Wetlands Management in Vietnam's Mekong Delta: An Overview of the Pressures and Responses

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Abstract

This paper introduces the characteristics of the Delta and outlines the pressures that are impinging on the sustainability of the Delta's wetlands. Although these pressures are non-linear and interacting, three are considered prominent. These pressures stem largely from rice production and the associated large-scale water control infrastructures, shrimp aquaculture, and the inadequacy of the current institutional arrangements. Responses to these pressures are discussed noting the diverse interventions made in the past and the present. Moreover, key points raised by authors in the succeeding chapters in this volume are highlighted and a short description of the WorldFish Center project is provided.

Introduction

Just before the Mekong River meets the South China Sea through its nine branches, it forms a huge and very productive delta known in Vietnam as Cuu Long Delta but more popularly referred to as the Mekong Delta. The whole Mekong Delta[1] is known to be "the hearth of one of the earliest civilizations in mainland Southeast Asia" where the legendary "Funan" is thought to be located (Fox and Ledgerwood 1999). It is also one of Asia's largest deltas (Van Lap Nguyen et al. 2000). 71% of the delta lies in Vietnam while the rest is in Cambodia. In Vietnam, it covers 11 provinces and an area[2] of around 3.9 million ha. Although representing only 12 % of the country's total land area, it is the most important food-producing region in the country (Chu Thai Hoanh and Thai Dinh Khang 1993; Bui Chi Buu et al. 1995; Van Lap Nguyen et al. 2000). Vietnam's Mekong Delta is home to 16.9 million people with an average annual population growth of 2.2% (Duong Van Ni et al. this volume).

The landscape in the delta is defined by its soil type and hydrology (Chu Thai Hoanh and Thai Dinh Khang 1993; Cantho University 1997; Rothuis 1998). There are 3 main types of soil in the delta (i.e. alluvial, acid sulfate, and saline) and 9 agro-ecological zones (Table 1). Alluvial soils, usually located along main rivers, cover 31% of the total area in the delta and are agriculturally productive. Acid sulfate soils (ASS)[3] are highly acidic and have low fertility. This type of soil covers around 41% of the delta. About 19% of soils in the delta are saline soils due to salt-water intrusion from December to May (i.e. dry season) 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 (Chu Thai Hoanh and Thai Dinh Khang 1993; Le Dien Duc 2001). Most saline soils are located along coastal areas and have limited uses (Rothuis 1998). Strong acid sulfate soils are located in the Plain of Reeds (Dong Thap Muoi), Long Xuyen Quadrangle, and Ca Mau Peninsula while saline soils are located along a narrow fringe in the coastal areas of Long An, Tien Giang, Ben Tre, Tra Vinh, Soc Trang, and Minh Hai Provinces (Bui Chi Buu et al. 1995).

1 Unless otherwise stated, any reference to Mekong Delta or the delta in general in this paper refers to the Vietnamese Mekong Delta.
2 The total area of the delta is 5.5 million ha. The rest is located in Cambodia (Van Lap Nguyen et al. 2000).
3 ASS are characterized by their potential to develop high levels of acidity upon exposure to oxygen. Acid is released from the oxidation of the iron sulphide, pyrite (FeS_2). When it is inert, it is called potential ASS . They become actual ASS when potential ASS is exposed to oxygen through various natural or anthropogenic processes (Hashimoto 2001).

Table 1. Agro-ecological zones in the Mekong Delta (Adapted from NIAPP 1993 in Bui Chi Buu et al. 1995)

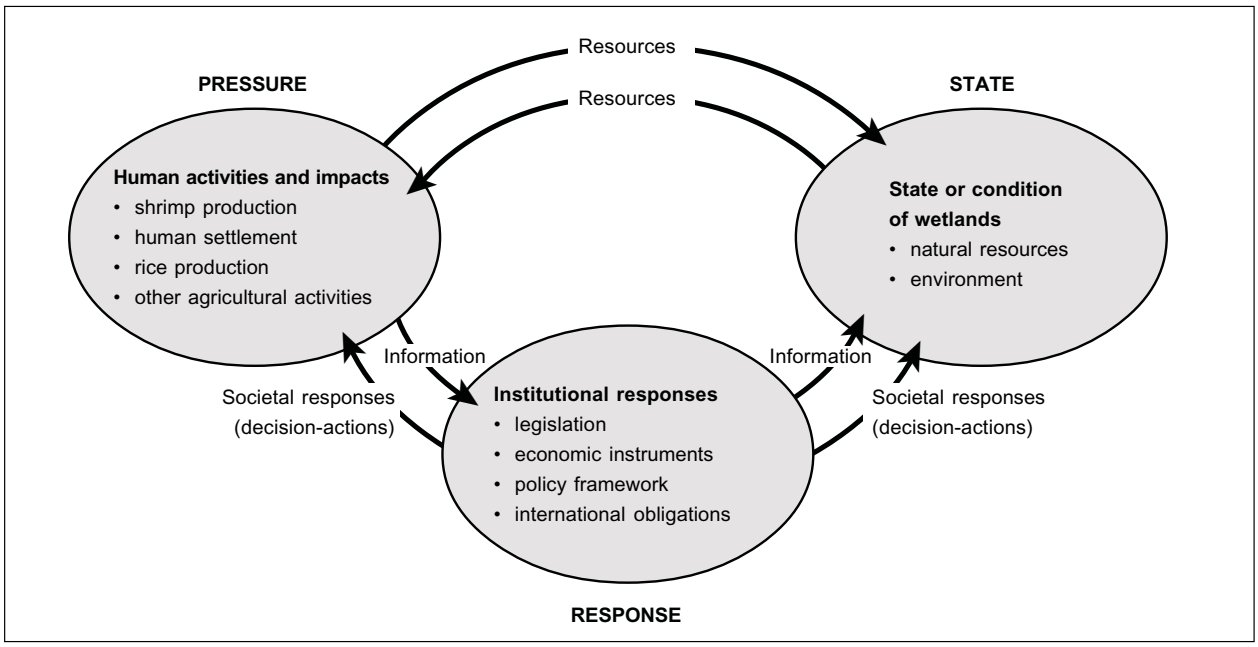
Zone	Description	Area ('000 ha)
1	Alluvial soils: areas with freshwater	1 200
2	High coastal plain: includes alluvial and acid sulfate soils with saltwater intrusion in the dry season	669
3	Low coastal plain (Ca Mau Peninsula): includes potential acid sulfate soils (sulfaquents or sulfaquepts) and is affected by tidal flood and heavy rain, poorly drained, saltwater intrusion	684
4	U Minh forest (peat soils): largely growing *Melalueca*	195
5	Tidal coastal plain: includes swampy tidal areas from Long An to Minh Hai growing mangrove forests	216
6	Dong Thap Muoi flooded area: includes large areas of acid sulfate soils (sulfaquepts), deeply flooded from August to November	496
7	Old alluvium area: in Long An and Dong Thap Muoi provinces along the border between Viet Nam and Cambodia	123
8	Ha Tien lowland area: acid sulfate soils, some saltwater intrusion, high organic matter, flooding in rainy season, well drained	218
9	That Son mountain area	42
	Total	**3 843**

Hydrology defines the vegetation in the delta and local rainfall, river discharge and tidal fluctuations affect the water regimes (Chu Thai Hoanh and Thai Dinh Khang 1993; Rothuis 1998). During August to November, flooding occurs due to high rainfall and overflow of the Mekong River System (Van Lap Nguyen et al. 2000). Tons of sediments are deposited on floodplains during flooding contributing to soil fertility (Rothuis 1998). Although there are regional variations in annual precipitation in the delta, it is generally high. The western part has around 2 400 mm, the central part has 1 300 mm, and the eastern part has 1 600 mm (Bui Chi Buu et al. 1995).

