Water Environmental Governance in the Mekong River Delta, Vietnam

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Abstract
The Mekong River Delta in Vietnam is the largest agriculture and aquaculture production region of the nation. The total natural area of the Delta amounts to 3.9 million ha, of which 2.4 million ha of land is currently used for agriculture and aquaculture and 0.4 million ha for forestry. As the most downstream part of the Mekong River to both the South China Sea and the Gulf of Thailand, the Delta is a large tropical wetland. Also, the Delta is very densely populated with intense associated water pollution. The combination of the hydrological regime, sea, soil-type and pollution poses water quality management problems for irrigation.
This paper identifies five water environmental problems in the Delta that are the principal limiting factors of agricultural production and human health, i.e. (i) the salinity intrusion in the coastal areas, (ii) the effect of acid sulfate soils, (iii) the polluted water from human activities, (iv) the fresh water shortage in the dry season and (v) the flood in the rainy season. The discussion and conclusion present the people's adaption strategies and water gorvernance issues in pursing sustainable management in the region.

Keywords: Mekong River Delta, water environment, governance, sustainable management.

Introduction
The Mekong River is the world's second richest river basin after the Amazon River region in terms of biodiversity (WWF, 2004). The Mekong River is a large international river with special characteristics and important roles in the Mekong countries. Every year, the Mekong floodwaters from deposit fertile sediments from the upper basin of China, Myanmar, Thailands and Laos to fields and wetlands in Cambodia and Vietnam. At Phnom Penh, the river meets the Tonle Sap River, then splits into Tien River and Hau River before flowing across the border of Vietnam and continues to branch into six tributaries in Tien River and three tributaries in Hau River, to the the South China Sea and the Gulf of Thailand (Figure 1).

The Mekong River Delta (MD) is located in the Southeast Asian tropical monsoon zone. The Delta in Vietnam is bordered to the North by Cambodia, to the west by the Vam Co River, to the south by the Eastern Sea and to the west by the Gulf of Thailand. The whole MD is flat and low laying except for some low mountains and hills in Chau Doc and Ha Tien. The MD has great potentials for agricultural production with a population of 18 million inhabitants (2006) living in 4 million hectares of land. In the past 20 years, the area of cultivable land has grown rapidly, aided by the expansion and increased density of the irrigation and drainage canals system. There is an extensive network of canals that have been constructed in the last 300 years: over 7,000 km main canals, 4,000 km canals of on-farm systems and more than 20,000 km of protection dykes to prevent early floods (MARD, 2003). Since 1976 to 1990,

agricultural areas in the Delta have increased by approximately 20%, however, total production has doubled (Hoanh *et al.*, 2003). Rice cultivation areas have increased yearly by more than 100,000 ha during the period 1995 -1999 (Tuan *et al.*, 2004a). The Delta contributes more than 50 percent of staple food and 60 percent of fish-shrimp production of Vietnam (Minh, 2000). Historically for practical reasons the population has settled down densely along the stream banks, resulting in a high concentration of human pollutants along the water bodies in the Delta.

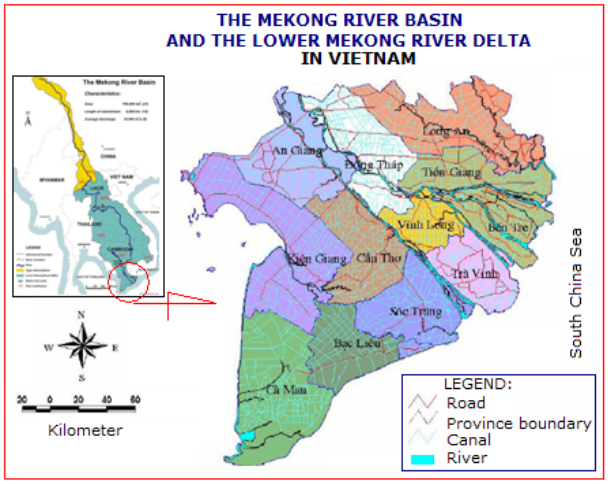

Figure 1. The Mekong River Delta in Vietnam

The goal of this research paper is to identify the current knowledge on water environmental problems in the MD, to review the local people's adaptation and the government policy, and to suggest future strategies for the implementation of water environmental governance for a sustainable development of the Delta.

