use and management in the MD

In this subsection, we will highlight the general situation of the agro-chemical use and management in the MD. Recent years have witnessed a lot of agricultural changes in the MD regarding the reclamation of saline and acid sulphate soils in Ca Mau, Bac Lieu, Soc Trang, Long An, Dong Thap and the dyke management in An Giang. Thanks to these changes, cultivation areas where have been increased from one to two and three crops per

year. Such a increase of land rotation forces farmers to use more fertilizers and agro-chemicals to compensate for the nutrient loss from harvest. Since monoculture, particularly in rice cultivation caused diseases to break out, farmers are urged to use more agro-chemicals. In addition, the development of aquaculture has also increased the uses of chemicals and thus polluted the water quality of Hau and Tien Rivers. As a matter of fact, most required amount of fertilizers and agro-chemicals for domestic use cannot be adequately provided by local production. Therefore, the government has to import fertilizers and agro-chemicals which are not easy to control. Table 5 presents the fertilizer import of Vietnam during the period of 1995-2004. As shown, the imported amount of fertilizer increases overtime in this period, of which, urea is imported with the highest fertilizer amount.

Table 8: Fertilizer import of Vietnam from 1995-2005

Unit: Thousand tons

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Fertilizers	2311,0	2787,1	2526,7	3448,0	3702,8	3971,3	3288,2	3820,2	4135,1	4064,8
Of which										
SA						436,4	390,0	549,0	509,0	671,1
Urea	1356,2	1658,3	1480,0	1944,0	1893,0	2108,3	1652,0	1818,0	1926,0	1709,5
NPK						200,1	127,0	275,0	219,0	311,6
DAP						591,0	574,0	613,0	767,0	596,8
Potassium						411,5	483,0	517,0	662,0	696,3
Others						224,0	62,2	48,2	52,1	79,5

Source: GSO, 2005

According to an estimate by one company of agricultural services in Bac Lieu in 2002, the consumption of fertilizers in Bac Lieu amount to approximately 30,000 tons and 490 tons agro-chemicals. In reality, the quantities of fertilizers and agro-chemicals could be much higher as they have followed an upward trend in cultivation area. This is an urgent matter to all provinces in the MD even though the departments of agriculture and rural development and the agricultural extensions has launched many programs such as IPM, "3 down, 3 up program", which aim to encourage farmers to reduce the usage of fertilizers and agro-chemicals. To some extent, these programs not only help to minimize the production cost but also help reduce the residues release to the environment.

As reported by Can Tho Department of Rural Development (2004), the residues of agro-chemicals in the surface water were tested against two groups of chemicals: organic clo (Heptachlor, Aldrin, DDE, Dieldrin, Endrine, TDE, DDT) and organic phosphorus (metha Midophos, Methyl Parathion, Dimethroat) in the first two quarter of 2004. The result showed that the agri-chemicals were detected in surface water samples in different areas, especially in agricultural production areas. Presently, the concentration of these residues is still at an acceptable level, which is under the level of WHO and TCVN 5942-1995 and TCVN 6774-2000 about the concentration of agro-chemicals in water. A part from agro-

chemicals, DDT was detected in a couple of water samples even though the use of this chemical had been banned from using for a long time.

Agro-chemicals do not only pollute the water resources, they also make the soils polluted. According to the data in Appendix 3, the use of agro-chemicals increased 450 tons in 2003 as compared to 2002. With respect to the result of soil quality monitoring, in all the sample sites in Cantho, agro-chemical were detected with BHC amounting from 13.33-21.30 ppm, Endosulfan-1 from 12.86-22.25 ppm and other substances did not detected such as Heptachlor Epoxid, Aldrin, Heptachlor, Dieldrin, Endrin, O,P* DDD, Endosulfan Sulfat, Endrin Aldehyde, Methoxyclor. From the soil quality monitoring in many years, agricultural land in Cantho has been polluted slightly with agro-chemicals and this pollution has been increasing. However, as compared to the Vietnam standard 5941-1995, the content of agro-chemical residues in soil in Cantho was still from 10 to 100 times below this standard.