Several factors determine the geological formation in the delta including flooding from the Mekong River system, which brings sediments downstream to the South China Sea, monsoon regimes which affect depositional processes and movement of suspended sediments, tidal regimes which transport sediments onshore, and neo-tectonic movements which lead to uplifts or depression of land masses. Each of these factors interacts in various ways to produce the varied landscape in the delta. The Mekong Delta can be divided into 5 areas based on geological structures and surface landscape features especially the nature of its sediments. These are the Plain of Reeds, located on the northern bank of the Mekong River and having one of the lowest depressions in the hinterland; the Long Xuyen Quadrangle, on the northwestern bank of the Bassac River; the Central Area, in the central part of the Mekong Delta; the Eastern Coastal Area, a broad coastal plain running from Go Cong, Ben Tre, Cuu Long, Soc Trang and Bac Lieu; and Ca Mau Peninsula, on the southwestern part of the Mekong Delta (Van Lap Nguyen et al. 2000).

The Plain of Reeds is occupied by swamp deposits about 0.5 to 1.0 m high above present sea level (a.p.s.l.). In Long Xuyen Quadrangle, lowland swamp deposits occupy the western part and hills and mountains, made of basement rocks, are formed in the north with elevations of 50 to 716 m a.p.s.l. Fluvial deposits are predominant in the Central Area including channel, bank and flood basin deposits. The sediments in the Eastern Coastal Area are composed mainly of coastal plain deposits especially in areas 2.0-2.5 m a.p.s.l. In areas between 0.5-1.0 m a.p.s.l, mangrove and salt marsh deposits are found. In Ca Mau Peninsula, coastal plain deposits are found at elevations of 2.0 m a.p.s.l and marshy deposits in 1.0 m a.p.s.l. Mangrove forest, 90 km long and 25 km wide, is found on the southern part of the peninsula (Van Lap Nguyen et al. 2000).

Figure 1. Pressure-State-Response Framework



Based on human settlements, agriculture, land use and the type of natural resources, there are 3 main types of ecosystems in the Delta: (1) towns and cities including privately owned lands, (2) agricultural lands and (3) natural or semi-natural wetlands. Town and cities cover only 7% of the total land area. Agricultural lands constitute 83% of the area and hold 70% of the population while urban areas occupy 10% of the area and hold 30% of the population (Duong Van Ni et al. this volume).

Pressure-State-Response Framework

As a way of arraying all the available relevant information on wetlands in the delta into a coherent and logical picture, a framework is needed. In this publication, the pressure-state-response framework is used.

This framework offers a way of understanding the relationships of 3 sets of information: pressure, state and responses. It is a popular framework for reporting environmental indicators and the state of the environment (Dumanski and Pieri 1997; Cockburn Sound Management Council 2001; Kammerbauer et al. 2001). In this framework, pressures ("why is it happening?") leading to a certain state ("what is happening?") are identified together with the responses ("what is being done about it?"). This framework shows the causal relationships and linkages among sets of information. The responses refer to the institutional and policy improvements designed to remedy, reduce or mitigate changes brought about by the pressures and to thus improve the state. Pressures, on the other hand, refer to the set of human activities or institutions that bear on wetland environments while state is the condition of the wetlands and its resources as affected by the pressures.

State of the Wetlands Environment in the Mekong Delta

With an extensive land area and a dynamic hydrology, it is expected that wetlands would be the prominent feature in the delta's landscape. Vietnam's total wetland area is several times bigger than other countries in the Lower Mekong Basin such as Laos or Thailand (Dubois 2000). The different types of wetland -one of the major ecosystems in the delta (Duong Van Ni et al. this volume) – vary depending on the classification use. Existing wetland classification in Vietnam describes wetlands in terms of land use as shown in Table 2. These types can be broadly collapsed into 2 categories: inland and coastal wetlands. Inland wetlands are dominated by

Table 2. GIS analysis of changes in different land use types in the Mekong Delta between 1993 and 1995 (Adapted from Nguyen Van Nhan 1997)

	Wetland Unit	1993 (ha)	1995 (ha)	% Change
1	Bare Marine Sub-tidal	857 070	850,607	0
2	Coastal Mudflat	6 451	12 318	+91
3	Coastal Aquaculture	53 357	138 264	+159
4	Coastal Mangrove Plantation	78 660	26 986	-66
5	Coastal Salt Marsh	53 437	4 803	-91
6	Coastal Non-tidal Multiple Rainfed Wet Rice	29 567	70 789	+139
7	Coastal Non-tidal Single Rainfed Wet Rice	350 847	243 294	-31
8	Coastal Non-tidal Other Crops	10 375	11 446	+10
9	Coastal Non-tidal Grassland	28 843	57 307	+99
10	Coastal Non-tidal Aquaculture	5 524	28 009	+407
11	Coastal Saline/Brackish Lagoon	794	2 498	+215
12	Bare estuarine Sub-tidal	290 088	291 007	0
13	Estuarine Mudflat	59 630	67 319	+13
14	Estuarine Saltworks	8 679	10 935	+26
15	Estuarine Aquaculture	16 318	41 897	+157
16	Estuarine Mangrove Plantation	43 105	8 881	-79
17	Estuarine Salt Marsh	19 506	18 374	-6
18	Estuarine Sandy Ridge	38 797	38 797	0
19	Estuarine Non-tidal Multiple Rainfed Wet Rice	230 831	204 504	-11
20	Estuarine Non-tidal Single Rainfed Wet Rice	230 276	207 225	-10
21	Estuarine Non-tidal Other Crops	37 556	40 461	+8
22	Estuarine Non-tidal Grassland	8 573	2 696	-69
23	Estuarine Non-tidal Aquaculture	3 765	15 308	+307
24	Perennial River and Canal	127 833	129 643	+1
25	Riverine Banks and Bars	230 919	208 203	-10
26	Floodplain Grassland	183 401	164 768	-10
27	Floodplain Multiple Irrigated Wet Rice	817 945	825 021	+1
28	Floodplain Single Irrigated Wet Rice	223 345	208 076	-7
29	Floodplain Wet Rice Rotated with Upland Crops	42 069	71 354	+70
30	Floodplain Other Crops	69 680	67 688	-3
31	Seasonally Flood *Melalueca* Plantation	59 605	52 850	-11
32	Seasonally Flooded Orchards/Plantation	38 289	35 473	-7
33	Permanent *Melalueca* Forest Reservoir	53 513	50 821	-5
34	Seasonal Reservoir	3 442	3 544	+3
35	Seasonally Flooded Grassland	54 146	30 621	-64
36	Seasonally Flooded *Melalueca* Plantation	39 528	28 951	-27
37	Seasonally Flooded Single Rainfed Wet Rice	126 935	136 400	+7
38	Seasonally Flooded Multiple Irrigated Wet Rice	140 771	157 398	+12
39	Seasonally Flooded Wet Rice Rotated with Upland Crops	17 871	21 567	+21
40	Seasonally Flooded Other Crops	10 047	16 988	+69
Non-wetlands types		405 192	514 499	+27
Mekong Delta Total		**5 117 590**	**5 117 590**	

Table 3. Globally threatened and near-threatened bird species in the Mekong delta (Adapted from Buckton et al. 1999)

English Name	Scientific Name	Threat Category
Bengal Florican	*Houbaropsis bengalensis*	Endangered
Chinese Egret	*Egretta eulophotes*	Endangered
White-shouldered Ibis	*Pseudibis davisoni*	Endangered
Asian Dowitcher	*Limnodromus semipalmatus*	Near-threatened
Asian Golden Weaver	*Ploceus hypoxanthus*	Near-threatened
Asian Openbill	*Anastomus oscitans*	Near-threatened
Black-headed Ibis	*Threskiornis melanocephalus*	Near-threatened
Eastern Curlew	*Numenius madagascariensis*	Near-threatened
Grey-headed Lapwing	*Vanellus cinereus*	Near-threatened
Oriental Darter	*Anghinga melanogaster*	Near-threatened
Painted Stork	*Mycteria leucocephala*	Near-threatened
Sarus Crane	*Grus antigone*	Near-threatened
Lesser Adjutant	*Leptoptilos javanicus*	Vulnerable
Spot-billed Pelican	*Pelecanus philippensis*	Vulnerable

floodplain wet rice, seasonally flooded grassland, and *Melalueca* forests while coastal wetlands are generally dominated by mangrove forests. Only 3 types of wetlands can be considered semi-natural. The rest are far from being in a truly natural state. These are the seasonally inundated grassland, mature semi-natural mangrove forest, and mature semi-natural *Melalueca* forest (Buckton et al. 1999).