Water environmental problems

There are only two seasons in the MD: rainy and dry seasons. The long-term average annual rainfall in the MD varies from 1,400 - 2,200 mm. About 90% of total rain water falls from May to October. At the end of the rainy season, due to the combination of floodwater draining from the upstream areas, the overland flood water from Cambodia enters the Vietnam border. Uptream high water flow combined with the inland high rainfall and the effects of high tide from the sea result in thousands hectares of land are inundated, mainly the Northern parts of the MD known as the Long Xuyen Quadrangle and the Plain of Reeds. Along the 600 km-coast, the sea tide strongly influences the water quality due to the sea water intrusion. In the dry season, all the coastal lands are affected by salinity intrusion. In addition, in low level areas, soil is covered by acid sulphate content. These natural conditions combined with the traditional ways of human life based on intensive river water resource use result in the water environmental problems of the Delta. Generally, there are three main water quality problems of which, two of them are the principal limiting factors of agricultural production and human health in the Delta (Tuan *et al.*, 2004b):

(i) *Salinity intrusion*: About 2.1 million hectares of the MD coastal areas (50%) are affected by salinity during the dry season from December to May. Saline intrusion is one of the principal limiting factors in crop production, especially for rice, as crops are intolerant of salinity in the soil and water beyond 4 gram per liter. As an impact, more saline intrusion has

led to more salinity in groundwater layers. Salt water infiltration into ground water is very common in the coastal areas of the MD, especially the popular exploitation layer of 80 - 120 meters for household wells.

(ii) *Acid sulfate soils* (ASS): Acid sulfate soils occupy 1.6 millions hectares (47%) of the MD mainly in the large areas of Long Xuyen Quadrangle and Plain of Reeds, the West Hau river, a part of Ca Mau peninsula. ASS has high iron sulfide content. This soil is very sensitive to the fluctuations in the river discharge and groundwater table. From March and April, the subsurface water level lowers by approximately 1.0 meter and therefore the deep cracks in the soils result in oxidization of the pyrite horizon into acid sulfate. Floods can transport toxic water from ASS areas to other non-ASS areas.

(iii) *Polluted water*: The Mekong River is becoming more polluted as a result of the agricultural and industrial chemicals and domestic untreated wastewater, which are discharged directly into open water bodies. In some places, the polluted water is seriously threatening public health and socio-economic development.

(iv) *Fresh water shortages:* In the dry season, normally lasting 7 months, the average discharge of the Mekong River is under 2,500 m^3/s, and sometime even to 1,700 m^3/s, with the groundwater table lowering by 2 - 3 m in some places. Scarcity of water for irrigation affects nearly 1.5 million hectares of cultivable lands in the dry season. The Mekong river water level decreases and leads to more intense seawater intrusion. As a consequence many coastal areas suffer serious shortages of fresh water supply.

(v) *Floods*: Discharge of the Mekong River during the wet season averages of 39,000 m^3/sec. About 1.2 - 1.9 million of hectares of the southwestern part of the Delta is under annual flood. High floods caused losses of human life, millions of dollars worth of damage, including houses, infrastructures and crops. Records of flood losses show that children were at high risk.

People's adaptation and government's policies

Salinity intrusion

Salinity intrusion has a positive effect for reducing acidity in potential ASS land; as the pH in water is higher. When there is a lack of saline water in fields, as with saline protection dikes as in some districts of Bac Lieu and Kien Giang, soil acidification occurs in the dry season making soil much less productive, lowering the agricultural yields. The presence of brackish and saline water is considered by some coastal shrimp farmers and fishermen to be a positive occurrence as a source for their livelihoods (Miller, 2003). Choosing to adapt their activities to correspond with salinity intrusion, farmers are able to implement a more varied production scheme to raise shrimp during the dry season. The marine and coastal region contributes more than half of exported aquatic value for Vietnam. However, further expanding the shrimp industry will have a negative impact on salinization affecting local livelihoods. In salinity management, mangrove forest replanting is perhaps the most controllable method to mitigate the harmful effects caused by shrimp farming.