5.2 Environmental problems in agro-chemical use and management in the MD

In this subsection, we will discuss the impacts of agro-chemical use on human health, aquatic life, water quality and soil over the past ten years. We also consider management problems of agro-chemicals. Table 9 will list some existing studies on this issue.

Table 9: Environmental problems of agro-chemical application in the MD

No.	Problems	Cited source
1	The impacts of agro-chemical use on human health, aquatic life, water quality and soil	- White I. et al, 2000; - Minh L. Q., 2001; - Dung N. H et al, 1999; - Department of Rural Development of Ca Tho, 2004; - Truc N. T. T, 2005; - Huan N. H., 2001; - Phuong N. M, 2002); - Khoa L. V., 2002
2	Poor management	- Department of Environment and Natural Resource Management, 2004 - Huan N. H., 2001

Health risk

Research find that a crop effectively uptakes 30% of the total amount of fertilizer while the rest is either washed off by run-off or accumulated in soil. This process brings about

contamination to the environment. This issue of chemical residues in agricultural products receives more concerns by the public, press and the scientists. The poisons of pesticides can be attributed to exposures to pesticides, which contaminate workplace, living environment and food (Wheeler D; Dung N. H. et al, 1999).

Dung et all (1997) study health consequences from pesticides of rice farmers in the MD. Their results shows that farmers used up to 75 types of fungicides, insecticides and herbicides. Many of these fall under World Health Authority categories I and II, which are classified as moderately and extremely hazardous, respectively. This study also showed evidence of eye, skin, cardiovascular and neurological effects due to pesticide use. Many experienced multiple acute poisoning symptoms at one time. While more than 95% of farmers thought that a long-term application of pesticide adversely effects their health, only 33% used protection equipments like caps, masks or special clothing when spraying. Cost and discomfort are reported as the main reasons not using protection equipments. Health costs incurred by this exposure were estimated to be between 89,310 VND and 94,129 VND per farmer per hectare.

Another study of farmer practice in fertilizers and pesticides in Tan Thuan commune, Chau Thanh district, Hau Giang province in 2004 (Truc N. T. T, 2005) showed that 53.7% farmers did not use safety clothes when they sprayed pesticides. The most common symptoms after spraying chemicals were dizzy (48.1%), fatigue (35.2%), shortness of breath (22.2%), vomit (13.0%) and headache (9.3%).

The adverse impacts of agro-chemicals do not impose only on farmers but also on people who consume agricultural products with high concentration of pesticide residues and who expose regularly to pesticides. This group of victims may include producers, traders and farmers' members.

Aquatic life and water quality

Impacts of what on the aquatic life and water quality are also considered. Very usually agro-chemicals used for rice and plants are not fully uptaken by plants and soil. The rest of the used agro-chemicals are washed away and probably diluted to creeks, canals and rivers. The hazardous chemicals might accumulate and magnify in aquatic organism and food chain (Huan N. H., 2001; Phuong N. M, 2002). Further more, as lots of people in the MD have habit of using water directly from river, so it is very likely for them to use contaminated water.

Soil contamination and soil organisms

Soil contamination and soil organisms are also affected by agro-chemicals. Many scientists have warned farmers of their pesticide using on their farms. The amount of agro-chemicals which is not uptaken by the plants and water, goes to soil and accordingly

affects soil condition and soil organism. The other parts will be endosmosis to the groundwater (Huan N. H., 2001; Khoa L. V., 2002).

Management problems of agrochemicals

Another problem of agrochemical use involves the management aspect. Agro-chemicals. Agrochemicals, especially pesticide management covers a wide range of tasks including import, production, formulation, distribution, marketing, training, safe handling and obsolete stocks of pesticides. Before the 1990s, pesticide management regulations were nonexistent in Vietnam. Given government subsidies, pesticides were imported and distributed to farmers by State agencies. On average, the annual pesticide use in the whole country was between 13,000-15,000 tonnes of finished products, including those extremely or highly hazardous in WHO categories . These included methyl parathion, monocrotophos and methamidophos, as well as the highly persistent DDT and HCH(7) (Huan N. H., 2001).