The state of the wetlands in the delta is succinctly summarized in a World Wildlife Fund publication:

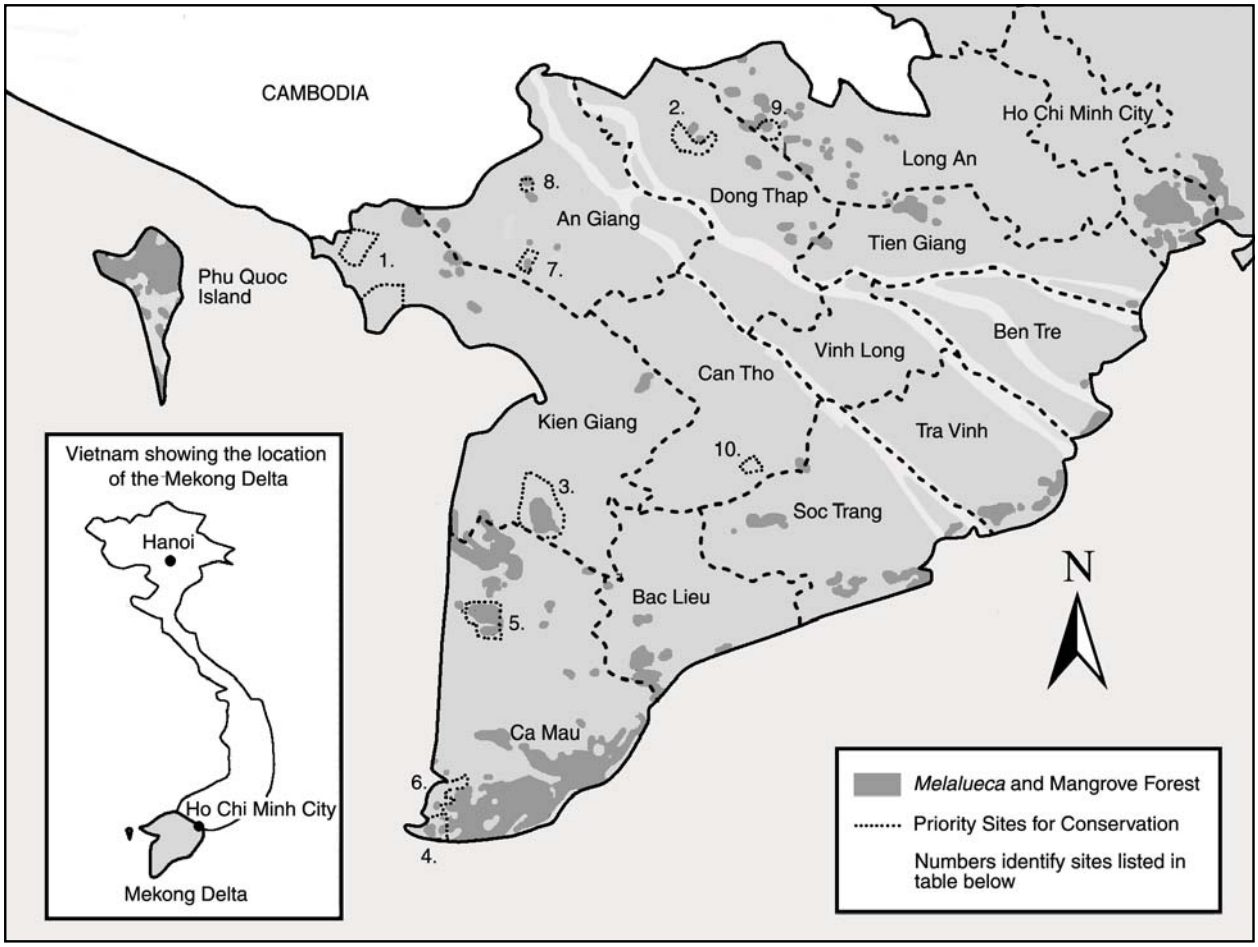
> "The wetlands of the Mekong Delta were once extensive and varied. Today, much of the Delta has lost its natural habitat, although remnants of the once extensive peat swamp forests, freshwater forests and flooded grasslands are represented in these wetlands. As the last representation of these significant habitats, important for distinctive plant communities, threatened bird communities and other significant animals, conservation efforts are now highly critical and are an urgent priority." (Baltzer et al. 2001)

A Birdlife International study showed that seasonally inundated grasslands and swamps, and mature semi-natural *Melalueca* forest have the highest number of bird species as well as supporting high numbers of globally threatened and near-threatened bird species. Of the 194 species recorded in the delta, 14 (Table 3) are globally threatened (Buckton et al. 1999).

As a result of these threats, 10 priority wetland sites are in need of conservation in the delta (Figure 2). The seasonally inundated grasslands of the Ha Tien Plain, Kien Giang Province, demand the highest priority as their unique biodiversity is being threatened by agricultural intensification (Figure 2) (Buckton et al. 1999).

Agricultural intensification to increase rice production and aquaculture are among the major causes of physical changes in the wetlands environment in the delta (Cantho University 1997; Rothuis 1998; Safford et al. 1998; Buckton et al. 1999; Tran Triet et al. 2000; Le Dien Duc 2001). As shown in Table 2, it is in the aquaculture and rice production sectors that the biggest percentage change in land use is manifested. But that is only half the story. Unsustainable economic development goals, global demands, poverty and shortcomings of current institutional arrangements are causing as much change in the wetland environment of the delta as agricultural intensification and aquaculture. In short, the problem is non-linear, and caused by various interacting factors which need to be untangled, so that their roles in the destruction of wetlands in the delta can be understood, and management of the wetlands improved.

Figure 2. 10 key priority wetlands sites for conservation in the Mekong Delta[4] (Adapted from Buckton et al. 1999)



1. (highest priority)	Seasonally inundated grasslands of the Ha Tien plain
2.	Tram Chim National Park
3.	U Minh Thuong Nature Reserve
4.	Dat Mui Nature Reserve
5.	Vo Doi Nature Reserve
6.	Bai Boi
7.	Tinh Doi
8.	Tra Su
9.	Lang Sen
10. (lowest)	Lung Ngoe Hoang

4 Map is adapted from (Buckton et al., 1999) online version at <http://www.wing-wbsj.or.jp/~vietnam/pdf/report12.pdf>.

Pressures on the Wetlands Environment

As highlighted previously, intensification in agriculture - primarily in the production of rice - and aquaculture - primarily in the production of prawns - together with demographic, social and institutional factors are the major pressures leading to changes in the wetlands in the delta. This is largely driven by the current economic policy of the government, *doi moi* (renovation), to revitalize the agriculture sector and to alleviate poverty. This section will start by discussing the economic policy of the government and then highlight the associated pressures which the policy brings.