To limit saltwater intrusion into agricultural areas, saline water intrusion floodgates were installed or are planned for much of the lower Mekong River. Since the last two decades,

many saline control projects have been built. In the freshwater - brackish water environment zones, many farming models have evolved, such as rice-shrimp rotation systems to maximize returns through both rice and high-value, extensive or semi-intensive shrimp production.

Acid sulfate soils

There were many researches on ASS in the Mekong Delta last 30 years. Disturbance by excavation or drainage of ASS for flood mitigation, urban development and agricultural production can result in large areas acidified with significant environmental, social and economic problems. In the MD, ferrous iron (Fe^{2+}) is commonly found from underground. It causes metallic taste and bad smell for domestic and industrial uses. Rice and other crops in strong ASS do not grow well.

The solution is a smart combination of the ways for controlling irrigated water, tidal flushing effects, adjusting suitable crop calendar and applying chemical methods. The inland *Melaleuca* tree or some kinds of reed, that have pretty good tolerance to such a strong acidification condition, should be replanted and restored as forest wetlands in the ASS land. Their main functions are the provision of forest commodities, the regulation of the water balance and biodiversity conservation. For drinking water source, groundwater in ASS area is pumped out and can be treated by aeration and filtration. Aeration is used to change iron content ferrous to ferric form (Fe^{3+}) and to reduce tastes and odors.

Polluted water

Parallel with the fast increasing agricultural yields and production, the MD is facing more and more water pollution problems by human and animals waste, agro-chemicals such as pesticides, herbicides, and fertilizers. Moreover, processes of the urbanization and industrialization together with the rapid population growth that leads to greater water demand for upholding and developing the regional economy. This results in lack of clean water in the poor communities. This issue in the MD is also common for Vietnam as a whole. Addressing the water needs of people may be linked to the effort of poverty reduction and living conditions improvement as well as environmental protection, especially in water bodies as a whole.

The Law on Water Resources (approved on 1998, effected in 1999) and the Law on Environmental Protection (1993, revised on 2001) cover a number of policy measures regarding suitable and effective water sources utilities and water environmental protection in Vietnam. Applying constructed subsurface flow wetland is a promising solution as a small scale approach for domestic wastewater treatment solutions. Constructed wetlands and the reuse of waste/wastewater for agriculture may be available alternatives that adapt the different sustainability considerations including designed low cost installation as well as simply operation and maintain. It also has a significant contribution to food production.

Fresh water shortage

There is a very big difference in discharge between the wet season and the dry season. In 7 months of the dry season, the river discharges one-third of the total annual flow. The low discharge of river water also leads to the salinity. Freshwater from river and canal is only used in the upper parts of the delta, where the water quality is not affected by high concentration of salinity and/or acidity and/or pollution. This has an environmental impact, which not only affects the rice-cultivation by local farmers but also results in limitations of living habits and health by local farmers. The agricultural production currently consumes 85 - 90% of the total water supply. At present, about 75% of the inhabitants in the urban and 35% in the suburban

and rural have access to clean drinking water, this figure drops to 20% in far and deep areas (Tuan, 2003). Environmental authorities became aware of the looming fresh water crisis.

As a result, the "National Strategy for Clean Water Supply and Rural Environmental Sanitation up to 2020" of the Government of Vietnam (2000) was elaborated as part of the national "Poverty Reduction Strategy Paper" to take responsibility for the Millennium Development Goals. In An Giang and Kien Giang, building reservoirs in high lands for keeping stream water is one of the water collection ways. Many water resources projects have been established and implemented during the last three decades in order to keep track of the demand and to ensure food security and improvement of the living standards for people of the Vietnam Government. Depending on the water sources capacity and land use pattern in the dry season, the major rice and other vegetables cropping calendars in the MD are proposed and implemented.

Floods

In the Mekong Delta, annual floods are always a part of the life of natural and people. Under the views of many farmers and scientists, floods are not only seen as a "disaster". There are multiple replenishing and revitalizing benefits from the rising of floodwater to the Delta. The Delta people are better prepared in current years for flood control thanks to the dyke building and irrigation development, as well as public awareness campaigns aimed at cutting child casualties. Closing dyke or August dyke may be act as crop protection. Crop damage has been minimal, given that the summer-autumn rice crop is almost complete when the floods hit.