Since 1990, pesticide management has improved with the introduction of regulations on what the development of an inspection network from central to grassroots level and the presence of a stronger infrastructure for quality assurance. As a result, the number of pesticides on the restricted and banned lists has continuously increased (Appendix 7), and the imported quantity of restricted pesticides has decreased between 1991 and 1998 (Appendix 8). The restriction and banning of highly toxic pesticides such as carbofuran, endosulfan, methamidophos, monocrotophos, methyl parathion, phosphamidon since 1994 has reduced the adverse pesticide impacts on the environment and community health. The number of cases of food poisoning due to residues of methamidophos in vegetables has reduced sharply since this ban. However, according to two surveys of pesticides use conducted in 2000 of which one survey is a comprehensive nation-wide inspection and other studies farmers' confidence, attitude and practices in a safe and effective use of pesticides in the South of Vietnam, the retails and farmers appear to have had a poor practice in selling and using pesticides (Appendix 9 and 10) (Huan N. H., 2001).

6 CONCLUSION AND RECOMMENDATION

The forest area in the MD in 2004 is334.8 thousand ha with 6% of forest cover of the delta-lowest in Vietnam. The remaining forest area in the MD is still threaten by forest fire, agricultural development, population pressure and the lack of knowledge and institutional management.

About 70% soil areas in the MD are problematic soils (acid sulphate and saline soils). Reclamation, irrigation, intensification have been introduced to the delta, leading to an increase in agricultural land from 55.8% in 1966 to 74.5% in 2003. At the meantime, land

use and management in the MD were facing with the conflict in land and water use, soil fertile and degradation and conserving the last wetland plots in the MD.

Water resource in the MD gave this area both the benefits and constrains. Water resource helped to reclaim the soil and to increase the agricultural land in the MD. The inherent characteristics of water resource, e.g. flood, drought, water control and integrating management, on the other hand, bring more challenges to water management in the MD.

Agro-chemicals are the results of the agriculture and aquaculture development in the MD. As have been shown, the use of pesticide and fertilizers has increased over years in many provinces and pesticide residues were found in rivers in the delta. The impacts of agro-chemicals on human health, aquatic life, water quality and soil were reported; however, they had not been fully understood fully. The management of agro-chemicals, especially of illegal pesticides and farmers' practice of using agro-chemical are the major concerns in agrochemical management.

There are some recommendations for further studies relating to environmental economics:

- The total value of forest, wetland, contribution of forest to the poor in the MD.
- Cost benefit analysis of land use such as the irrigation and reclamation cost.
- Valuation of water resource in the MD, the environmental impacts of agricultural activities, especially rice, shrimp and fish.
- Assessments of agrochemical impacts on human, aquatic life and solutions for better management in agrochemical uses.

