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ADDRESSING WATER RESOURCES MANAGEMENT IN THE MEKONG DELTA

A Summary Report for the WPP Grant

WATER
PARTNERSHIP
PROGRAM

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Abbreviation and Acronyms

CPO	...	Central Project Office
DARD	...	(Provincial) Department of Agriculture and Rural Development
DONRE	...	(Provincial) Department of Natural Resources and Environment
DPC	...	District People's Committee
GoV	...	Government of Vietnam
GSO	...	General Statistics Office
IDMC(s)	...	Irrigation and Drainage Management Companies
IMC	...	Irrigation Management Company
IMT	...	Irrigation Management Transfer
IWRM	...	Integrated Water Resources Management
MARD	...	Ministry of Agriculture and Rural Development
MONRE	...	Ministry of Natural Resources and Environment
MPI	...	Ministry of Planning and Investment
MRC	...	Mekong River Commission
MDWRM-RDP	...	Mekong Delta Water Management and Rural Development Project
NWRC	...	National Water Resources Committee
O&M	...	Operation and Maintenance
PPC	...	Provincial People's Committee
SCADA	...	Surveillance, Control and Data Analysis
VNMC	...	Vietnam National Mekong Committee
WPP	...	Water Partnership Program
WUO(s)	...	Water User Organization(s)

Executive Summary

The Mekong Delta is the major pillar of Vietnam's agriculture, accounts for more than 25% of the national GDP, and is the origin of some 90% of its rice exports and 75% of fishery export value. With changing agro-climatic conditions, economic incentives and demographic patterns, and upstream development of the Mekong River, water resources management and development in the Mekong Delta has become more sophisticated and is facing a number of major challenges.

In 2010, the World Bank was provided a grant fund from the Water Partnership Program (WPP) to assist the Government of Vietnam, through the Ministry of Agriculture and Rural Development (MARD), with reviewing priority challenges, exploring opportunities and solutions, and developing programs to strengthen the capacity for water management investment planning and helping local farmers to start taking adaptation measures to address the possible impacts of climate change. Four studies were conducted by a national institution (Can Tho University) and international consultants, including (a) a Case Studies on local conflicts on land and water resources use; (b) Development of on-farm level pilot for better water resources management; (c) Agricultural Water management challenges; and (d) Review of the current institutional arrangements for operation and maintenance for water management infrastructure. These studies helped inform the design of the Mekong Delta Water Management for Rural Development Project (MDWM-RDP) Component 1: Water Management Planning and Efficient Utilization which is funded by the World Bank and is under implementation since June 2011.

This report is a summary report outlining the key findings of the four studies. The study demonstrated that timely technical inputs from national and international consultants could help ensuring synergy and timely integration of structural and non-structural measures into an investment project designed to improve the effectiveness of water resources management for rural development. The reviews also highlighted the urgency of strengthening the capacity of key agencies on policies, planning, operation and maintenance, and monitoring and evaluation so that the water resources development process becomes robust enough to accommodate adaptive management of water resources in line with changing on-farm demands while minimizing potential conflicts.

The following paragraphs highlight the overall conclusions of the four studies and indicate how they are integrated into the design of the MDWM-RDP:

a. As a result of the combined pressures of further agricultural intensification across the delta and uncertainty related to the impacts of the upstream development and climate change, revisions are necessary to the current approach of water resources planning, with a greater focus on both regional and local analysis.

b. Despite the uncertainty with regards to climate change impacts on agriculture, the following conclusions emerged from various discussions: (a) integrated and detailed knowledge is required of the water management requirements of all the main production systems, and performance of existing water management infrastructure needs to be carefully assessed; (b) climate change and upstream development will impact water regimes, and require changes in farming system and water management accordingly; and (c) improved, flexible and responsive institutional

mechanisms need to be developed to better manage existing conditions, the more so under the impacts of climate change and upstream development.

c. Given the need to meet socioeconomic development targets of the country, it is expected that over the next several decades Delta's agriculture development would undergo major structural changes, including land consolidation, changes in production patterns, mechanization, and further diversification of land uses. Major driving forces will include changing domestic market demand, price trends and consumer preferences in international food markets, rural to urban migration, increased non-agricultural use of land and water, technological change, and changes in the water regime due to upstream developments and climate change. Below outline key elements of future water management in the Delta in the context of these broader structural changes:

- *Infrastructure Investment.* There is a continued need for investing in water management infrastructure, particularly investment in the sluice gates at the secondary and tertiary levels to enable more responsive and flexible support the water delivery needs of to diversifying farmers. Further, major dredging works in the primary and secondary canals are also critical to fulfill their design conveyance capacity or to cope with new demands. An estimate suggests that the current conveyance is between 50 to 70 percent of the design capacity. The dyke systems also need to be reinforced to protect against salinity intrusion in the lower part of the Delta and mitigate flood risks. Dyke designs also need to be upgraded to allow the passage of vehicles and agricultural machinery; mechanization is increasing in response to rising labor costs and the need to raise product quality and reduce physical product losses associated with traditional manual practices.

- In light of the potential climate change impacts, MARD is considering a series of new major infrastructure investments, including several long coastal and river dykes and larger sluice gates at the major river mouth. In the process of planning such large scale infrastructure it is critical for the MARD to consider pertinent economic, environmental, and social aspects and to explore alternative strategies, including the introduction of adaptive agriculture and/or other adjustments in land use. Assistance is needed to screen emerging proposals and to consider alternative (and perhaps more cost-effective) strategies of climate change adaptation.

- *Increasing Water Productivity*. As fresh water during the dry season (and, to a lesser extent, during wet season) is likely to become increasingly unreliable and scarce, and as non-agricultural water demands grow, the risks of conflict over water are also likely to increase in the future. As increases in agricultural area are reaching their maximum limits, the focus of water management and agriculture should turn to increasing water productivity (i.e. the value of agricultural product per unit water used). Support could include both: (a) on-farm investments (such as land leveling, water distribution channels) as well as agronomic support services including improved land and water management systems and breeding of more productive, less water demanding crop and livestock varieties, and (b) off-farm investments (e.g., installation of Surveillance, Control, and Data Analysis (SCADA) systems).

- *Updating the Mekong Delta Master Plan.* The Mekong Delta Master Plan was prepared in 1994. Since that time, there have been tremendous changes in the Mekong Delta including the structure and scale of economic activities, changes in water use by different sectors, and the

development of varied infrastructure related to water resources. Additionally, many factors external to Vietnam have arisen including constructed and planned upstream dams and irrigation systems, pollution, and awareness of climate change. In updating the master plan, a pragmatic approach would be to target particular dimensions, such as infrastructure and water use by sector, and examine the 'robustness' of plan modifications in the context of various scenarios. This would subject the plan to various 'stress tests', identifying potentially vulnerable areas where agriculture could be adversely affected. Revisions to the plan could then initially focus on addressing those identified vulnerabilities across different water use sectors, including agriculture, water supply and sanitation, industrial uses and the environment.

- Given the complexity of the situations it is necessary to establish good and timely information management system and a flexible set of institutional arrangement for coordination between managers and users and amongst users with different needs so that the potential benefits can be maximized while minimizing the potential conflicts. The combined pressures of further agricultural intensification across the delta and the potential impacts of the upstream development and climate change on the water flows and water quality (mostly uncertain) will require effective coordination and cooperation among water planners, operators, and users to avoid further environmental degradation and safeguard remaining coastal resources critical for the delta.

d. While the Irrigation Divisions, Irrigation and Drainage Management Companies (IDMCs) and the provincial Departments of Agriculture and Rural Development (DARDs) have basic technical and administrative capacity to operate the water management infrastructure at the provincial or lower level, their capacity and the current institutional setting has to be upgraded to be able to effectively address expected climate change impacts and the diversified needs from various water users. The current system for water management provides for some integration between different water uses in the rural landscape (eg irrigation, aquaculture and drinking water) but is segmented along provincial lines; there is a need to develop a sub-regional analytical and planning framework for improved planning, monitoring, and coordination—especially to address water use conflicts/competition and manage large irrigation and/or flood control systems which span more than one province. In particular, the study recommends that:

- *Communication with water users:* there is a need to intensify the communication between the IDMCs and DARDs and the end water users. The water resources authorities are making infrastructure planning and management decisions based upon the 1994 Delta Master Plan and static land use considerations. Yet, water users are making strategic and dynamic decisions based on evolving opportunities (e.g., markets) and climate conditions. These differences could create conflicts between the water authorities and water users, and it is necessary for the provincial and district water resources authorities to communicate with the water users, providing information and forecasts about the availability of fresh water and patterns of salinity intrusion to facilitate their decision making, while the provincial and district water resources authorities need to consider inter-provincial flows and diversions of fresh water.

- *Strengthening capacity of Water User Organizations (WUO):* establishing WUOs is urgently needed to enable community water-related decision-making and improve on-farm water use efficiency. Diversified agriculture and aquaculture have already raised the risks for potential conflicts over water use (saline water vs. brackish or fresh water) within the same irrigation schemes. While the Government has adopted a policy on irrigation management transfer (IMT) and adopted a decree to transfer the responsibilities for managing the tertiary and quaternary irrigation facilities to WUOs, implementation has been slow. In the Mekong Delta, with the support of AusAID, 24 groups of WUOs have been established in An Giang Province on a pilot basis. The DARDs and IDMCs need to implement IMT to enable farmers to make collective decisions on water use, mitigate possible conflicts, and contribute to the overall management of the irrigation schemes. Further, attention also needs to be given to improving on-farm water productivity, especially in the context of scarce dry season fresh water availability.