When the war ended in 1975, Vietnam was a country in shambles and its economy needed serious repair. A policy known as *doi moi* was introduced by the 6th National Congress of the Party in 1986 to bring a market orientation to the Vietnamese economy. Central planning was slowly replaced with market-driven approaches toward integrating Vietnam into a new sphere of international relations, foreign policy and trade. Some of the key reforms initiated during the 1980s and early 1990s were: the decollectivization of agriculture, the return to family-based farming and the effective privatization of the agricultural sector; the devaluation and unification of exchange rates; the liberalization of most prices; a tightening of the budget constraint on state-owned enterprises, their significant rationalization and an increase in related managerial autonomy; the development of a two-tier banking system; the increase and maintenance of significantly positive real interest rates to encourage domestic savings; a significant reduction in subsidies and the state budget deficit; and an open door policy on foreign direct investment, official development assistance and external (UNDP-Vietnam 1997).

In the years after *doi moi* was launched, economic growth was impressive with real GDP growth at around 9 to 10 % per annum. The budget deficit and the annual inflation rate were remarkably reduced. There was also an expansion in foreign trade and the floodgates for foreign direct investment were opened resulting in increased production and income for the economy. Vietnam also became the world's third largest rice exporter, a huge leap from being a net rice importer (UNDP-Vietnam 1997). On the poverty-alleviation front, UNDP reckoned that *doi moi* led to a significant reduction in rural poverty especially when compared to the years prior to *doi moi* (UNDP-Vietnam 1997). Though all these improvements were sustained during the 1997 financial crisis, any neo-liberal economic framework may be threatened by political (e.g. terrorism) and economic (e.g. technology meltdown) factors in today's global economy, unless a strong and accountable government ensures effective economic management (Adger, Kelly et al. 2001a).

Observers (e.g. UNDP-Vietnam 1997; Adger, Kelly et al. 2001a, b; Adger, Kelly, Nguyen Huu Ninh et al. 2001) believe that the gains of *doi moi* need to be deepened in order to make substantial improvements in Vietnamese society and the economy. While lofty achievements have been made, a lot remains to be done to truly revolutionize the lives of ordinary Vietnamese.

Table 4. A chronology of major political changes in Vietnam since reunification in 1975 (Adapted from Adger, Kelly et al. 2001a; and others)

Unified Period	
1975-79	Expansion of collectivized agriculture in Southern Vietnam
1979	Chinese invasion of northern Vietnam
1979	Limited introduction of household contract system in agriculture
1981	National application of household contract system under Directive 100; cooperatives and
	work point system still operating
1986	*doi moi* introduced following Party Congress
Renovation Period	
1988	Agricultural reforms under Decree 10. Collectivization of farms in Mekong Delta. Land
	allocation on lease system. Cooperatives to act as a service operation to household agriculture
1988-93	Land ownership still with the state. A rental market for land emerges even though illegal
1993	Land Law instigates 20-year and longer leases of agricultural land

In the area of wetlands management in the Mekong Delta, two parallel processes associated with *doi moi* need to be understood, as they put pressures on the future state of the wetlands. These are agricultural intensification, primarily through rice production, and aquaculture production, primarily through shrimp aquaculture. Associated with these two main pressures is the increasing use of large infrastructure projects to ensure rice and shrimp production. These projects are bringing additional pressures to bear on wetlands resources.

Pressures Associated with Intensification of Rice Production

Agriculture occupies 83% of the delta and its development in the Mekong Delta has always been associated with the production of paddy rice, which was made possible through an extensive network of canals, connecting villages and depression areas and providing for irrigation and drainage (Duong Van Ni et al. this volume). Agricultural output in the Delta is highest compared with the rest of the country (Table 5), as it is relatively land abundant and highly irrigated; thus it is also relatively well-off compared with other regions (Minot 2000).

Rice is both a cash crop and a staple food in Vietnam. It accounts for 78% of the annual cropland and 90% of staple food production in the country. It also provides for 75% of the calorie intake of a typical Vietnamese household and almost 30% of the value of consumption expenditure (Ryan 2002). Rice production in the Mekong Delta, and for the rest of Vietnam for that matter, is a major source of income among its agricultural households. It accounts for 31.5% of household income. Ninety-five percent of rice surpluses are produced in Vietnam's Mekong Delta while the rest come from the Red River Delta. Other regions such as

Table 5. Profile of farming households in Vietnam, by region (1992-93) (Adapted from State Planning Committee and General Statistical Office 1994) quoted in Shintani (2001)

	Northern Uplands	Red River Delta	North Central	Central Coast	Central High-lands	South-east	Mekong Delta	Whole Country
Agricultural output value (1 000 VND (US $ 0.07))	3 783	3 820	2 952	3 097	5 071	5 250	6 942	4 365
Paddy output (kg)	1 192	1 638	1 375	1 596	946	2 406	4 456	2 071
Value of product of husbandry (1 000 VND (US $ 0.07))	1 455	1 483	1 128	1 320	860	1 795	1 685	1 451
No of household members (persons)	4.9	4.1	4.5	4.9	5.7	5.0	5.2	4.8
Persons of labour participation age	2.0	2.2	2.6	2.5	2.4	2.5	2.4	2.4
Agricultural and forestry land (ha)	0.737	0.280	0.399	0.422	1.128	0.930	1.105	0.638
Annual crop land (ha)	0.438	0.243	0.312	0.372	0.710	0.611	0.907	0.486
Production equipment (1 000 VND (US $ 0.07))	362	236	348	549	3,410	1 995	1 637	803
Value of animals owned (1 000 VND (US $ 0.07))	828	597	916	949	638	1,295	732	800
Crop cultivation expenses (1 000 VND (US $ 0.07))	378	605	525	743	918	1 607	2 095	934
Husbandry current expenses (1 000 VND (US $ 0.07))	172	333	280	485	302	921	638	409

the North Mountain, North Central Coast, South Central Coast, Central Highlands and Southeast have rice deficits (Minot and Goletti 1998).

Rice exports (Table 6) were boosted during *doi moi* as the government liberalized its markets, prioritized agriculture and exports, promoted international trade and decollectivized agricultural production, although large scale rice exports had been initiated during French colonial rule (Pingali and Vo-Tong Xuan 1992; Minot and Goletti 1998; Ryan 2002). During 1985-95, rice production grew by 5% annually (Ryan 2002), and now generates 15% of Vietnam's export earnings (Ni and Xuan 1998). Rice exports from Vietnam account for 11-13% of the world's rice exports. Yet a short-run increase in the price of rice would greatly affect the majority of Vietnamese as six out of ten households and five out of seven regions are net buyers of rice, even though poverty has been reduced (Minot and Goletti 1998). As the situation is now, poverty is still severe in the countryside and the quest for institutionalizing poverty alleviation by the government necessitates capitalizing on its comparative advantages in which rice production obviously is pre-eminent.

Intensification of rice production is the avowed goal of government policy in order to strengthen the country's economy, alleviate poverty and ensure food security. In so doing, vital institutional and policy infrastructures are being put in place to jumpstart the process. Vital policy changes include reduction of the export duty on rice, strengthening of individual property rights, land reform, adoption of high yielding varieties and an increase in the export quota (Ryan 2002). On the physical infrastructure side, large-scale water control projects have been initiated, especially in the Mekong Delta, to support the intensification of rice production (Hashimoto 2001) and reclamation of acid sulfate soil (ASS) areas through leaching (Minh et al. 1997). All these developments have led to a rapid and remarkable transformation in the Delta from broad grasslands to rice paddy fields (Koji 2001)[5].

While these projects have brought benefits in terms of increased productivity, they have also brought new pressures to the wetland environment in the Delta and heightened the potential for environmental degradation. These pressures need to be properly considered so as not to subvert the goals which these developments target. The projects include large-scale dry season irrigation schemes; flood and drainage control measures mostly in the form of canals, dikes and sluice gates; and land reclamation in ASS areas.