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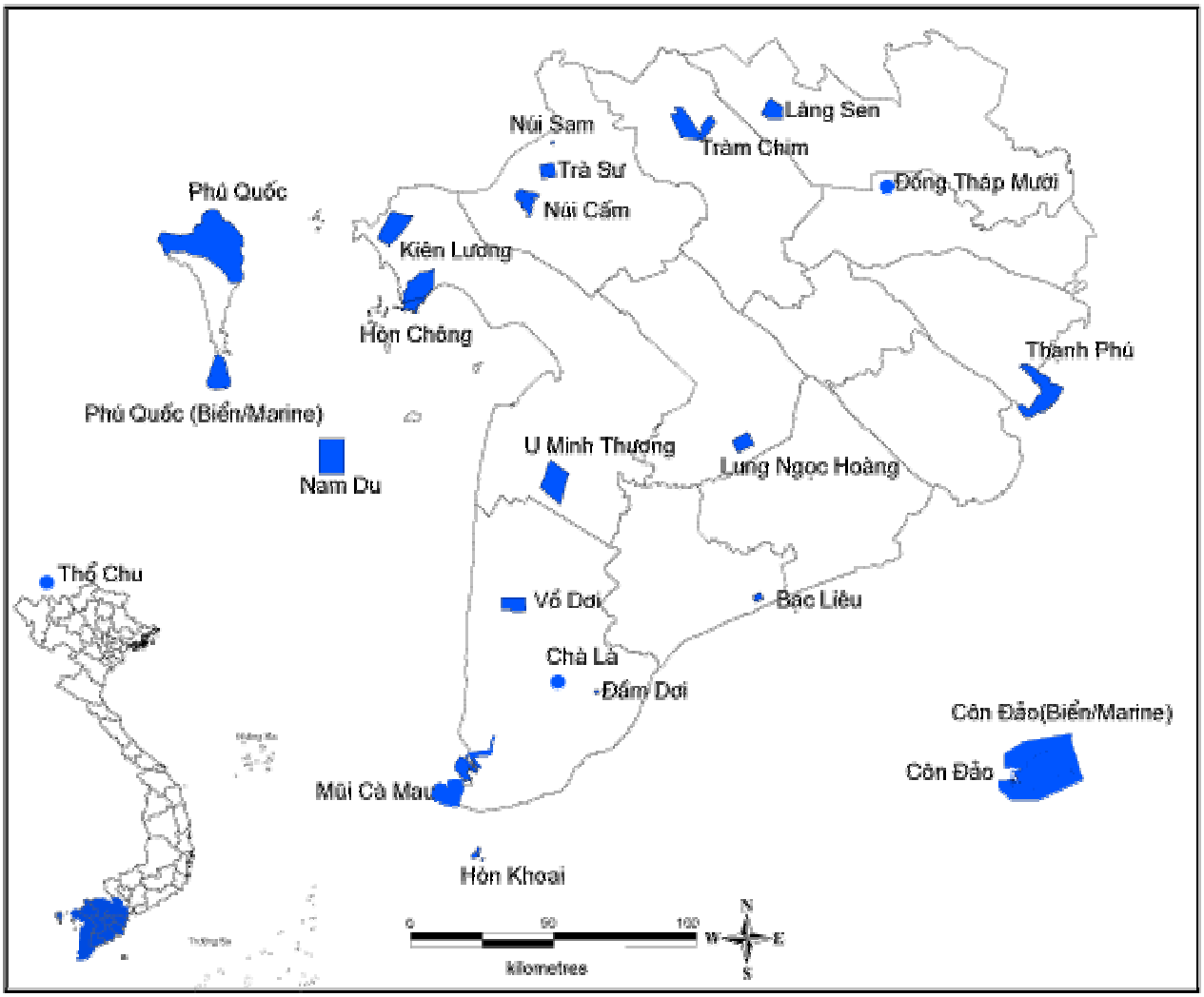
APPENDIX

Đồng bằng Sông Cửu Long/Mekong Delta
An Giang, Bạc Liêu, Bến Tre, Cà Mau, Cần Thơ, Đồng Tháp
Kiên Giang, Long An, Sóc Trăng, Tiền Giang, Trà Vinh, Vĩnh Long



Source: IUCN

Appendix 1: Protected sites in the Mekong Delta

Appendix 2: The area of plantation forest from 1995-2004 in the MD.

Unit: Thousand ha

Province	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*
The MD	**39.5**	**24.5**	**27.7**	**21.0**	**17.2**	**18.2**	**20.1**	**22.7**	**25.7**	**21.4**
Long An	0.1	1.1	2.0	2.0	3.5	6.6	6.7	7.2	7.5	5.0
Tien Giang	0.4	0.7	0.2	0.3	0.1	0.4	0.8	1.0	1.4	1.3
Ben Tre	0.3	0.5	0.4	0.2	0.2	0.2	0.3	0.1	0	-
TraVinh		0.2	0.3	0.5	0.6	0.2	0.5	0.2	0.2	0.2
Đong Thap	0.4	0.2	0.1	0.5	0.2	0.2	0.5	0.9	0.5	0.2
Vinh Long	-	-	-	-	-	-	-	-	-	-
An Giang	0.7	1.0	2.4	2.0	1.6	1.5	1.7	1.6	1.3	0.8
Kien Giang	26.2	9.0	13.6	5.3	2.6	3.5	4.5	5.2	7.2	6.1
Hau Giang		0.1	0.1	0.1	0.0	0.0	0.3	0.1	0.2	0.3
Soc Trang		0.9	0.6	0.7	0.6	1.0	0.6	0.5	0.4	0.5
Bac Lieu	0.2	0.3	0.2	1.1	1.3	0.3	0.7	0.2	0.2	-
Ca Mau	11.2	10.5	7.8	8.3	6.5	4.3	3.7	5.7	6.8	7.0
Can Tho	-	-	-	-	-	-	-	-	-	-