- *Enhancing sustainability of investment:* In the short to medium terms, the Government will continue to finance a large part of the significant maintenance costs for irrigation systems from central and provincial budgets. Under such circumstances, several improvements to the current arrangements could be considered to improve financial transparency and cost-effectiveness of the current arrangements, including: (i) development of clear business plans to cover the financial, operational, and technical aspects of Irrigation Divisions/IDMCs or other management institution operations; (ii) monitoring at the national/regional level the performance of Irrigation Divisions/IDMCs based on a set of benchmarks; (iii) investment in Irrigation Divisions/IDMCs' logistics and systems to reduce operational costs; (iv) formulation of WUOs at the local level to manage lower system (tertiary and below) level irrigation, and be counterparts to the Irrigation Divisions/IDMCs to monitor the Irrigation Divisions/IDMCs' performance.

- *Improvement of efficiency and effectiveness of Operation & Maintenance (O&M):* to improve efficiency and effectiveness of O&M performance, the study identified the need to moving toward a fully integrated management approach that effectively links provincial irrigation management agencies and water users by providing technical assistance, logistical support, and capacity building on planning and operations. This approach will also leverage existing knowledge and institutional structures and result in modern irrigation management institutions and practices that improve water management, enable higher production in agriculture, protect against flood, and increase the ability to adapt to climate change impacts. Key activities of such an approach could include (i) technical assistance for organizational and business planning (staffing, functions, financial, contracting, performance monitoring), operations (expenditures, budgeting, procedures), and asset management, including design and training for a SCADA (Surveillance, Control, and Data Analysis) system; (ii) logistical support for the provincial irrigation management agencies (e.g. Irrigation Division, IDMCs, and Management Boards) including office renovations, equipment, vehicles; and (iii) Technical assistance on Participatory Irrigation Management to establish and/or develop WUOs in the participating

provinces, including initiation of performance based contracting processes between WUOs and provincial irrigation management agencies[1].

e. The findings of the local case studies further suggests that water resources interventions should focus on not only agricultural production but also water-related ecosystem services and on broader rural development, enabling job opportunities for the poor. There should also be support for improved farming practices such as organic fertilizer application for rice production or more adaptive farming systems (i.e. rotational rice-aquaculture or commercial integrated fruit-aquaculture systems) in the flood zone, appropriate adjustments of shrimp cropping season, using rice cultivars with salinity-tolerance and/or short-growth duration, other rice farming practices (i.e. potassium application), and salinity-removing ditches in paddy fields.

f. Integration, participation and decentralization are key elements for successful management of water resources in the future of Mekong delta. The main purpose of water resources management projects should be not solely agricultural production improvement but crop water productivity, household livelihoods and in broader perspective – rural development. To achieve this, attention should be paid to promote a combination of structural and non-structural measures through close consultation among key stakeholders through a participatory planning process. Activities in the Delta should be designed to meet the local needs and contexts and be integrated with local development plans to maximize investment efficiency. Local farmers and stakeholders should actively participate in the project life cycle, from planning to implementation, monitoring, evaluation, improvement and extension. Enhancement of public-private partnerships is of great importance.

[1] These recommendations were incorporated into the design of the Mekong Delta Water Management and Rural Development Project, Subcomponent 1-2

SECTION I: WATER MANAGEMENT IN THE MEKONG DELTA: CHALLANGES AND INSTITUTIONAL RESPONSIBILITIES

1.1 Background

1. The Mekong Delta (MKD) is the major pillar of agricultural production in Vietnam, and the origin of 90 percent of the country's rice exports and 75 percent of the total fishery export value. Great investments in land and water development in the Delta have allowed substantial intensification of production to feed a nation, while also providing employment and livelihood opportunities for its population. Yet, the MKD is currently faced with numerous challenges, including a changing agro-climatic environment, significant upstream water resources developments in the wider Mekong River Basin, changing demographic patterns and accelerated urbanization processes, and diversified economic incentives for production as a result of changing macro-economic policies. All of the above poses considerable stress and added complexities on the sustainable management of water and related land resources in the Delta.

2. In 2010, the World Bank was provided a grant from its Water Partnership Program (WPP) to assist the Government of Vietnam, through the Ministry of Agriculture and Rural Development (MARD), to review priority issues in the Mekong Delta, explore options to cope with these new challenges, and discuss and prioritize adaptation measures to address changing water management challenges including anticipated climate change impacts. This report summarizes key findings of the analytical work carried out under this program, and highlights the most critical findings alongside recommendations elaborated jointly by participating parties: government agencies at national and provincial level, national and international experts, and farmer representatives.

3. The Mekong Delta covers an area of approximately 5.9 million hectares (ha) of the southern parts of Cambodia (2 million ha) and Vietnam (3.9 million ha). The Vietnamese parts of the Mekong Delta (the Delta) comprises 12 provinces and one municipality (Can Tho) with a total population of 17.7 million people[2]; 22 percent of the national total. To date, 63 percent of the land surface of the Delta is used for agricultural production.

4. The population density in the Delta is among the highest in the country[3] at 436 person/km², and agriculture remains among the most important sources of income in the region with roughly 80 percent living in rural areas. And while the poverty rate has declined over the past years, the average monthly income per capita remains below the national average, and significantly below the Southeast. Available statistics indicate, that in the MKD, the share of the monthly income per capita derived from agriculture activities is around 37.7 percent, significantly higher than the national average (24.8 percent)[4]. At the same time, analysis has shown that the rate of underemployment in

[2] General Statistics Office (GSO) 2008.
[3] Only the Red River Delta and the Southeast Region show higher densities.
[4] GSO 2006; GSO 2008.

the Delta is also higher than the national average which contributes to significant shifts in the composition of rural labor and livelihoods[5].

5. During the last two decades, rice production in Vietnam has almost doubled, thereby moving the country from being food insecure to one of the largest exporters of food stuff[6]. Most of the production gains can be attributed to increases in land productivity achieved by more intensive agricultural production. Much of this increase can also be attributed by the developments within the Delta. For long, the Delta has been a major producing area for rice, dating back to efforts in the last two centuries. But while rice production in the area stagnated in the 1960s and 1970s (due to war and the subsequent low incentives associated with collectivized agriculture), the *Doi Moi* reforms, introduced in the late 1980s, have spurred significant achievements in terms of achieving higher levels of agricultural production and productivity; particularly in the Delta which accounted for about two-thirds of the country-wide expansion in rice production[7].

6. As in other deltaic environments in Southeast Asia, the livelihood of people is strongly related the flow of rivers, the seasonal variations and the development and management of available water resources. The Delta is characterized by two distinct flow seasons: a high season from June to November and low flows from December to May. And while the upper parts of the Delta suffer from floods during the rainy season, coastal areas are impacted by salinity intrusion during the dry season. Flood and salinity control infrastructure, as well as irrigation infrastructure, extensively shape the Delta's water use regime associated with the agricultural production systems that have been promoted, including intensified rice monoculture. More than 5000km of canals exist in the MKD, a substantial amount of large-scale saline water protection schemes to limit saltwater intrusion, and an impressive amount flood protection works, dykes and pumps to manage the waters of the Delta. The combined positive impacts of these interventions range from its significant contribution to the national rice surplus, to its role in poverty reduction and social stability and the importance of export earnings. Yet, and despite the achievements of the past, the Vietnamese Mekong Delta is now faced with substantial new challenges: partly resulting from changes and developments at a regional and global scale; and partly as a result of the legacy of the country's own policies and interventions.

7. There is a general consensus that the Delta is among the world's most vulnerable environments to the impacts of climate change. While the potential impacts of climate change are both long-term and complex (cutting across all different economic sectors and the environment), it is recognized that the impacts on agriculture will be particularly profound. In 2009, the Ministry of Natural Resources and Environment (MONRE)[8] published the most recent climate change scenarios for the country, and projected that the annual average temperature will increase by 0.6°C in Southern

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[5] Huy H. T. and Khoi L. N. D. (2011). Analysis of Labour Migration Flows in the Mekong Delta of Vietnam. In M. Steward and P. Coclanis (Editors): Environmental Change and Agricultural Sustainability in the Mekong Delta. Advances in Global Change Research 45. Springer

[6] Vietnam currently accounts for more than 20 percent of world rice exports.

[7] For a summary of recent rice production in the MKD see e.g. Jaffee S. et al. (2011). From Rice Bowl to Rural Development: Challenges and Opportunities Facing Vietnam's Mekong Delta Region.

[8] MONRE (2009). Climate change, sea level rise scenarios for Vietnam. Ministry of Natural Resources and Environment, Hanoi.

Vietnam by 2030; 0.5 - 0.6°C in the dry season and 0.6 - 0.7°C in the wet season. At the same time, annual precipitation is projected to increase by 0.4%, but with less rains in the dry months from December to May, leading to a sharper seasonality and increased variability. The same report indicated that the sea level could rise by around 17 cm by 2030 and up to 75 cm by the end of the century.

8. In the MKD, one of the key concerns with regards to climate change is related to the impact of the flood regime that nourishes the floodplains. Changes in annual and seasonal precipitation across the Mekong River Basin are projected to change the flood hydrology. One estimated change could be an increasing trend in the annual maximum water depth and flooded area during the average and the driest years. In addition, irregular rainfall is considered a particular threat to agriculture, particularly for the summer-autumn rice crop season[9], as dry spell events during the early season are project to increase; June/July coincide with critical crop growth periods where water demand by rice is significant. This raises the potential for reduced crop yields and crop damage, while it also could result in higher production cost for farmers, as the reduced rainfall would need to be compensated by other water sources which would require to pump water from different sources (canals, ponds or groundwater)[10]. At the same time, impacts of climate change will potentially also include (a) higher evapotranspiration as a result of increased average maximum temperature (during the dry season), (b) further salinity intrusion as a combined result of changing upstream flows and rising sea water levels; (c) declined secondary crop cultivation and freshwater aquaculture affected by declining water availability of freshwater inflows into the Delta (both a result of increased upstream diversions and reduced run-off because of climate change), and many other secondary impacts with detrimental impacts on water resources and agricultural production in the Delta[11]. It has been projected that the combined effect of sea level rise and changing flooding patterns will result in a direct net loss of arable land in the Delta; MONRE (2009) estimated a sea level rise of 30 cm by 2050 and of about 75 cm by the end of the 21st century. This is very significant as analysis has shown that a sea level rise of about 20-40 cm would affect all three rice cropping seasons by limiting the number of rice crops per year[12].