Canals serve many functions such as irrigating cropping areas, draining floodwater and runoff from cropping areas to main channels, and transporting and disposing of waste. Canals are also used to remove acid water from ASS. Even prior to the war, canals were being built in the Delta primarily for transportation, defense and rice cultivation (Koji 2001). But the intensity of canal building has increased in recent years and by the 1990s, virtually all waterways in the Delta formed a single network with a total length of around 5 000 km. Dikes, on the other hand, prevent or delay the flooding of cropping areas and human settlements. Dikes also impound water, which may be useful for certain fishery or aquaculture activities as well as providing platforms

Table 6. Production and trade of rice in Vietnam (Adapted from Ryan 2002)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Paddy production (metric tonnes)	19.0	19.2	19.6	21.6	22.8	23.5	25.0	26.3	27.6	28.3
Actual export quota (metric tonnes)	N/A	N/A	N/A	1.9	1.6	1.9	2.0	2.9	3.6	4.0
Rice exports (metric tonnes)	1.4	1.5	1.0	2.0	1.7	2.0	2.0	3.0	3.6	4.0*

** Originally the quote was set at 4.0 million tonnes, but in mid-1998 the goverment revised this down to 3.6 million tonnes due to concerns about drought and food security.*

5 However, the next section will show that the transformation of the delta did not end with rice production. Certain parts of the rice producing areas of the delta especially those located along the coastal areas became shrimp farms.

for land transport. Sluice gates are mechanisms to control the flow of water in and out of canals and to regulate the water level in cropping areas (Hashimoto 2001). Reclaiming ASS for rice production and other agricultural products is done through leaching, which is a means of transferring acidity to the surrounding area (Minh et al. 1997).

The environmental impacts of these projects are manifold. Leaching ASS, which accounts for 40% of the Delta's land type, has the potential for acid pollution, which, in turn, affects aquatic organisms, fisheries, crops and other domestic uses of water (Minh et al. 1997) as there is a threshold which these can withstand. In relation to ASS, the water-control projects, especially canal construction, has exposed through excavation large volumes of potential ASS to the air, leading to pyrite oxidation, hence to seasonal soil acidity and increased mobility and deposition of potential toxins such as manganese and aluminium. Such an increase in soil acidity may affect the growth of crops and changes the biodiversity of the area, especially with respect to the succession of acid-tolerant species over intolerant ones (Hashimoto 2001).

When acid pollution is flushed through waterways, it can cause mass mortality, disease, disfigurement and reduced growth rates of aquatic organisms aside from encouraging the growth of toxic blue-algae. In addition, the natural pattern of downstream flow of floodwater over the delta plain is fragmented and complicated, resulting in a potentially massive deposition of sediments in main channels – which makes canal maintenance costly – and increasing the duration and depth of inundation. Overbank flooding on the delta plain brings sediments which may be important in maintaining the productivity of the soil, but the addition of dikes in the landscape prevents this from occurring. There are also cases where land reclamation associated with these water-control projects has led to the destruction of some of the last remaining stands of *Melalueca* forests. These impacts seriously threaten the sustainability of the wetlands in the delta (Hashimoto 2001).

Pressures from Shrimp Aquaculture

As with the intensification of rice production, Vietnam's aquaculture industry is expected to be a flagship in the country's quest for economic growth and development under the auspices of *doi moi* and its consequent policies of liberalization and increased exports. Thus, the government's plan for its aquaculture sector is an expression and result of *doi moi* (SCP Fisheries Consultants Australia 1996; Luttrell 2002). Its faith in the benefits of aquaculture is unequivocal. It believes that economic development and growth is possible through aquaculture as this industry has yet to realize its true potential. Vietnam reckons that its wealth of natural resources such as 445 000 ha of coastal marine habitats, 390 000 ha of brackish-water, 1 million ha of inland waters and 560000 ha of agricultural ecosystems should provide the fuel to achieve its objectives. Its Ministry of Fisheries, the agency in charge of aquaculture development, believes that accelerating investment in aquaculture is possible, as such investment is financially attractive, economically viable and the entrepreneurs are eager to expand operations (Institute for Fisheries Economics and Planning 1997).

Aquaculture is seen to have the greatest growth potential within Vietnam's fisheries sector, as its marine capture fisheries as well as inshore and nearshore areas are already experiencing various degrees of over-exploitation. In the late 1990s, aquaculture contributed 30% of the total fisheries production of 1.3 million tonnes and an export earning of US $ 250 million. By 2010, most of the increase in earnings from fisheries exports is expected to come from aquaculture. Coastal aquaculture in particular is expected to be where growth in commercial and export-oriented production can occur. Employment in aquaculture is expected to exceed 1 million by 2010, three times its original size, as it is the plan of the government to use this subsector to absorb excess capacity in inshore fisheries and to relieve fishing pressure. The number of people currently employed by this sub-sector is estimated at around 300 000 (SCP Fisheries Consultants Australia 1996).

The massive expansion of brackish-water aquaculture – especially the culture of high valued species such as *P. monodon, Penaeus indicus,* and *P. merguiensis* (TranTruong Luu 2000) – in the Mekong Delta came in the wake of *doi moi* especially with the decollectivization of land from cooperatives to individual households and land reform. In 1994, there were about 254 000 ha of brackishwater ponds in the country with 237 000 ha used largely for shrimp production. However, expansion has been increasing since then, as for instance in Minh Hai Province in the Mekong Delta, where there were 131 000 ha of ponds

in 1994 and 142 000 ha in 1996. Eighty percent of the country's total land area devoted to aquaculture is in the Mekong Delta (SCP Fisheries Consultants Australia 1996) and covers different production systems and yield (Table 7). The average yield is considered low, ranging from 100 to 400 kg/ha/yr depending on the production system (Cao Thang Binh and C. Kwei Lin 1995).

In saline areas and especially during the dry season, shrimp farming is practised when rice farming is not feasible due to high acidity in the soil. This practice allows farmers to earn extra income during times when earnings from rice farming are not forthcoming. Improved extensive and semi-intensive shrimp production systems (Table 7) are adopted over the same piece of land where a wet season rice crop is grown. The rice field is redesigned with a trench and dike surrounding it to act as a refuge for the shrimps. A flapgate and trap system controls the amount of water flowing between the rice fields and trenches (Tran Thanh Be et al. 1999). This system prevents the acidity of the soil from building up due to long exposure to air and pyrites seeping out from cracked and overturned soil. Integrated farming systems are now being adopted such as salt-artemia-shrimp farming, which allow for the land to be used throughout the year (de Silva 1998).

Good global demands accompanied by high prices and government support (e.g. preferential taxation, credit to infrastructure support to make shrimp production lucrative) underlie its production in the Mekong Delta (SCP Fisheries Consultants Australia 1996; Luttrell 2002). Estimates by de Graaf and Xuan (1998) show that shrimp farming increased by 3 500% between 1976 and 1992. This confirms the shrimp's well-earned reputation as the most important traded commodity by value in Asia (NACA 2000). Elsewhere in the tropics, shrimp production predominates in mariculture (de Silva 1998), less for domestic food consumption than for export and foreign exchange (NACA 2000).

The ambitious plan for the aquaculture sector may have lofty economic objectives, but ironically it brings pressures which can potentially subvert the integrity and sustainability of the very system economic development is anchored on. Already the yield from the country's shrimp industry is in decline due to a host of factors such as viral infections, massive destruction of mangroves, increasing soil and water acidity, poor pond management and overexploitation of natural shrimp stocks (de Graaf and Xuan 1998). If the earlier experience from Vietnam and the lessons from other countries are any indication, intensive shrimp production has huge environmental costs (such as those in Table 9) which several authors have pointed out (see Bailey and Skladany 1991; Primavera 1991; Stonich 1995; Macintosh 1996; Bailey 1997; Clay 1997; Primavera 1997; Stonich et al. 1997; Boyd and Clay 1998; Boyd et al. 1998; Menasveta and Fast 1998; Paez-Osuna et al. 1998; Primavera 1998; Boyd and Schmittou 1999; Flaherty et al. 1999; Stonich and Bailey 2000; Paez-Osuna 2001; Senarath and Visvanathan 2001; Hein 2002; Luttrell 2002)[6].