*Source: GSO, 2005; * Estimated*

Appendix 3: The destroyed forest area by fire from 1995-2004

Unit: ha

Provinces	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*
The MD	**2,072**	**19.6**	**314.2**	**10,213**	**12.3**	**98.5**	**287.7**	**10,137**	**670**	**1,479.8**
Long An	205	2.0		224.0		31.0	0	1,485	99.7	452.9
Tien Giang	0	0	0	0	0	0	0	150	0	50.0
Ben tre	0	0	0	0	0	0	0.1	0	506	
Tra Vinh	0	0	0	0	0	0	0	0	0.3	
Đong Thap	37	10	12	9.3	2.0	4.0	0.4	7.8	7.8	5.0
Vinh Long	-	-	-	-	-	-	-	-	-	13.5
An Giang	79	7.3	3.7	29.0	10.3	63.0	0.2	0.5	16.2	958.0
Kien Giang	0	0	243	8,653	0	0	0	4,069	0	958.0
Hau Giang	0	0.3	0.5	31.0	0	0	0	1.8	0	0.2
Can Tho	-	-	-	-	-	-	-	-	-	-
Soc Trang	8	0	5.5	57	0	0	0	0	0	-
Bac Lieu	0	0	0	0	0	0	287	0	0	-
Ca Mau	1,743	0	49.5	1,210	0	0.5	0	4,423	40	0.2

*Source: GSO, 2005; * Estimated*

Appendix 4: The destroyed forest areas from 1995-2004 in the MD

Unit: Ha

Provinces	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*
The MD	**2,592**	**6.5**	**454.9**	**312.7**	**15.2**	**205.8**	**110.1**	**571.9**	**41.2**	**34.8**
Đong Thap	200	2.0	2.3	8.6	1.0	0.1	0	0	0	-
An Giang	0	4.5	0.4	2.6	0	0	0	0.1	0	-
Ben Tre	0	0	0	0	0	0	25.4	46	6.4	9.4
Kien Giang	0	0	15	0.3	0	0	9.5	7.8	9.0	7.0
Tra Vinh	0	0	0	0.2	0.2	0	0	9.1	4.7	8.5
Soc Trang	0	0	2.2	1.0	1	0	3.5	3.9	1.2	-
Bac Lieu	0	0	25	0	0	161	55	438	0	-
Ca Mau	2,392	0	410	300	13	44.7	16.7	67	19.9	9.9

*Source: GSO, 2005; * Estimated*

Appendix 5: Land use by provinces in the MD in 2003

Unit: thousand ha

Province	Total area	Of which			
		Agricultural	Forest	Special use	Residential
Mekong Delta	**3973,9**	**2960,5**	**371,5**	**246,2**	**100,6**
Long An	449.1	323.4	58.5	30.2	11.1
Tien Giang	236.7	179.0	12.8	17.7	7.8
Ben Tre	232.2	167.6	6.2	11.6	7.1
Tra Vinh	221.5	180.0	6.1	9.9	3.3
Vinh Long	147.5	117.1	0.0	9.5	5.0
Đong Thap	324.6	247.8	14.6	22.4	16.6
An Giang	340.6	263.0	13.0	29.0	15.0
Kien Giang	626.8	422.4	118.9	41.8	11.5
Can Tho	139.0	117.0	0.0	9.4	4.7
Hậu Giang	160.8	137.7	3.6	7.3	3.4
Soc Trang	322.3	259.0	10.9	23.0	5.3
Bạc Lieu	252.6	208.8	5.4	15.5	4.0
Ca Mau	520.2	337.7	121.5	18.9	5.8