9. At the same time that climate change impacts will become more pronounced, current and planned upstream developments in the Upper and Lower Mekong Basin are projected to substantially

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[9] The cropping season for this crop starts in April and harvest is generally around August.

[10] TKK & SEA START RC (2009). Water and Climate Change in the Lower Mekong Basin: Diagnosis and Recommendations for Adaptation. Water and Development Research Group, Helsinki University of Technology (TKK) and Southeast Asia START Regional Center (SEA START RC), Chulalongkorn University. Espoo, Finland.

[11] Such secondary impacts include for example the Water and Sanitation Sector. A recent study commissioned by the World Bank assessed climate change vulnerability in the Water and Sanitation Sector in Ben Tre Province, and suggests that the highest risk from climate change for the WSS sector in Ban Tre are associated with seawater level rise and the possible increase of salinity. Additional risks identified with the study included the impacts to water treatment facilities (through increased corrosion rates) and to the livelihood systems highly dependent on agriculture activities. (AECOM 2012. Climate Change Vulnerability in the Water and Sanitation Sector: Ben Tre Province, Vietnam. Water and Sanitation Program. World Bank)

[12] A recent summary of impacts induced by climate change are collected in Steward A. M. and Coclains P. A. (Editors): Environmental Change and Agricultural Sustainability in the Mekong Delta. Advances in Global Change Research 45. Springer.

change the hydrology of the Delta, as increased investments into irrigation and hydropower (as well as broader patterns of economic development), are likely to have implications on the availability, timing and quality of water reaching Vietnam. For example, China has developed six dams in the mainstream Mekong; Lao PDR plans to develop as many as 40 hydropower stations both in tributaries and the mainstream Mekong; while Cambodia intends to develop several large-scale irrigation schemes within its own section of the Mekong Delta. While the cumulative impacts of these developments are still not fully understood and uncertainty remains, yet it becomes apparent that there will be substantial impacts on flow regime. A recent study, for example, estimated that increases in irrigated land in upstream country and 42 near-future hydropower dams may reduce rice productivity by 170,000 tons; under a low flow scenario up to 200,000 tons; much of this reduction is associated with the increasing levels of salinity intrusion[13]. Such a decline would present roughly 1% of the total current production. And while the most upstream dams on the Mekong river are not likely to greatly affect the quantity of water reaching Vietnam, they may significantly reduce and/or alter the amount and composition of sedimentation[14], which could trigger increasing levels of coastal erosion of the river mouth. Further, increased dry season abstractions to supply the augmented areas of irrigation upstream could reduce dry season flows into the Delta, accentuating salinity intrusion.

10. Importantly, salinity intrusion impacts in the MKD go well beyond impacts on crop production and aquaculture, and includes important impacts on water supply and sanitation as a large part of the population in the Delta still accesses surface water resources for household consumption In addition, increased levels of salinity intrusion could contribute to further deterioration of groundwater quality which is also a significant source of freshwater in the area. (Box 1).

Box 1: Climate Change Vulnerability in the Water and Sanitation Sector

A recent and on-going study commissioned by the Water and Sanitation Program - World Bank15 assessed climate change vulnerability in the Water and Sanitation (WSS) sector in the Mekong Delta (Ben Tre Province), and suggests that the highest risk from climate change for the WSS sector in Ben Tre is associated with seawater level rise and the possible increase of salinity. Additional significant risks identified during the study included the impacts to water treatment facilities (through increased corrosion rates). While the project is still ongoing, and recommendations are still being finalized, preliminary findings suggest that (a) climate change impacts to the WSS sector should be considered as an integral part of finding solutions to both new developments as well as for upgrading existing systems, and should not be treated in isolation of the important challenges that the sector faces because of other environmental pressures; (b) a high level of uncertainty on the impacts of climate change to the WSS sector persists; (c) it is appropriate to start implementing adaptation measures for potential climate change, but such initiatives should not be part of a stand-alone strategy; and (d)

[13] Toan T. Q., Trung N. H. and D. K. Nhan (2011). The Mekong Future Project: First Draft Report on the Hydrological Simulation.

[14] Chinese and Lao dams may increase dry season flows, but significantly reduce the sediment and somewhat reduce the wet season flows; Cambodia irrigation schemes would reduce the flood risks, but also reduce the dry season river flows.

[15] AECOM (2012). Climate Change Vulnerability in the Water and Sanitation Sector: Ben Tre Province, Vietnam. Water and Sanitation Program. World Bank

above all, it will become increasingly important to look at the WSS sector in relation to wider water resources management challenges in the Delta.

11. But while the combined effects of climate change and upstream developments are looming on the prospects of the MKD, significant changes internally are equally profound; in terms of quality quantity and timing.

12. Growing urbanization and industrialization in the central and eastern parts of the Delta is threatening the quality of water available for both agricultural and domestic uses. This is already visible in parts of the Delta, such as My Tho in Tien Giang Province, where there are rising water quality concerns in the export-oriented horticulture production. In general, while water resources development has provided the hydrologic environment supporting the intensification achieved in irrigated agriculture, the productivity gains would not have been possible without a significant shift in input use, and the enhanced use of agro-chemicals including: (a) fertilizer and pesticides in rice production; and (b) processed feed, pesticides, and veterinary drugs in the aquaculture sector. The extensive use of such inputs has been recognized as a source of environmental degradation and pollution. Associated with this are water quality concerns that are rising in importance, as much of the water quality problems are a result of the runoff of agro-chemicals into surface water bodies[16], which serve rural people as the most important source for their daily water needs[17].

13. At the national and provincial levels, official targets continue to be set on the area of land to be put under paddy and overall rice production. Yet, land and associated water use is significantly shifting, as farmers in the Delta seek higher economic returns from non-rice crops including shrimp aquaculture and rice/fish poly-culture. This shift has been stimulated by both the attractive economics of shrimp/fish production (both for domestic and export markets), and the changes to the agro-ecological environment, as the availability of freshwater and patterns of salinity intrusion are influencing the viability and economic rational of farm enterprises. This shift in cultivation, and the resulting differing production environments - away from monoculture rice production - triggers fundamentally different water requirements with regards salinity levels and freshwater inflows, with water managers stretched to fulfill the heterogenic water demands. This includes important issues such as (a) upstream-downstream water competition, (b) the impacts of acid sulphate soil reclamation, (c) water conflicts within the coastal zone, and (d) constraints to accessing and sharing of water[18].

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[16] MRC/WUP-FIN (2006). Mekong Delta Socio-Economic Analysis: Hydrological, Environmental and Socio-Economic Modelling Tools for the Lower Mekong Basin Impact Assessment. Mekong River Commission and Finish Environment Institute Consultancy Consortium. Vientiane, Lao PDR.

[17] In response to this challenges, the government has promoted a campaign "Three reductions and three gains" which aims to reduce inputs, reducing fertilizers, seeds and insecticides. The core idea of the campaign is to introduce more environmentally friendly practices (thereby also improving farmers' health), while at the same time allowing farmers to harness short-term economic benefits through higher (and more sustainable) yields.

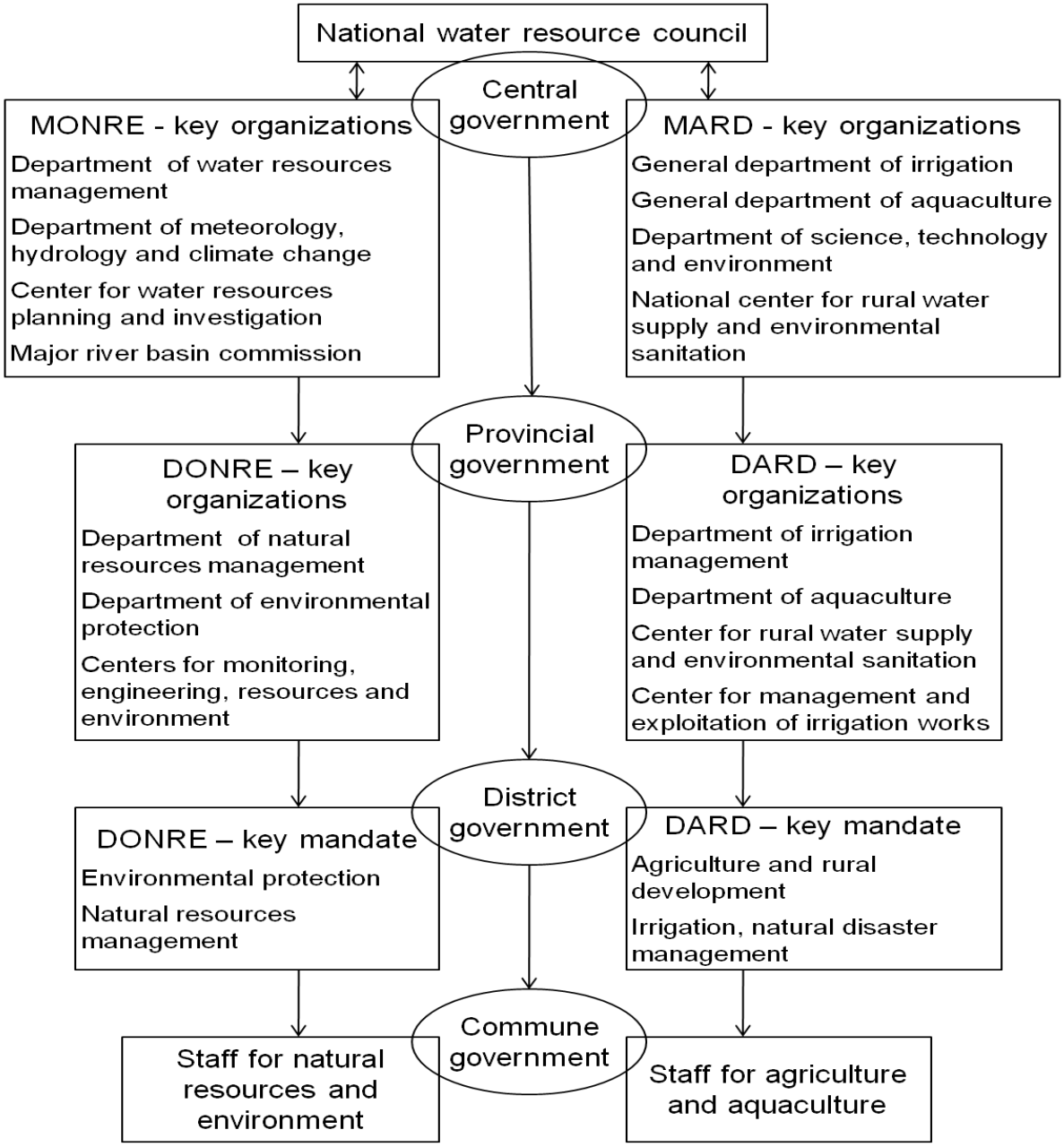
[18] See for example: Nhan D. K. et al. Water Use and Competition in the Mekong Delta, Vietnam. SUMERNET Mekong Delta Monograph, Chapter 4.