Table 7. Area and output of different shrimp production systems in the Mekong Delta (Adapted from Cao Thang Binh and C. Kwei Lin 1995)

System	Area (ha)	Farm size (ha)	Production (kg/ha/yr)
Extensive shrimp/fish	160 000	1-10	395
Improved extensive	1 100	1-4	357
Semi-intensive	800	0.5-1.0	1 670
Shrimp-mangrove	26 000	2-10	342
Salt-shrimp	6 000	2-20	100
Others	11 300	–	–
Total	**204 350**		

6 Cognizant of the environmental impacts of shrimp aquaculture on mangroves, civil society groups such as the Mangrove Action Network and the International Shrimp Action Network are actively campaigning on this issue.

Table 8. Environmental impacts of extensive shrimp culture on mangrove forests in the Mekong Delta (Adapted from Phillips 1998)

Environmental Impact	Specific Details
Coastal erosion	Increased coastal erosion in Tien Giang, Ben Tre, Cuu Long and Minh Hai Provinces
Salinity intrusion	Removal of mangroves has led to increased vulnerability to storm damage and saline intrusion. In 1991, more than 2000 ha of rice fields at Can Gio District, Ho Chi Minh City were damaged by saline intrusion
Shrimp post-larvae	Declining availability of post-larvae has resulted in decreased yields from extensive shrimp ponds although over-fishing may also be important
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. From 1986, yields from extensive shrimp ponds declined from 297 kg ha^{-1} to 153 kg ha^{-1} in 1988

In the Mekong Delta, shrimp farming occurs in the intertidal areas along its coast as farmers rely on tidal water exchange to bring nutrients and seeds to the ponds (Lovatelli 1997) especially in extensive systems. Hatchery-produced post larvae and supplementary feeding were gradually introduced during the early 1990s as the production systems intensified (de Graaf and Xuan 1998). Because of its location on the coastal zone and the nature of the activity, significant environmental impacts are starting to emerge such as those listed in Table 8. Yet these impacts pale in comparison with those being reported in other countries, especially Thailand, Bangladesh and India; impacts include nutrient and organic loading; intensive use of chemicals; groundwater removal; decline in biodiversity associated with wild fry bycatch and introduction of exotic species (Primavera 1998).

The conversion of mangroves for shrimp culture has been reported in the Delta (de Graaf and Xuan 1998) and represents the most pernicious impact of shrimp aquaculture (Primavera 1998). The World Bank estimated in 1994 that its environmental cost over the past 10 years was US $ 279 million. This comes from the opportunity cost of improperly designed and managed shrimp ponds, loss of sustainable mangrove forest activities, loss of capture fisheries, and the increased cost of dike maintenance (SCP Fisheries Consultants Australia 1996). It is estimated that in the 1940's there were 400 000 ha of mangroves in Vietnam, 250 000 ha of which were in the Mekong Delta. The country's mangroves were reduced to 290 000 ha by the 1950's as wood, charcoal and firewood use intensified. When the Vietnam war erupted, 104 939 ha were further destroyed especially in Ca Mau Cape, where defoliants and herbicides were used (Phan Nguyen Hong and Hoang Thi San 1993; TranTruong Luu 2000). From here onwards, mangrove conversion for shrimp aquaculture predominates until recently when conversion to rice production began to catch up (Tran Thanh Be et al. 1999).

In rice-shrimp farming systems in the Delta, practices associated with shrimp farming have led to two major environmental problems: salinization of rice-shrimp fields and the neighbouring rice-monoculture fields, and sedimentation in rice-shrimp fields. Salinization occurs when rice-shrimp farmers inundate their rice fields with salty water for a period of 4-5 months a year to enable shrimp culture. In rice monoculture areas, saline water has two impacts. One on bare fields during the dry season when it leaches or washes over the area; another on the growth of an existing rice crop. As the soil is already salty due to periodic saline intrusion, the inundation of salty water dramatically increases the salinity level and leaching fails to remove the salts locked in the soil. As a result, rice yield is affected, as there is a certain salinity threshold that rice can tolerate. Also the amount of time for the rice-cropping season is affected, as rice-shrimp farmers need sufficient time to flush the soil (Tran Thanh Be et al. 1999). A similar situation has been widely reported in the case of inland shrimp

farming in Thailand where transportation of saline water has had serious impacts on soils and freshwater systems (Flaherty et al. 1999). On the other hand, sedimentation happens when sediments are deposited by river water during the dry season. This causes rapid shallowing of rice-shrimp fields necessitating extra labour to remove the sediments and allow for water to be properly impounded for the rice to grow (Tran Thanh Be et al. 1999).

Aside from the above-mentioned impacts, shrimp farming also has negative socio-economic impacts which can be gleaned from the experiences of other countries. In particular, it has led to loss of mangrove goods and services; it has led to land conversion, privatization and expropriation of fragile coastal ecosystems for private interests; it has led to marginalization, rural unemployment and rural-urban migration to seek better work opportunities; and to food insecurity as pond-produced shrimp is unaffordable in poor households (Primavera 1998). In the Mekong Delta, there are signs that these problems are beginning to emerge as in the case of Nam Hai Commune in Thinh Binh District, Ca Mau Province.

In this commune, shrimp farming has led to upheaval in the social structure, a lowering of water quality and the destruction of existing vegetation. Originally, Nam Hai Commune was a rice growing area but when it failed to provide sufficient income, residents converted all their rice lands to shrimp farms in the mid-1980's to ride with the shrimp boom. Profit from this new venture was only good until there was a dramatic fall in shrimp yield during the early 1990s and from then on, profits were poor. Some shrimp farmers are now thinking of reconverting their ponds to rice fields but this is not easy, as it requires more money to move earth back into the pond and build dikes. Thus, the shrimp boom has led to the collapse of household economies of poor shrimp farmers, to high debts, and has sharpened the division between rich and poor households as the former were able to adapt more easily (i.e. they have more options) than the latter. In acts of desperation and resistance, some poor shrimp farmers marginalized by the decline of the industry and lack of other employment opportunities have resorted to theft (Luttrell 2002).

Table 9. A summary of positive and negative impacts of the shrimp expansion in Vietnam and its subsequent failure (Adapted from Luttrell 2002)

Positive impacts
• Increased foreign earnings for Vietnam • Livelihood diversification in an area where rice returns are low owing to salinity and problems of acid sulfate soil. • Opportunities for credit and preferential taxation for shrimp farming households. • Increased earnings for local authorities from selling contracts over previously 'unused' land and resources. • Increased trading opportunities and other multiplier effects in the area.
Negative impacts
• Rivers affected by chemical, heat and sediment pollution owing to runoff from shrimp ponds, thus adversely affecting natural products. • Enclosure of open-access areas restricting livelihood sources for the poorest. • Increased landlessness as households which cannot afford the capital investment needed for shrimp farming are pushed off the land. • Little benefit accrues to the area as many of the shrimp farmers who are able to profit from shrimp farming are from outside the commune. • Increased conflict over land.
Impacts of the subsequent failure of shrimp farming
• High levels of debt in all shrimp farming households, restricting transfers to other income-generating activities. • Forced diversification of livelihoods. • Increased tree planting on private land as the value of the shrimp ponds decreases. • Increased landlessness as poorer pond owners are forced to sell the land to pay debts. • Falling land prices, richer households selling the land and a lower income group moving in.

Table 9 summarizes the impacts of shrimp expansion and its failure in Vietnam. It appears that, while some benefits accrued to the national economy, household security is seriously threatened, and there are indications that social upheaval may become a possibility if current trends are not corrected and social safety nets are not in place.