An action plan for reducing the flood risks and keeping the flood benefits for sustainable development with the flexible spirits of "Avoiding the Floods, Living with floods and Controlling the Floods" was proposed as people's strategy and government's policy. Depending on the natural and social-economic conditions, floods can be controlled by both structural and non-structural measures.

Discussion and conclusions

Water in the MD is necessary to be considered in all of its aspects. Water resources should be monitored and controlled for both their quantity and quality corresponding to the economical and environmental development requirements. The changes in space and time of their characteristics need to be recorded to allow for a necessary balanced analysis. The water quality monitoring routines for decision making are suggested in figure 2.

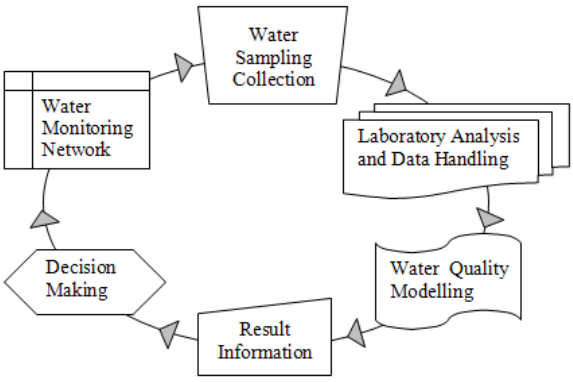

Figure 2. Suggested water quality monitoring routines

In principle, the water distribution according to the human demands can be solved by water balance problems and building the water control systems. However, in fact, the water distribution solution is not as good as expected due to the insufficient data of the changeable

water sources and the constraint of financial and human sources. In some cases, it is required to shift to from one kind of cultivated crop to another or to resettle the rural living and production for a less water consumption. Many human domestic activities, agricultural and industrial production have caused pollution of freshwater, intrusion of salinity, water logging of agricultural land, destruction of wetlands and loss of biodiversity in mangrove forest and coastal areas. These negative impacts are among of reasons holding back the social-economic development in the MD in the present and future. It is necessary to analyze the economic development purposes and health and environmental needs in water balance budget in planning stages. Each result should be presented fully in the public media to seek consideration and feedback

Although the amount of water on the delta is large, the capacity of clean water is finite in general and the demand is increasing. Therefore a sustainable water management should be incorporated in the targets of the country development as meaning water resources system has used to be efficient.

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References
MARD (Ministry of Agriculture and Rural Development, Government of Vietnam). (2003). Atlas of Some Selected Hydraulic Works of Vietnam. Hanoi, Vietnam.
Government of Vietnam. (2000). *Quyết định số 104/2000-QD-TTg ngày 25/8/2000 về việc phê chuẩn Chiến lược Quốc gia về Cấp nước sạch và Vệ sinh môi trường Nông thôn đến năm 2020*. Decision No 104/2000-QD-TTg dated August 25, 2000 on approving the National Strategy for Clean Water Supply and Rural Environmental Sanitation up to 2020 (in Vietnamese).
Hoanh, C.T., T.P. Tuong, K.M. Gallop, J.W. Gowing, S.P. Kam, N.T. Khiem and N.D. Phong (2003). Livelihood impacts of water policy changes: evidence from a coastal area of the Mekong River Delta. *J. of Wat. Pol.*, **5,** 475-488.
Miller, F. (2003). *Society-Water Relations in the Mekong Delta: A Political Ecology of Risk*. PhD thesis. University of Sydney, Australia.
Minh, L.Q. (2000). *Environmental Governance: A Mekong Delta case study with downstream perspectives*. CanTho University, CanTho, Vietnam.
Tuan, L.A., G. Wyseure, L.H. Viet and P.J. Haest. (2004a). *Water Quality Management for Irrigation in the Mekong River Delta, Vietnam*. International Conference on Agricultural Engineering, AgEng2004, Leuven, Belgium.
Tuan, L.A., G. Wyseure and L.H. Viet. (2004b). *Sustainable Water Management for Rural Development in the Mekong River Delta, Vietnam.* The second International Symposium on Southeast Asian Water Environment, Ha Noi, Vietnam.
Tuan, L.A. (2003). *An Overview of the Drinking Water Supply Situation in the Mekong River Delta, Vietnam*. Oral Presentation on the Workshop: Water Supply in the Mekong River Delta. CanTho University, CanTho, Vietnam.