14. Managing and maintaining the hydraulic infrastructure on which the production in the MKD relies, also comes at substantial costs. In early 2008, the Government of Vietnam has abolished irrigated charges from farmers, while operation and maintenance being largely financed through government budget, except fees covered by on-farm facilities. Yet, in the meantime, the canal system and installations required periodic maintenance (including dreading of sedimentation in the canals), which is not sustainably accounted for under current cost-sharing arrangements.

15. At the national level, three key organizations are involved in water resources management include the Ministry of Agriculture and Rural Development (MARD), the Ministry of Natural Resources and Environment (MONRE), and the National Water Resources Committee (NWRC). At the provincial level the two most dominant organizations are the (provincial) Department of Agriculture and Rural Development (DARD) and the (provincial) Department of Natural Resources and Environment (DONRE) at local level (see Figure 1). The NWRC has been established to advise the government on water resources management and solve conflicts between ministries and also between ministries and provinces associated with water resources management. Under MARD, key departments include (a) the Department of Irrigation; (b) the Department of Agriculture and Rural Development (especially its Directorate of Water Resources and the Directorate of Fisheries Aquaculture); (c) the Bureau of Plant Protection; (d) the Bureau of Agriculture Extension; (e) the Rural Water Supply and Environmental Sanitation; and (f) the Department of Science, Technology and Environment are also relevant to water resources management. MARD is responsible for management of water-related sectors such as agriculture, forestry, aquaculture, salt production, irrigation systems, rural water supply, dike management and disaster management. The Central Project Office (CPO) under MARD is responsible for the preparation and management of various investment projects, mostly fund by international donors.

16. MONRE is a relative new agency compared to MARD. MONRE is also responsible for land administration, environmental protection, hydro-meteorological services and the oversight for mineral resources, water resources, coastal resources and offshore islands. Under MONRE, key agencies as related to the water sector are (a) the Department of Water Resources Management, (b) the Department of Hydro-meteorology and Climate Change, (c) the Center for Water Resources Planning and Investigation, and (d) the River Basin Commission. MONRE through its Vietnam National Mekong Committee (VNMC) also serves as the national focal point for the Mekong River Commission (MRC), which is an intergovernmental organization to manage overall water resources in the mainstream of the lower Mekong Basin.

Figure 1: Organization structure of water resource management


National water resource council
Central government
MONRE - key organizations
Department of water resources management
Department of meteorology, hydrology and climate change
Center for water resources planning and investigation
Major river basin commission
MARD - key organizations
General department of irrigation
General department of aquaculture
Department of science, technology and environment
National center for rural water supply and environmental sanitation
Provincial government
DONRE – key organizations
Department of natural resources management
Department of environmental protection
Centers for monitoring, engineering, resources and environment
DARD – key organizations
Department of irrigation management
Department of aquaculture
Center for rural water supply and environmental sanitation
Center for management and exploitation of irrigation works
District government
DONRE – key mandate
Environmental protection
Natural resources management
DARD – key mandate
Agriculture and rural development
Irrigation, natural disaster management
Commune government
Staff for natural resources and environment
Staff for agriculture and aquaculture

17. Under the guidance of the respective Provincial People's Committees (PPCs), provincial DARDs are responsible for planning and implementation of agriculture and rural development measures. Provincial Irrigation Divisions and/or Irrigation and Drainage Management Companies (IDMC) under the DARDs are responsible for O&M of irrigation and flood control systems within their respective provinces. At the on-farm level, while the Government adopted a policy to promote participatory irrigation management through establishment and strengthening of the WUOs, the implementation of this policy in the MKD has not been fully started.

18. There are other organizations involving in water resources management and the key ones are (a) River Basin Organizations, (b) Research and education institutions, (c) the Hydraulic Engineering Consultants Corporation II, (d) irrigation and drainage management companies, and (e) civil society organizations.

19. What is undeniably apparent from the above is the significant challenges that water users and managers in the Delta currently face on multiple levels: the uncertainty of climate change and pace of upstream; the economic shift triggered by changes in macro-economic policies, including changing land use patterns and urbanization; and deteriorating water quality. To address some of the challenges, a WPP Grant has been used to help key stakeholders, including the government (particularly MARD), village level authorities and farmers to jointly identify their particular priority issues related to water management and climate change and develop a set of actions to be supported by a water resources management project in the Delta, which would be financed by the Bank. In implementing the Grant, the following four issues have been considered to be critical to address climate change impacts:

(a) Water resources infrastructure planning. The current water infrastructure planning is in principle based on the Mekong Delta Master Plan developed in 1992, with the current water management planning being undertaken at the provincial level. In the light of the uncertainties, including climate change, the master plan will have to be reviewed and revised; however, as there are many interrelated factors (e.g., climate change, upstream development, and urbanization), it was found to be more appropriate to examine the robustness of the current master plan vis-à-vis anticipated impacts first, rather than preparing a new master plan straight away. Further, the current provincial level water management have to be further integrated, at least sub-regional level (e.g., western, central, and eastern parts of the Delta), to better account for upstream and downstream impacts.

(b) Conflict over land and water use. At this moment, there is no serious water shortage in the Delta, and conflict among the farmers over land and water use is predominantly at the local level. Nevertheless, the increasing water demand, partly due to climate change, would result in more serious water shortage and intensifying competition over the available water resources among farmers. It was there therefore considered important to assess the current situation with regards to water conflicts, understand the root cause of such conflicts and explore possible solutions.

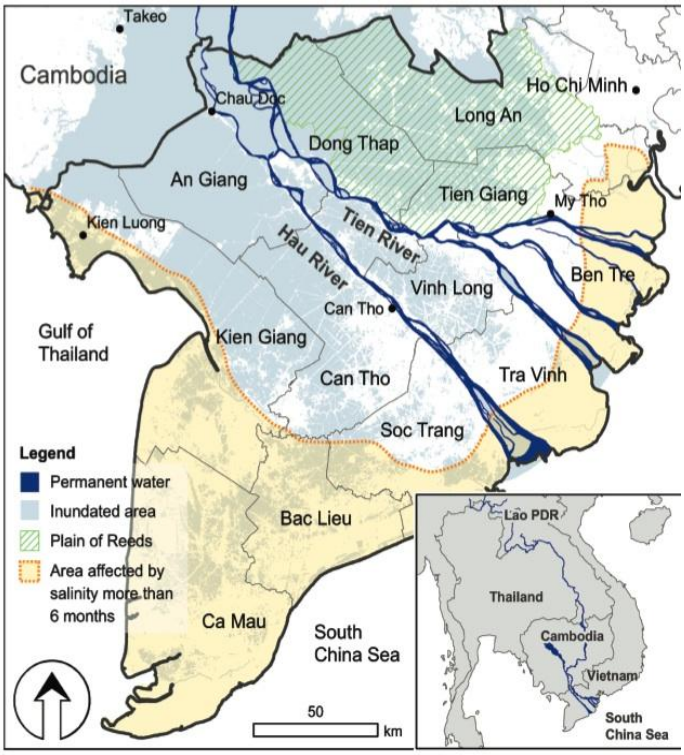
(c) Operation and maintenance. Irrigation is key in the Delta to mitigate the shortage of dry season freshwater to enable rice production, while it also is required for shrimp aquaculture to regulate salinity levels in the brackish water environment. In fact, since the establishment of the Socialist

Republic of Vietnam, significant investment have been made to develop networks of canals in the Mekong Delta. However, operation and maintenance of these canal networks is a challenge for the Government. First, a huge amount of sediments are deposited within the canals every year (estimated 140 million cubic meter Second, because of the openness and multi-use of the canal networks, it is extremely difficult to charge tariffs from water users for particular uses. As a default, the operation and maintenance has been carried out solely under the Government's financing. Proper O&M and maintaining the design conveyance capacity of the canal is a pre-requisite to mitigate climate change impacts, and the study has reviewed the current setting for the operation and maintenance and explore some possible improvements.

(d) On-farm water management. The MARD has focused almost exclusively on off-farm infrastructure (main, primary, secondary, and tertiary canals and sluice gates) for public investment. However, experiences in other deltas (e.g., Egypt) suggest that improved on-farm water management would be most critical to increase the efficiency of water use. Considering the possible shortage of freshwater in the dry season, it would also be important to start exploring options at the on-farm level, through infrastructure and technical assistance, to increase water productivity. The Delta has a few distinct agro-ecological zones based on soil and water availability, and a part of the WPP Grant has been used to identify possible on-farm water management pilot programs with participation of farmers at different locations.