Pressures from Inadequate Institutional Arrangements

Legislation on wetland management in Vietnam consists of a number of laws and regulations which include those on agriculture, forestry, environment and fisheries (Doan Nang, this volume). Thus, there is no single legislation covering the use, development, management or conservation of wetlands. The Land Law of Vietnam defines wetlands as "lands with waterbodies". The precise meaning of wetlands is not elaborated in the Land Law. The focus of these wetland provisions is on their economic use rather than on their protection or conservation value.

Artificial wetlands are not covered by this legal framework. The protection of wetlands environment is covered under general environmental legislation such as the Law on Environment Protection (1993). Out of more than 500 environmental protection regulations enacted since 1976, only ten cover wetlands directly. As wetlands are the interface between land and water, wetland use is also covered under the Law on Water Resources, particularly by the provisions on the use of water resources. It is proposed that a decree on the use and management of wetlands be formulated. The decree would define the involved agencies and outline their roles and fill in gaps in the existing legal framework in order to make the framework more responsive to current realities (Doan Nang, this volume).

The institutional dynamics in the management of wetlands in the Delta is shown in the case of Ben Tre Province, one of the coastal provinces of the Delta. The province has more than 100 species of mangroves. Following re-unification in 1975, several agencies were assigned the task of developing plans for the exploitation, protection and development of wetlands in the province. These agencies were: the Department of Forestry, Department of Land Administration, Department of Fisheries and Department of Science, Technology and Environment. Steering committees or management boards were also established to implement these plans. However, there are conflicts over policy interpretation on wetlands use and management, as wetlands are jointly used for forestry and aquaculture. The establishment of protected areas in the Delta is governed by the Law of Forest Protection and the Regulation for Protecting Aquatic Resources in Coastal Areas (Trinh Van Y, this volume).

Nevertheless, additional policies on sustainable use and wetlands management are required at the national level. Le Thanh Binh (this volume) outlines a proposal put forward by the National Environment Agency for a national strategy on the sustainable management of wetlands in Vietnam. She notes that the present strategy on wetlands management is based on a number of laws such as the Law on Environment Protection, the National Action Plan for Biodiversity, the National Action Plan for Environment 2001-2010, the Convention on Biodiversity and the Convention on Wetlands (Ramsar, Iran, 1971) (cf. Doan Nang, this volume). While enshrining coordination among the various sectors involved in wetland use and development as an essential policy mechanism, the strategy is aimed at ensuring the sustainable and effective use of wetlands. Thus, the key themes in the strategy are integration at the levels of policy and management, zoning and proper planning. The other highlight is conversion of mangrove areas into fish or shrimp ponds or ricefields and the possibility for re-converting some of these areas back to mangrove areas.

Currently, a national policy to rehabilitate and develop five million hectares of forests is in place in Vietnam. According to Nguyen Ngoc Binh (this volume), Director of Vietnam's Forestry Development Department, the program will run until 2010 and targets 5 million hectares of forest to be reforested with another 9.3 million hectares to be protected. This is quite an ambitious government program with noble objectives such as ensuring ecological security, conserving genetic resources and biodiversity, creating 2 million permanent jobs and contributing to poverty alleviation. The program budget from the national treasury is being developed and the Vice Prime Minister chairs the committee overseeing this program. Tax incentives are provided to those who plant trees or perennial crops on barren lands or those who invest in wood processing industries. The program also encourages plant breeding to supply materials for reforestation. Foreign investors are encouraged to enter into joint ventures

with national organizations on reforestation and wood processing projects. A challenge to this program is the absence of a clear land use policy that may affect investments in reforestation. In terms of wetlands, this program has a bearing on the use and management of important forest ecosystems in the Delta such as mangrove and *Melalueca* forests.

In the Delta and elsewhere in the country, special use forests (SUFs) are designated. SUFs are one of the three types of forests in Vietnam, which includes protected forests and production forests. SUFs serve a variety of purposes including the maintenance of ecosystem integrity, conservation of biodiversity, scientific research and protection of cultural and historical values. SUFs include three kinds: national parks, natural reserves and cultural-historical forests. The government aims to increase the country's forest coverage and considers SUFs so important that management boards, acting as state-run economic units, manage these forests. For small SUFs, protection and development may be handled by organizations, households or individuals (also referred to as "forest owners"). If the management of SUFs is not assigned, the district people's committees (PC) are expected to assist provincial people's committees at district and commune levels in the management of SUFs (Nguyen Tuan Phu, this volume).

Some components of the legal framework for natural resource management in Vietnam are listed by Hoang Huu Cai (this volume). This includes the Forestry Resource Protection and Development Act, Law on Environmental Protection, Vietnam National Environmental Action Plan and the Vietnam Forestry Action Plan (cf. Doan Nang, this volume). Important stakeholders in the Delta wetlands include the provincial Department of Agriculture and Rural Development (DARD), the provinces' extension centers, provincial Forest Protection Departments, forestry/fishery enterprises, district agricultural extension stations, forest protection stations, people's committees and the communities. These entities need different kinds of support in order to enhance their roles in the natural resource management process. The support activities can range from enhancing skills and capabilities to financial and information support.

In view of the problems of wetland management in the Delta as reported in various papers in this volume, effort needs to be directed toward analyzing the wetland management "institutions" and deriving the economic value from wetland goods and services in order to influence the policy, plans and decisions toward more sustainable and efficient outcomes. Trinh Truong Giang et al. (this volume) of the University of Agriculture and Forestry in Ho Chi Minh City have outlined the lessons learned from existing and past wetland management arrangements. Since 1995 UAF has been involved in the study of the institutional aspects of natural resource management, especially those relating to the country's wetlands. These authors contend that governments are not the sole stakeholders in natural resource management. To institute proper natural resource management, grassroots organizations should be involved and sectoral management should be discontinued. A transparent and participatory decision-making process increases the effectiveness of the state management of these resources and reduces transaction costs, thereby leading to more sustainable outcomes.

Beyond these formal institutions, there is increasing concern especially among those who are observing trends in global environmental change (for example Adger, Kelly et al. 2001a) that the economic liberalization policies advocated under *doi moi* are increasing the collective vulnerability to hazards (e.g. cyclones and climate change) of populations within precarious environments. This liberalization is thought to erode institutional resilience to these hazards. Adger (2000) argued that the system of local autonomy has, in effect, a potential cost in terms of collective vulnerability to hazards as the reformulation of "the organs of administrative power does not lead to greater local participation and collective empowerment". Instead, these changes decrease opportunities for coherent collective action and often reinforce the uneven distribution of power over resources.

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7 These projects exclude those that are considered general agricultural research, commercially oriented agricultural projects, irrigation and water supply and sanitation.

8 Forty-eight of these projects received multilateral funding while the rest have bilateral funding. The environmental projects in 1999 were at least six times larger than in 1995 (UNDP-Vietnam 1999).

Responses

We have mentioned some of the pressures on the sustainability of wetlands in the Mekong Delta. There are other factors that can impose pressures on how these resources are managed and used. These include the poverty situation in the Delta and demographic trends of the population within it, as well as those of the whole nation. The donor community, NGOs, private sector and the government have responded in various ways to the challenges. Over the whole of Vietnam, 173 environmental projects[7] were implemented with funding of at least US$ 1.4 billion[8] in 1999 (UNDP-Vietnam 1999). A sizeable chunk of these projects was implemented in the Delta. Though it is not easy to ascertain their impacts, it is fair to say that the responses are varied and the projects or programs initiated are diverse. Table 11 lists the projects or programs that have been implemented or are in various stages of implementation. The list is not comprehensive and may represent only a small portion of the whole picture. A more complete picture is presented in UNDP-Vietnam (1999).