Source: GSO, 2005

Appendix 6: Export output and export turnover of Rice of Vietnam from 1995 to 2005

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2
export outputs (thousand tons)	1.99	3.00	3.57	3.73	4.51	3.48	3.73	3.34	3.81	4.00	
export turnover (million USD)	530	588	871	1,019	1,025	667	625	726	727	887	1
Price (USD/ton)	266.6	284.7	243.6	273.4	4.2	4,191.7	167.5	217.2	190.7	221.7	2

Source: Buu B.C., 2005

Appendix 7: Triple Irrigated Rice in the Mekong Delta

Year	Area (ha)	Cited source
1975-1980	Very few	Le Van Khoa (1997-1999)
1985	1,108	Tran An Phong (1986)
1990	10,237	Nguyen An Tiem (1993)
2000	>230,000	GSO, 2000

Source: Khoa L.V., 2001.

Appendix 8: Surface area of aquaculture and shrimp output in Vietnam and the MD from 1995 to 2004

	1995	**1996**	**1997**	**1988**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Surface area of aquaculture (Thousand ha)										
Vietnam	453.6	498.7	504.1	524.5	524.6	641.9	755.2	797.7	867.6	904.9
MD	289.4	316.5	327.1	341.8	332.9	445.3	546.8	570.3	621.2	650
MD/VN (%)	63.8	63.5	64.9	65.2	63.5	69.4	72.4	71.5	71.6	71.8
Shrimp outputs (tons)										
Vietnam	55,316	49,749	49,298	54,884	57,452	93,503	154,911	186,216	237,880	290,201
MD	47,121	39,652	38,133	39,382	41,400	68,995	118,432	142,909	182,221	230,662
MD/VN (%)	85.2	79.7	77.4	71.8	72.1	73.8	76.5	76.7	76.6	79.5
Long An	1.8	2.5	2.5	3.1	2.9	3.4	6.6	7.3	10.2	12.1
Tien Giang	9.6	9.2	9.1	9.1	9.8	8.4	8.8	9.6	10.8	11
Ben Tre	24.7	24.7	21.1	23.4	27.9	29.3	25.6	36	37.7	42.1
Tra Vinh	22.6	25	30	35	36	52.6	54.3	25.2	30.2	33.6
Vinh Long	1.2	1.1	1.1	1.2	1.2	1.4	1.3	1.4	1.5	1.6
Đong Thap	3.2	1.2	1.4	1.7	1.8	1.9	2.3	2.6	2.6	2.8
An Giang	1	1.3	0.9	0.9	1.2	1.3	1.3	1.8	1.6	1.9
Kien Giang	12.5	19.3	25.1	27.2	29.3	34.6	42.6	49.7	62.1	78.4
Can Tho (*)	8.3	10.5	11	12.5	11.9	12.6	13.6	16.5	10	11
Hau Giang									7.5	8.2
Soc Trang	3	24.1	28.5	25.8	30.5	41.4	53.2	48.3	57.1	51.4
Bac Lieu	41.4	42.6	42.2	40.3	38.9	54	83	100.6	112.3	118