20. *Objective of this Report.* The Sections II, III, IV and V below summarizes the outcomes of the above-mentioned studies. Map 1 shows the Delta and an overview of the distribution of fresh and saline water.

Map 1: Mekong Delta; distribution of fresh and saline water, and provincial boundaries.



SECTION II: WATER RESOURCES PLANNING CONSIDERATIONS

21. This section summarizes the findings of a study on agricultural water management challenges, carried out by an international consultant (Mr. Hugh Turral), aimed to review existing provincial plans of the six provinces located in the western part of the Delta. The focus was on the current practices of the Department of Agriculture and Rural Development (DARD) on water resources management regarding (a) technical and economic consideration, (b) environment and social issues, and (c) potential impacts of climate change, including making recommendations to identify priority actions related to technical assistance and capacity building in light of upstream development and climate change adaptation which could lead to the development of climate-smart provincial water management plans, and a portfolio of key investments for the future. Overall conclusion and key findings are highlighted below.

22. *Key Findings*. In the future, the Delta will remain to be the main a critical area for agricultural production for the country and will play remain its important role in ensuring national food security (and rice exports). Some 1.8 million hectares of agricultural land is currently reserved for rice production, expansion of aquaculture and fruit production will likely continue, and agro-industrial development will be promoted. How well these policies are going to be implemented could depend on the capacity of the Government and farmers to be responsive to the changes in water flow regime due to upstream development and climate change ; let alone the policy to increase productivity, competitiveness, and living standards in the Delta. Key challenges are as follows:

(a) Rural development and poverty reduction is priority in the Delta: Some studies suggested that poverty in the Mekong Delta appears to be connected to two main factors: (i) indebtedness and (ii) ethnicity. A significant proportion of the poorest segment of society is landless and derives their livelihoods from laboring (often seasonal) and capture fisheries in wetlands and coastal zones. Landlessness is increasing, particularly when farmers try to intensify or diversify their production system, fail, borrow money and sell their land use rights. A significant proportion of the poor are from ethnic minorities, notably the Khmer. Although the poverty rate is low, many farmers are considered to be marginal, and could easily be reclassified as poor under changing conditions. Despite relatively high prices for rice, many farmers fail to make adequate incomes from rice production as production costs are high, even after water charges and other taxes have been abolished. In general, it is anticipated that any change in water resources management will have a relatively greater impact upon the poorest.

(b) Complexity of the water resources regime in the Delta and potential impacts due to acid-sulphate soil: Conditions in the Delta are complex and development pressure has already been high. It experiences flooding and sedimentation from the Mekong River, highly seasonal rainfall, and salinity intrusion from the surrounding seas. Moreover, the area is underlain by acid-sulphate soils, which present little problem if inundated or saturated by saline water which has three times the buffering capacity of freshwater. If potentially acid-sulphate soils are exposed to air, they ripen and liberate large quantities of acid into solution lowering pH to less than 3.5 in streams as well as in the parent soils. Acid-sulphate soils are generally overlain by deposited river sediments that may be up to several meters thick, but digging canals and excavating embankments may expose acid-sulphate soils that then generate acid runoff. Typically, acidic flushes are generated

by the first rains in the wet season, mostly from exposed dry acid soils. Where it is possible to maintain flooded conditions, even with fresh water, potentially acid-sulphate soils can be used for rice production. Development effort has been made in the acid-sulphate soils areas (Plain of Reeds and Long Xuyen quadrangle) and the experience suggested that the process will take years of draining and leaching of toxic acidification, reclamation, and treatment with large applications of lime. Vietnamese scientists have also progressively mapped acid-sulphate soils, saline intrusion, freshwater zones and developed supporting computer software (such as VRSAP) to model the hydrodynamics and salt transport of natural and man-made waterways in the Delta. Although salinity can be well modeled and monitored, it is much harder to simulate the behavior of acidification in soils and waterways.

(c) Potential benefits and water use conflicts: Past development has resulted in a large canal network with sluices operations (mostly primary) and there are potential land and/or water use conflicts due to poor management of water resources. Conflicts over water management arise due to the complex boundaries between freshwater, brackish water, and saline water systems, and the different needs for water quality (and volume) for different agriculture production. For example, rice-shrimp farmers need brackish water conditions in the dry season and require access to salty water that can be pumped from canals and rivers. If saltwater penetrates into intensive rice growing areas in the dry season, then yields decline and crops may be lost. It is necessary to open the sluice gates to release saline, stagnant or polluted water and allow new fresh water in from the Hau River. These releases need to be carefully coordinated with downstream, high value shrimp producers, who do not want their ponds polluted by agrochemicals, or even too much fresh or weakly saline water.

In Ca Mau, Bac Lieu, Soc Trang region of the Delta, soils are too acid to allow rice cultivation, however extensive cultivation of fish and shrimp is possible, provided brackish water is available, and some lime is applied. Where soils are neutral enough to grow rice in the rain season, but acidity rises in the dry season, it is possible to produce fish and shrimps (extensively) in rice paddies in the dry season (Rice-Shrimp). On the coast, and downstream of sluice gates, it is difficult to control salt water intrusion and thus brackish water production systems, mostly intensive shrimp, are most appropriate. There has been an economic revolution on shrimp culture (P. monodon) for export, but the production system remains considerably more diverse than in Thailand, with only about 15% of producers classified as intensive industrial enterprises. The largest numbers of farmers are extensive rice-shrimp farmers (~40%) and “intensive” family farms (~40%). The pattern of farming systems is dynamic and changes in production system occur rapidly.

(d) Decision Making: the reviews suggested that the provincial authorities have been making investment and management decisions without good knowledge on the broader longer term consequences of upstream developments and the climate change impacts on agriculture, and their longer term environmental impacts (e.g. on water quality/ quantity, erosion, land fertility) of intensive agriculture/aquaculture. Key environmental and social issues included the presence of acid sulfate soil; salinity intrusion; heavy rainfall, flooding, and sedimentation; degradation of mangrove; coastal erosion; degradation of water quality due to development activities, including expansion of agriculture and aquaculture; potential conflict in land and water uses, including

those related to construction of dykes and canals and operation of the sluice gates; and poverty of ethnic groups, mainly Khmer. Although no climate change impacts have been estimated on agriculture, aquaculture, forestry and natural environment in the Mekong Delta to date, it is likely that climate change impacts to the poor will be substantial.

(e) Upstream Developments and Climate Change Impacts on the Delta: There are three type of impacts that will likely affect the Mekong Delta: (i) changes in flow regime of the Mekong River, which will be coupled with future development of the Mekong River upstream dams (for hydropower and irrigation) and increasing water abstraction as well as diversion for irrigation in Thailand, Laos and Cambodia; (ii) impacts of sea-level rise on inundation and saline intrusion in the Delta; and (iii) impacts of higher temperatures and rates of evapotranspiration. This will lead to higher crop water demand and likely lower (potential) crop water productivity. Although various studies have been carried out by the Mekong River Commission (MRC) and several Vietnamese institutions, consistency and agreement among these studies needs to be further improved.

(f) Environmental Protection and Management in the Western Delta: the environmental impacts of current rural development, such as hydraulic control, the expansion and intensification of rice agriculture, expansion of aquaculture and shrimp farming, are all likely to be exacerbated by climate change. Agriculture, human settlement, navigation and road networks will inevitably reduce and/or change natural habitat and its associated bio-diversity. In the Delta, the expansion and intensification of rice cultivation and the associated canal, dike and sluice infrastructure have been the major causes of all these changes directly and indirectly. Natural wetland has been cleared with significant changes in flora and fauna, and subsequent agrochemical use (fertilizers, pesticides and herbicides) has impacted aquatic communities and eco-systems further downstream. Irrigation and water control infrastructure has blocked the passage of migratory species and altered their dynamics. Irrigation canals and ring dykes have been superimposed on networks of canals that were originally designed for navigation; the largest example being Quan Lo Phung Hiep. Fresh water, transferred from the Hau (Bassac) River has been transported westwards mixing in different patterns with salt water moving eastwards from the West Sea and northwards from the East Sea. The difference in tidal ranges and reaches of these two seas result in a complex distribution of the brackish-freshwater boundary and operation of sluice gates which have been installed (for partial control of flood and salinity intrusion) could significantly change hydrology and water quality and can create significant impacts on the downstream water users. Two major challenges include:

- *Drainage of acid sulphate soils* by leaching method (such as in Long Xuyen Quadrangle) can result in acidification of waterways and adjacent land uses. Upstream water use in the dry season can also contribute to a higher level of dry soil conditions in the acid sulphate soils area, leading to ripening and consequent acid flushes at the beginning of the rainy season. The potential impacts of such conditions in the future can be estimated by understanding the impacts of upstream development (increased dry season flows, due to storage release for hydropower generation), climate change scenarios and associated changes in agricultural water demand and use.

- *Coastal clearance of mangroves* to grow rice, which in turn has often transformed into shrimp ponds, has increased the vulnerability of the shoreline to erosion and deposition of sediment, especially to tidal and storm surges. Increased frequency of extreme events will be of greater concern than average sea level rise, especially in terms of the penetration of salinity into the interior of the delta. Storm surges are rare in the Mekong (one in 2000 and one in 2006 were recorded), but their frequency is likely to increase under climate change. In recent years, significant money and energy has been spent on coastal zone management and on the plantation of mangroves to both protect the natural coastline and the high value shrimp economy. However, it is too early to assess the benefits of mangrove plantation, and harder to predict their resilience and ability to mitigate sea level rise in the future. A few natural parks and bird sanctuaries have been established in the western part of the MKD, mostly Melaluca forests which are tolerant of acid sulphate soils.

SECTION III: REVIEW OF THE CURRENT INSTITUTIONAL ARRANGEMENTS FOR OPERATION AND MAINTENANCE

23. An international consultant (Mr. Eric Biltonen) was engaged to conduct a quick review on the current institutional arrangement for operation and maintenance (O&M) of irrigation infrastructure. The consultant found that conducting an expenditures review on O&M to establish a benchmark for monitoring is not possible at present due to the lack of data. However options for the future cost sharing for O&M including the establishment of a separate funds similar to the road maintenance funds was explored. The overall conclusions and key findings from this study are summarized below.