To cite an example of the kind of intervention initiated in the Delta, it is instructive to look at the Inventory and Management of Wetlands in the Mekong Delta project as this is a pioneering effort to inventory the wetlands in the Delta and serve as a scaffold for succeeding projects. This project, under the auspices of the Mekong River Commission, was carried out from 1991 to 1998 and involved the Lao PDR, Thailand and Vietnam. Between 1991 and 1998, the project achieved the following[9]:

1. Set up a wetland team composed of representatives from different agencies and disciplines;
2. Established a wetland classification based on Ramsar and MRC classifications;
3. Established wetland maps for the Mekong delta at scale 1/250 000 especially for Tram Chim, Thanh Phu (1/25 000) using GIS;
4. Established a database to manage all data related to the project;
5. Established Tram Chim area as a national park;
6. Proposed the establishment of Thanh Phu area as a national conservation area.

In eight years of operation, several insights were gained including[10]:

1. Wetlands are an integrated and sensitive ecosystem. The assessment of natural resources of the wetlands should follow standard methodologies in order for it to be comparable.
2. In Vietnam, there is no agency with the full power to manage the wetlands. As such, resource management in wetlands is according to sector such as fisheries, forestry and agriculture.
3. In Vietnam, there is no single policy on wetland management such that the management policies of the different sectors (fishery, forestry and agriculture) can be coordinated.
4. In the Mekong Delta, the increase in human population and economic development are the main causes for the degradation of the wetland area. There is over-exploitation of natural resources of the (natural) wetland and an imbalance between economic development needs and the potential of natural resources. This is the main reason for the degradation of natural resources in the wetland area. The conservation of the (natural) wetlands areas particularly those with high values of biodiversity, culture and history should be the main priority in the national wetlands management strategy.
5. The development of buffer areas is important in order to conserve and use the resources in (natural) wetlands wisely. There should be a project on this aspect.
6. Knowledge of limnology and of the real value of wetlands are very important for the wetlands researcher.

9 This is largely based on the presentation of Mr Nguyen Chin Thanh, Vice-Director, Institute for Inventory and Planning, Department of Forestry, entitled "Inventory and management of wetlands in the Mekong Delta: Result"

10 Ibid.

Table 10. Projects/programs implemented in the Delta

Sector	Project	Donor	Duration	Total Cost (US $ million)	Source
Conservation and protection of mangroves and wetlands	Mixed Shrimp Farming: Mangrove Forestry Models in the Mekong Delta	Australian Centre for International Agricultural Research (ACIAR)	1998-2000	0.603	(UNDP-Vietnam 1999)
Marine Protection	Evaluation of Brackishwater Farming Systems in the Mekong Delta	Australian Centre for International Agricultural Research (ACIAR)	1997-2000	0.670	(UNDP-Vietnam 1999)
Watershed	Poverty Reduction and Environmental Management in Remote Mekong Sub-Region Watersheds (RETA 5771)	Asian Development Bank (ADB)	1998-1999	0.082	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Social Forestry: Mangrove in Can Gio South Viet Nam	Belgium Administration for Development Co-operation	1995-1999	0.240	(UNDP-Vietnam 1999)
Marine Protection	Marine Aquaculture in the Mekong Delta and Upgrading of Research and Educational Capacity	Belgium Administration for Development Co-operation	1996-1999	0.430	(UNDP-Vietnam 1999)
Sustainable Agricultural Practices	Strengthening of Diversified Farming Systems in the Mekong Delta	Belgium Administration for Development Co-operation	1996-1999	0.170	(UNDP-Vietnam 1999)
Sustainable Use	Impact Analysis an Improvement of Rice-fish Farming System in the Semi-Deep Water Area of the Mekong Delta	Belgium Administration for Development Co-operation	1995-1999	8.700	(UNDP-Vietnam 1999)
Sustainable Use	Land Evaluation for Land Use Planning and Development of Sustainable Agriculture in the South of Vietnam	Belgium Administration for Development Co-operation	1996-2001	0.450	(UNDP-Vietnam 1999)
Sustainable Use	Sustainable Management of Resources in the Lower Mekong Basin	Federal Ministry for Economic Co-operation and Development (BMZ)	1997-1999	5.500	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Rehabilitation of Coastal Mangrove Forest Damaged by Typhoon Linda	Danish Agency for International Development (Danida)	1997-1999	0.450	(UNDP-Vietnam 1999)
Sustainable Use	U Minh Thuong Nature Reserve Conservation and Community Development	Danish Agency for International Development (Danida)	1998-2002	2.800	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Capacity Development in Environment Management in Can Gio Mangrove Forest	European Union	1999-2001	0.210	(UNDP-Vietnam 1999)
Forestry	Afforestation Technology Development Project on Acid Sulfate Soil in the Mekong Delta	Japan International Cooperation Agency (JICA)	1997-2000	3.900	(UNDP-Vietnam 1999)

Table 10(a). Projects/programs implemented in the Delta (cont.)

Sector	Project	Donor	Duration	Total Cost (US $ million)	Source
Forestry	Cat Tien National Park Conservation Project	Netherlands Government	1997-2002	6.300	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Rehabilitation of Mangrove Forests in the Mekong Delta	Netherlands Government	1999-2000	3.160	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Conservation of Key Wetlands Sites in the Mekong Delta	Netherlands Government	1998-1999	0.170	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Vietnam Wetlands Conservation and Management Programme: Towards a National Wetlands Programme	Netherlands Government	1999-2000	0.160	(UNDP-Vietnam 1999)
Sustainable Agricultural Practices	Problem Soils	Swedish International Development Cooperation Agency (Sida)	1999-2000	0.360	(UNDP-Vietnam 1999)
Agriculture, fishing, and forestry	Mekong Delta Water Resources Project	The World Bank	1999-2005	147.600	www.worldbank.org.vn/wbivn/projects/pro023.htm
Transportation	Mekong Transport and Flood Protection Project	The World Bank	2000-2006	N/A	www.worldbank.org/sprojects/project.asp?pid=P042927
Environment	Coastal Wetlands Protection and Development Project	The World Bank	1999-2006	65.600	www.worldbank.org/sprojects/project.asp?pid=P042568
Transportation	Inland Waterways and Port Rehabilitation Project	The World Bank	1997-2003	73.000	www4.worldbank.org/sprojects/project.asp?pid=P004843
Sustainable Use	Strengthening Capacity Development for Poverty Elimination in Tra Vinh	United Nations Development Programme (UNDP)	1997-2000	1.600	(UNDP-Vietnam 1999)
Conservation and protection of mangroves and wetlands	Mekong River Basin Wetlands Biodiversity Conservation and Sustainable Use Programme. Project Development Phase	United Nations Development Program (UNDP) and Global Environmental Facility (GEF)	1999-1999	0.350	(UNDP-Vietnam 1999)

Recognizing the need to build upon such prior experiences with wetlands management in the Mekong River Region, the WorldFish Center (formerly ICLARM) initiated in mid-2000 a project to (i) review and analyze existing laws, including customary rules and institutions concerning wetlands use and management; (ii) determine the economic, social and cultural values of the goods and services offered by wetlands; and, (iii) develop approaches for building and strengthening a national framework for multi-sectoral management of wetlands based on harmonized institutional and legal regimes and optimal economic, social and environmental benefits. The overall aim of the project is:

> "To enhance the quality of life of the people in the Mekong River Region by supporting environmentally sound development and sustaining and improving the values and functions of wetlands in the Mekong River Region".

The expected outputs of the project are:

a) Increased understanding of wetlands management issues at local, provincial, national and regional levels;
b) Improved capacity of riparian countries to promote sustainable wetland and aquatic resources management;
c) Improved linkages and networks on wetlands management between institutions at national and regional levels;
d) Improved economic valuation of wetlands and wetlands resources;
e) Strengthened capacity of relevant agencies to involve communities in sustainable use of wetlands resources;
f) Improved capacity to integrate local management systems into institutional regulatory and planning processes;
g) Improved institutional and legal frameworks for wetlands and aquatic resources management.