Ca Mau	160.1	155.1	154	161.6	141.5	204.4	254.2	271.4	277.7	277.9

Source: GSO, 2005
Notes: Cantho comprises Cantho city and Hau Giang province

Appendix 9: Fish raising output in Vietnam and the MD from 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	%
Vietnam	**209,142**	**255,958**	**279,324**	**285,626**	**335,979**	**391,053**	**421,020**	**486,421**	**604,400**	**696,953**	
MD	**119,475**	**155,871**	**165,591**	**164,072**	**198,714**	**234,755**	**248,468**	**283,326**	**366,051**	**433,617**	
Long An	3838	4,560	4,515	7,872	9,146	7,974	9,533	8,542	10,717	11,400	2.6
TienGiang	13,281	12,224	14,215	15,465	15,112	15,238	19,976	16,091	20,125	26,315	6.1
Be Tre	5200	4,725	7,490	5,215	5,675	7,331	9,313	7,244	9,848	9,575	2.2
TraVinh	8,523	7,394	14,500	15,400	15,100	17,863	19,091	25,353	31,312	31,815	7.3
Vih Long	6,093	6,110	6,092	6,144	6,503	6,907	8,159	11,470	17,112	22,120	5.1
Đog Thap	24,461	27,177	32,163	31,643	36,709	34,395	35,388	35,350	41,857	49,577	11.4
An Giang	34,421	47,993	41,133	40,728	60,742	80,032	83,335	110,157	136,231	150,238	34.6
Kie Giang	1,560	3,079	3,671	3,115	4,673	5,477	6,700	4,786	5,863	6,528	1.5
Cần Thơ **	6,263	7,054	7,493	7,043	11,342	12,963	15,057	25,148	36,246	50,509	11.6
Hậu Giang									9,867	15,634	3.6
Sóc Trăng	2,676	6,814	3,386	2,121	2,520	3,173	3,800	7,620	9,414	13,696	3.2
Bạc Liêu	891	3,794	3,873	4,463	7,397	11,805	9,167	9,638	13,772	25,670	5.9
Cà Mau	12,268	24,947	27,060	24,863	23,795	31,597	28,949	21,927	23,688	20,540	4.7

*Source: GSO, 2005; *: Estimated,*
Notes: Cantho comprises Cantho city and Hau Giang province

Appendix 10: The agro-chemicals usage in Can Tho Province from 2000 to 2003

Types of chemicals	Year			
	2000	2001	2002	2003
Fertilizers (Tons)	169,329.0	175,926.5	182,457.6	187,946.0
Agro-chemicals (Tons)	654.8	635.3	657.6	1,013.0

Source: The Department of Agriculture and Rural Development of Can Tho province, 2002-2003

Appendix 11: Active ingredients banned and restricted 1992-2000

Year	Number restricted	Number banned
1992	14	20
1994	15	22 banned; additional five pesticides banned for rice crops: carbofuran, monocrotophos, methamidophos, endosulfan and phosphamidon
1996	21	22 banned; three banned for import: methamidophos, monocrotophos and carbofuran
1998	19	23
2000	27	26

Source: Plant Protection Department, MARD

Appendix 12: Restricted pesticides imported, 1991-1998

Unit: Tons

Year	Total imports	Restricted pesticides	Percentage (%)
1991	20,300	7,500-8,000	36.9-39.4
1992	23,100	7,500-8,000	32.5-34.6
1993	24,800	7,500-8,000	30.2-32.3
1994	20,380	3,000	14.7
1995	25,666	3,000	11.7
1996	32,752	3,000	9.2
1997	30,406	2,500	8.2
1998	30,000	1,500	5.0

Source: Plant Protection Department, MARD

Appendix 13: A comprehensive nation-wide inspection in 2000 by Plant Protection Department

		Value	%
1	Pesticide retailer operating without a business license (No of answers)	388	23.4
2	Retailers had no store for pesticides or the stores were failing to follow safety regulations (no fore and explosion extinguishers, no first-aid kids, and pesticides construction materials, food and animal feeds (No of answers)	5,132	50.2
3	Use banned pesticides (methamidophos, DDT and other chemicals) (kg)	2,500	
4	Illegally imported or counterfeit pesticides (litre or kg)	4,753 litres 5,645 kg	

Source: Plant Protection Department, 2000 cited by Huan N. H., 2001

Appendix 14:The result of pesticide use of four provinces in the South of Vietnam (480 farmers)

	Farmers' confidence, attitude and practices in safe and effective use of pesticides	%
1	Farmers use pesticides excessively and not in compliance with the instructions on the labels	96.6
2	Know how to properly dispose of left-over pesticides	4.8
3	Farmers pour spray remains into canals, ditches or spray on other plants or use it up by continuing to spray	95.0

4	Bury pesticide containers and packing after use	38.1
5	Discard containers in the fields, into the canals, ditches, ponds or sell to scrap collectors or utilize for other purposes	Most answer

Source: Plant Protection Department, 2000 cited by Huan N. H., 2001