24. *Key findings.* The provincial-level DARD and the Irrigation Drainage and Management Companies (IDMCs) are the two main institutions responsible for O&M in the Delta. DARDs are the provincial level office of MARD and they are the technical agency with oversight responsibilities of irrigation management. They review plans, budget requests, and special requests for O&M from the IDMCs and then forward them to the Provincial Peoples Committees for final review and approval. The IDMCs are tasked with actual carrying out irrigation operations and maintenance. They work with the DARDs, districts and communes to develop the actual plans and estimated budgets for O&M. IDMC were formed back in the 1970s, and their status currently ranges from 100 percent state owned, to joint stock, to 100 percent privatized company. The degree of privatization affords them increased flexibility in expanding potential revenue generating activities.

25. Below highlights key aspects affecting organization structure and performance:

(a) Institutional arrangement for O&M operations in Vietnam are determined by law, from national level ordinances and decrees to local level laws. These laws specify function, responsibilities and tasks of the different irrigation management institutions including the operations and maintenance of irrigation infrastructure. Perhaps, the most important recent law affecting O&M in Vietnam is Decree 115/2008/ND-CP Detailing the Implementation of a Number of Article of the Ordinance on Exploitation and Protection of Irrigation Works. Decree 115 essentially abolished irrigation fees though a clause with a wide ranging set of exemptions. It further established that IDMCs would receive budgets from the state and local government according to established irrigation fee that were now exempted.

The most obvious impact of this decree was to remove from IDMCs one of the most obvious potential means for generating revenues through the provision of a service. Decree 115 raises several issues. First, IDMCs are (generally) transformed into service providers for a public good and dependence upon state subsidies to operate. Second, abolishment of the fee removes a potential important tool for encouraging efficient water use. Nevertheless, the IDMCs reported that the budget situation had in general improved after Decree 115 due to low collection rates of irrigation fees before the Decrees. The rationale behind the new law was that irrigation canals, bunds and dykes perform a range of public good functions; they perform wider water regulation functions and are widely used fir transport. Furthermore a large portion of maintenance requirements (eg for much of the dredging) are caused by impacts

upstream of particular irrigation systems, and their costs should not necessarily be borne by farmers.

(b) The institutional arrangements for O&M in the Delta are fairly consistent across provinces with only minor differences. Based on information and data gathered from DARDs and IDMCs, an institutional analysis was conducted with an aim to find ways to improve both the effectiveness and the sustainability of the agencies with due focus on (i) their responsibilities, functions and tasks, (ii) their financial situation including revenue sources, costs, business practices, and adequacy and effectiveness of spending, and (iii) their accountability mechanisms, both forward and backward, including reporting, communications, and performance indicators. Legal documents defining functions, responsibilities and tasks; documents outlining operations procedures; various related laws; and other reports were also reviewed.

The analysis suggested that while there is no set model for irrigation management in the Delta, there is a general structure that applies. This includes a provincial level technical irrigation management entity (e.g. IDMC, Irrigation Division, or Management Board) that oversees O&M for the entire system contained within the provincial boundaries. For interprovincial irrigation systems, there is usually an Interprovincial Management Committee to help coordinate and guide operations for the entire system. At the water user level, there are a wide variety of official and unofficial institutions (e.g. farmer groups, subzone management units) that carry out O&M functions. These are linked together through commune and district level institutions that act as communication channels to link the water manager and planners with the water users – both for planning and implementation as well as implementing operation plans. There is however certain information gaps that need to be filled or clarified and a more complete data on the financial situation for O&M at all levels will need to be gathered and analyzed.

(c) Existing Capacity and Constraints: it was found that while the institutional structure and processes were well understood, the IDMCs still struggle with inadequate budgets to perform O&M procedures as well as being constrained by a low level of technology. Moreover, reporting and accountability procedures lack a measurable set of performance indicators to monitor and track operational and financial performance. Communication structures are in place and work effectively. However, it was not clear how flexible current planning processes would be to facilitate a more diversified cropping pattern.

(d) Limited Financial Resources: The expenditures for O&M were reviewed and generally found to be inadequate. Due to the fact that the management agencies did not maintain data on their O&M or some details of the irrigation system, it was not possible to set up useful benchmarks. Currently IDMCs do not have data on irrigated area based on specific sections of the canals, so it is difficult to link O&M expenses in a more detailed manner than O&M expenses for the entire managed system. Moreover, the larger expense items for exceptional repairs were only made on an as-needed-basis, which means there was no regular pattern to benchmark. What benchmarking may be useful is to compare total year over year expenses along with monitoring the number or budget of exceptional repair items. Some of these items

can be and are reported by the irrigation management agencies to the DARD in their annual reports. No cost-sharing or trust fund option was proposed as there is no revenue stream to contribute to it. This was examined but found to be unsuitable with the current conditions. Below highlighted some of the key financial challenges:

- *Fee collection from farmers:* the Decree 115 issued in 2008 abolished collection of irrigation fees from farmers though with some exemptions. The Government is currently providing budget support for the IDMC and the irrigation division of the DARD to carry out necessary operation and maintenance of the primary and secondary canals of the irrigation schemes in the MKD through the public funding. This decision is particularly understandable for the MKD, where: (i) farmers can access water in many places as irrigation schemes are 'open', (ii) the irrigation canal systems in the MKD also serve important inland waterways for transporting passengers and goods, and (iii) major dredging is needed every 5 to 10 years due to the large amount of the sediment deposited in the canal system[19].

- *Financing options:* Different options to generate revenues or funding to perform operations and maintenance were explored during the study. One option explored was to set up a fund similar to the Road Maintenance Fund which would draw revenues from users of the irrigation service to pay for maintenance and replacement. Setting up such a fund would be difficult for the irrigation sector as the primary users are already exempted by law from paying a fee. Alternative users such as boats for transportation would be possible, although there seemed to be a reluctance to impose such a fee, even though collection of user fee from boat users is specified in the Decree 115. One promising option was in Soc Trang where the IDMC was 100% privatized and would bid on other projects. This holds the potential to generate additional revenue, but also to distract from the core irrigation O&M responsibilities.

- *Expenditure management:* A priority recommendation would be to establish clear expenditure management information systems, to help record expenditures, analyze the cost-effectiveness of different interventions and improve cost effectiveness. The GoV has taken initial steps to implement such a system through pilot testing irrigation benchmarking which would include detailed analysis of public expenditures. To ensure the efficient use of limited public funds, the analysis suggests that progress on such benchmarking would be desirable.

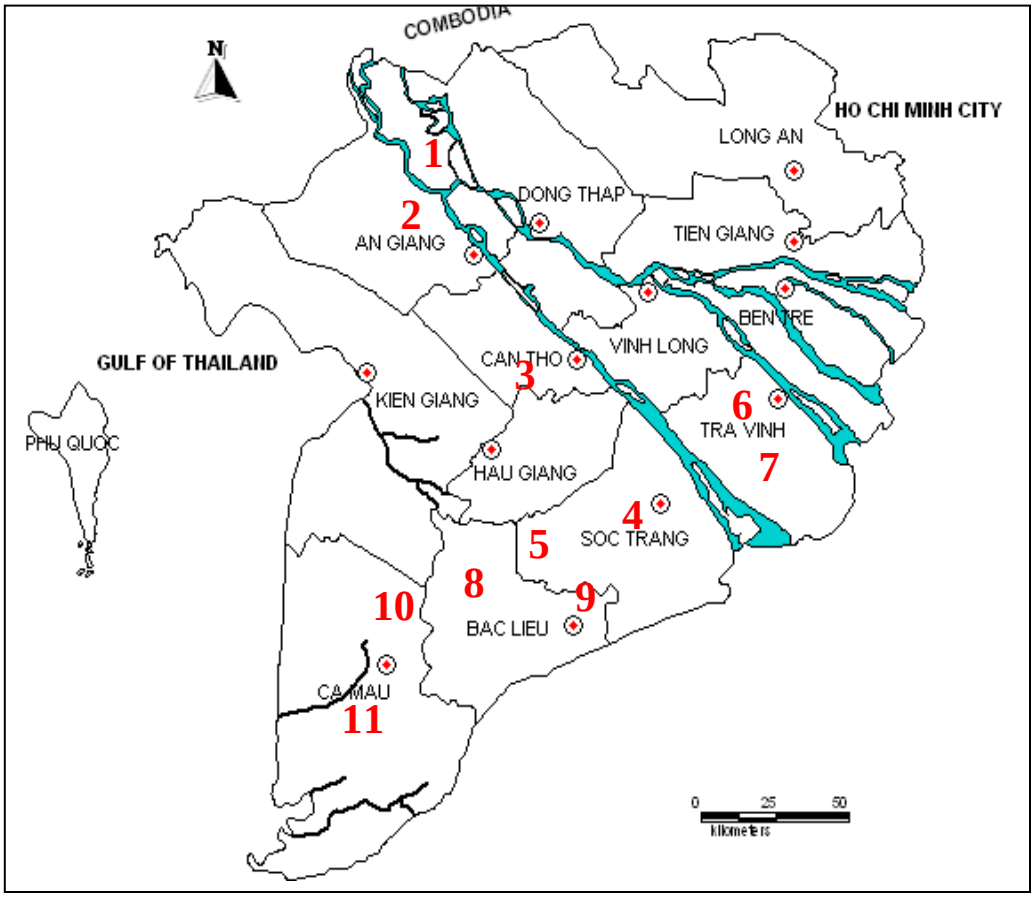
[19] An estimate suggests that the annual deposit of sediment in the Mekong Delta is 140 million cubic meters.

SECTION IV: CASE STUDIES ON LAND AND WATER CONFLICTS.

26. A study on potential local conflicts in the Delta was carried out by a team of social development specialist and agriculture specialist of Can Tho University with an aim to review Government policies, institutional arrangement, and current situation on water resources management in the areas where shrimp farmers and rice farmers experience local conflict over water resources use and management practices, and their respective views on current water infrastructure and management. The study comprised two parts (a) a literature review and (b) a social study on local conflicts. The outputs from the study have become the basis for the design of the on-farm level pilot for better resources management (Section V).

27. The social study was conducted following a participatory process. Eleven target areas were selected in consultation with local authorities covering 4 agricultural production zones: (a) flood zone, (b) freshwater-brackish interface zone, (c) brackish water zone, and (d) saline water zone and a total of 181 farmers representing different wealth groups were selected for group discussions and in-depth interviews. The site selection was based on the following criteria: (a) agro-ecological representative of the region, (b) past and planned projects on water resource management that have (potential) impacts on agricultural development and livelihoods of local people, and (c) availability of water use co-operation or competition, from which lessons learned could be used for planned water management projects and/or for further extension to adjacent areas.

Map 2: Location of the Selected Target Areas



Site No	Locations	Site No.	Locations
1	Phu Tan in An Giang province	7	Cau Ngang in Tra Vinh province
2	Chau Thanh in An Giang province	8	Phuoc Long in Bac Lieu province
3	Phong Dien in Can Tho city	9	Vinh Loi in Bac Lieu province
4	Tran De in Soc Trang province	10	Thoi Binh in Ca Mau province
5	Nga Nam in Soc Trang province	11	Cai Nuoc in Ca Mau province
6	Chau Thanh in Tra Vinh province		

28. Participatory assessments were conducted through focus group discussions with government staff at different levels and as well as with local people. At provincial and district level, discussion were made with officials of DARD and DONRE on changes in land and water use planning in the past, present and future and their impacts, problems of institutional settings on water management, and site selection. At community level, discussions were made with commune and hamlet officials to get an overall understanding on land and water uses and wealth of local households in the commune, and to identify target groups and households for data collection.

29. Based on common characteristics, and as a starting point to the study, the Mekong Delta was divided into three zones, as follows.

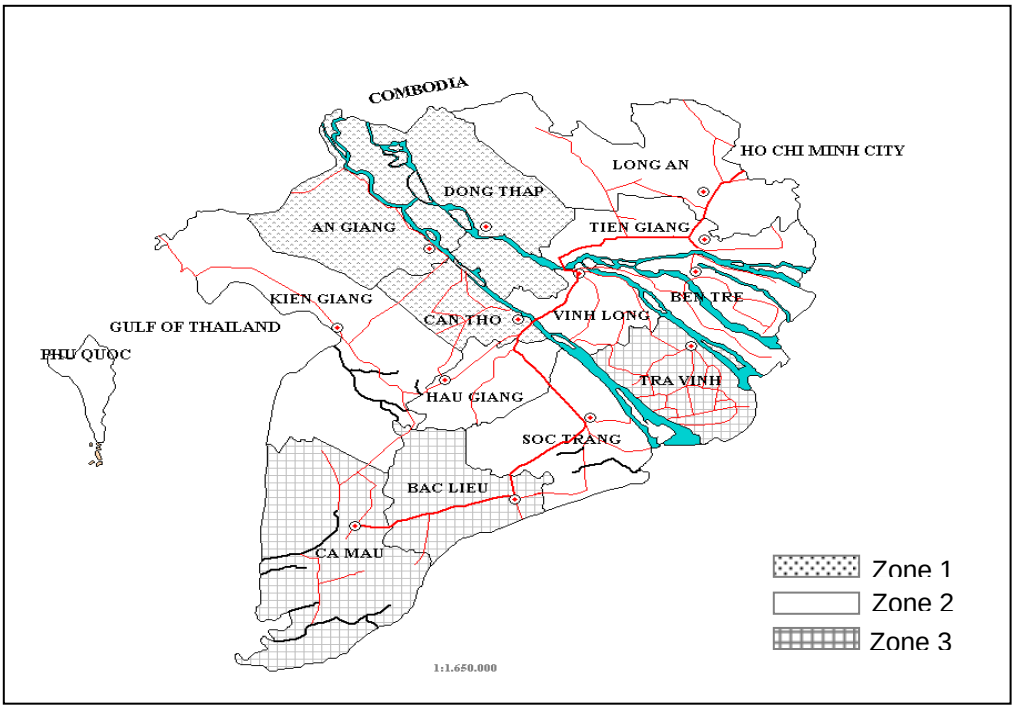
(a) Zone 1 (An Giang and Dong Thap Provinces; Can Tho City): This area is located in the upper riverine delta with alluvial soils. Freshwater is mostly available year-round in major canals with deep and prolonged inundation by the annual monsoon flood occurring in between August to November. Zone 1 could be characterized as an intensive rice production zone, where the ratios of rice-grown area for the dry season (DS) and the wet season (WS) crops to total agricultural land surface, and total rice-grown area. In this zone the intensive Pangasius catfish culture in ponds and cages also results in high fish production (about 406 tons/ha of pond per crop of 6-8months on average).

(b) Zone 2: (Ben Tre, Hau Giang, Vinh Long, Tien Giang, Soc Trang, Kien Giang and Long An provinces): is located in both freshwater (in the central part) and saline-water (lower part) agro-ecological systems with a wide range of soil types (alluvial, acidic and saline soils). In Zone 2, the freshwater part is less affected by the annual monsoon flood (shallow-water area) while the saline areas is highly influenced by saline intrusion during the dry season. This zone could be characterized by its intermediate intensification and high diversification of agriculture. The ratios of rice-grown area for the dry season and the wet season crop, and rice yields were higher in Zone 2 than in Zone 3. Fruit production is an important farming activity, particularly in Ben Tre, Tien Giang, Vinh Long and Hau Giang. Both freshwater fish farming and coastal shrimp culture (in saline water area) exist in Zone 2, but fish and shrimp production was lower than that in Zone 1 and Zone 3, respectively. Freshwater fish farming, particularly intensive Pangasius catfish culture, has been developed in recent years in Vinh Long and Ben Tre provinces.

(c) Zone 3 (Ca Mau, Bac Lieu and Tra Vinh provinces): are mainly located in the downstream parts of the MKD, where the agro-ecosystems highly depend upon rain-water during the wet season, while salinity intrusion from the sea during the dry season is significant. This zone is considered as a typically coastal area, where the aquatic environment and agricultural

activities are subject to seasonally varying salinity levels of surface water bodies. Extensive traditional rice cropping with one crop a year during the wet season and extensive (or improved-extensive) shrimp farming with one or two crops a year during the dry season being predominant for agricultural production. Intensive rice production is practiced, highly depending upon rainwater, mainly in salinity-control areas.

Map 3: Different Agro-Ecological Zones in the Mekong Delta



30. Since 2000, agriculture has diversified in the MKD, resulting in significant changes in land use and water resources requirements. The Government issued a policy on agricultural diversification and sustainability in June 2000, and farmers subsequently started to convert from rice farming into other crops. While rice cultivation has been intensified in the upper parts of the MKD, conversion to orchards and vegetable production has started in the central part, while conversion to shrimp culture (*Penaeus monodon*) has expanded considerably in the lower part especially in the area with brackish water. Since 2005, shrimp culture has also evolved from monoculture to rice-shrimp cultivation (shrimp during dry season and rice during wet season) to mitigate the risk of disease and pollution from feeds and chemicals used in shrimp production. During this period, some water management infrastructure investments have been made for the tertiary canals and sluice gates to support this diversification.

31. Key findings of the social study are highlighted below;

(a) Wealth ranking: Findings suggest that rural poverty rate in the study area was highest in sites situated in coastal areas, where the rate of Khmer population is high and agricultural production highly relies on rainfall and saline water from the sea. In these areas, the proportion of households with declining wealth in recent years was large, indicating that rural poverty reduction initiatives have not been fully sustainable. Livelihoods of rich households depended mainly on agricultural production while those of poorer groups rely highly on wage labour and natural resources exploitation. The participation and representation in community-based organizations of households in coastal areas, particularly poor groups, was weak.

(b) Household's Income and Water Uses Productivity. Water has multiple uses in the Delta and water use efficiency differs with agro-ecological zones and wealth groups. Rice, upland crops (including fruits), aquaculture and livestock production are the major farming activities across the study areas; rice production is considered a more important source of income in the flood, interface and brackish zones. Aquaculture, on the other hand, was more important in brackish and saline zones.

Results from the study suggested that livestock production provided higher income in the interface zone than in other zones while the farming activities created higher income per ha in the flood and saline zones than those in the interface and brackish zones, due to the dominance of rice and shrimp production. Income from the industry, service sector and exploitation of natural resources is still generally small, compared to farming activities. The interface zone had lowest income per capita and income per labor while the flood zone had the highest income per labor. Agricultural production, particularly rice and aquaculture, created more income for the rich groups than for the poorer segments of society. Farming income per ha was higher for the poor group with declined wealth in the flood zone than that for the other groups, due to efficient use of small farming area for small-scale aquaculture in tanks or net enclosure.

The results implied that (a) water use efficiency was low in the interface zone since its agricultural production is more vulnerable to freshwater availability from upstream parts as well as to salinity intrusion from estuaries and/or adjacent shrimp farming areas and to extreme weather events and (b) small-scale extensive aquaculture would be a way to improve wealth of households in the saline zone.

(c) Land and Water Uses in the Study Areas. Water allocation decisions and water management interventions/projects have significant impacts on change in land and water uses, crop pattern, agriculture production, and farmer income in the study areas. In Phu Tan of An Giang province, through the North Vam Nao project, flood water has been controlled and subsequently rice production has been intensified, shifting two rice crops per year to 8 crops per 3 years in most of the district. In the middle and lower part of the delta, water development projects were implemented in Nam Mang Thit, Quan Lo-Phung Hiep, O Mon-Xa No and Tiep Nhat areas with an aim to control salinity and development of irrigation systems for rice production in coastal areas. As a result, farmers at these project sites shifted from one traditional rice crop with long-growth duration and low yield to two or three modern rice with shorter-growth duration and higher yield. However, much of these practices have

been changed since 2000 in line with the government policy on shifting rice intensification to more diversified agriculture, and many rice-based farming systems like rice-shrimp/fish and rice-upland crop-livestock farming systems have emerged. This finding suggested that to accommodate effective implementation of diversification policy, function of water structures needs to be transformed, from salinity control for rice production to adaptive salinity management for shrimp culture in the dry season and rice culture in the wet season, through proper adjustments in operation and supplemental investments of small-scale water management structures.

(d) Water Related Issues and Causes. Water-related problems in the study areas as identified by farmers included (i) severe floods (in the flood zone), (ii) salinity intrusion and water shortage for crop production in the dry season, and (iii) droughts in the rainy periods (in the coastal zones). After the water resources management interventions, (iv) soil and water acidification has become a common problem observed in coastal zones in early rainy periods, which caused losses of rice harvests and damaged aquatic living resources.

Currently, although local water management projects have been put in operation and have had positive impacts, local people feel that they still face numerous water-related problems, which could become more severe in the future. Canal water pollution, the decline of aquatic resources, and water transportation constraints are commonly identified in the flood zone. In the interface zone, local people feel to encounter canal water pollution, salinity intrusion in the dry season, inundation in the wet season and droughts in early rainy season. In the brackish and saline zones, problems identified include canal water pollution, salinity, and inadequate freshwater, and groundwater depletion. In all of the sites, local people perceived that the present problems related to water could become more severe in the future under climate change.

(e) Conflict Management. So far, water conflict is mostly expressed under forms of complaints to the neighbors and/or local authorities, rather than of violence or vandalism at local level. The conflicts were found to remain mostly at the local level and at immediate stage. The problems were solved by the involved farmers themselves and local community-based organizations or authorities if necessary. In most cases, there was a process of shifting competition and conflicts to some forms of cooperation. For significant losses at broad scale, local authorities have applied a compensation system to farmers suffering losses from the natural hazard-mitigation fund (Decision No. 142/2009/QĐ-TTg). Previous studies have shown that poor people, who have limited livelihoods assets, are less able to secure access to water when water resources become scare and they often seek alternative options for dealing with the problem without confront with richer groups. This reveals that the role of local authority and community-based organizations in strengthening local institutional arrangements towards sustainable water resource management is of great importance in future water resources management interventions.

(f) Farmer Perceptions on Impacts of Water Management Projects: results from the focus group discussions show both positive and negative impacts, directly or indirectly, of water allocation decisions on agricultural production and environment at the study sites. The

impacts have been perceived differently by farmers between freshwater and brackish or saline water zones. Key perceptions are highlighted below;

- *Positive impacts* water management interventions in the flood and interface zoneshave benefited local communities through flood management and irrigation development and hence rice intensification, crop diversification, reduced orchard damage by big floods, transportation development and off-farm job creation for poor households. In brackish and saline zones, irrigation development and proper operation adjustments for salinity management structures have allowed farmers improving income from rice intensification and shrimp farming rotated with rice culture.

- *Negative impacts* of past interventions include, surface water pollution by residues of agro-chemicals and organic matters and by pathogens from rice intensification and improper management of shrimp farm effluents. In irrigated rice production zones, natural aquatic resources (on which the livelihoods of the poor highly depends) are perceived to be declining due to (i) constrained fish migration by dike barriers and (ii) heavy application of agro-chemicals for rice production. In the flood and alluvial zone, farmers thought that their rice field became less fertile, because of fewer alluvial depositions from flood control structures, leading to a higher application of chemical fertilizers to maintain yields of the dry season rice crop. In addition, some farmers complained that water management structures of O Mon-Xa No project have induced blockage of navigation routes and obstructed water transportation. With development of rice and shrimp within the same project area, the operation of water structures to satisfy demands of different water uses – rice and shrimp – has become complicated. Rice farmers have faced salinity intrusion from adjacent shrimp areas in the early and the late rainy season, while shrimp farmers in downstream areas have to deal with rice field effluent discharges (including agro-chemical residues and acidic water) in the early rainy periods.

<u>(g) Impacts on Agriculture Production and Income:</u> farmers' in-depth interviews verified most of the findings from the focus group discussions. Past water management interventions had both negative and positive impacts, directly and indirectly, on agricultural production, employment and environment. Below highlighted the key findings;

- *Impacts on rice production:* a large proportion of the interviewed farmers felt that, together with advanced farming technologies, water management projects allowed farmers to better access water to further intensify rice production, and that current rice production costs and yields are higher than those before interventions. In the flood zone, many farmers perceived that water management projects reduced field soil fertility and therefore apply a higher fertilizer rate to maintain rice production as before. An increase in rice production costs has been partly resulted from an increase in market prices of input materials and labor. However, a small group of farmers (4-11 percent) suggested that current rice production had lower costs, due to using less agro-chemicals from applying environment-friendly farming practices (3 gains – 3 reductions and 1 must – 5 reductions) but rice yielded less than before, due to pest out-breaks. In the brackish and saline zones, farmers said that current rice yields are lower than before, because of soil

salinization from local shrimp farming, salinity intrusion from estuaries and/or adjacent shrimp farming areas and extreme droughts.

- *Impacts on other agriculture production.* Unlike for rice production, local water management projects had impacts differently with farming activities of upland, livestock and aquaculture production. Flood and salinity control and diversification of agricultural water uses facilitated farmers to develop upland crop (including fruits) production. Around 60 percent of interviewed farmers in the flood and interface zones (i.e. flood and salinity control) perceived that their current production systems have become more intensive, which requires higher investment costs and gives higher production. Flood control projects have helped farmers better protect their orchards from monsoon floods and hence reduced drainage costs during flood periods. For livestock production, about 20% of interviewed farmers in the interface and brackish zones perceived that they have further developed the production and hence increased livestock production compared with before the projects. Impacts of water management interventions on aquaculture have been observed mainly in the flood, brackish and saline zones. A larger percentage of the surveyed households in those zones reported that they have invested more labor and material inputs on aquaculture to maintain or achieve higher aquaculture production. Common practice aquaculture systems include small-scale eel or frog farming in tanks, enclosed-net fish culture in ponds or in rice field, pond fish culture (in the flood zone), extensive or improved extensive shrimp culture alone or in rotation with rice in the wet season (in the brackish and saline zones). In some cases, local farmers in the study zones said that they had lowered shrimp production costs through development of rural markets and infrastructure (i.e. transportation and electricity), the availability of input materials as well as applying farming technological advances (i.e. stocking good quality juveniles with appropriate densities, rotating rice with shrimp). Other farmers however complained that local water management projects constrained potential yield of their aquaculture production, due to less productive flood ecosystems by flood control and polluted water in irrigation canal systems by discharges from expanded shrimp farming areas.

These findings suggest that proper operation of water structures to receive nutrient-rich flood water and to flush out pollutants, farm supplemental structures and farming technology measures are necessary to add synergies to local water management projects and hence further improved agricultural water productivity.

(h) Farmer Perception on Enabling Elements and Existing Constraints. Farmers recognized that there are opportunities to enhance positive impacts of water management projects through good agricultural practices in rice or shrimp farming and agricultural extension development at grass-root level. In the flood zone, especially in An Giang, promotion of farmer's network in irrigation management and of good agricultural practices was identified as an enabling element. In the coastal zones, agricultural diversification policies in promoting shrimp farming in dry season with rice in rainy season was considered as an enabler of adaptive salinity management. In these two zones, infrastructure and rural market development, urbanization and industrialization have been seen to provide job opportunities for rural labor; however labor demand for shrimp farming is less than those for rice farming. However, there are existing constraints and the common ones are poor small-scale irrigation structures at community level (i.e. tertiary and quaternary), poor farmer networks (i.e.

participatory irrigation and drainage management, common seasonal calendar establishment), and limited capacity of households in agricultural rice and shrimp production. In addition, other important constrains include small-scale and un-uniform production; poor coordination, monitoring and operation of water management structures at subproject (inter-province) level, and extreme weather. For example, in Vinh Loi and Phuoc Long (in Bac Lieu) and Tran De and Nga Nam (in Soc Trang), tertiary and quaternary canal systems, which are officially managed by the commune/community, are poorly maintained and operated due to financial limitation. Consequently, farmers downstream or far away from main canals could not access irrigation water for rice during low water flow periods. Moreover, water infrastructures to control salinity and store freshwater for rice irrigation is hardly available. Farmer networks need to be strengthened to establish rice or shrimp crop at the same time and with the same way, so that the water structures can be operated to satisfy the same need. In North Vam Nao, the expansion of water-saving techniques has been limited due to uneven field surface between farmers and inappropriate sharing of benefit between farmers and irrigation service provider, although water structures have been well constructed and farmer networks have been strengthened. These findings suggest that future water management projects need to pay attentions to both structural and non-structural solutions at different scale to maximize the effectiveness and efficiency of investments.

32. The study also conducted a review of institutional issues and challenges pertaining to the management of water in the MKD. It found that, generally, the institutional arrangements for water resources management in Vietnam has gone through a reform process and that water governance has improved. However, it found also that a number of challenges remain significant, and key challenges are highlighted below;

(a) <u>The legal, institutional and policy framework</u> remains ineffective with gaps, duplications and inconsistencies, and even conflict among different agencies. Thus, it is necessary to clarify functions and mandates of different agencies as well as to review and update current legal and policy frameworks in order to increase effectiveness and efficiency on water management.

(b) <u>Coordination and cooperation</u> between national and local agencies, between administrative levels and boundaries (province, district, and commune) and sectors remains ineffective causing difficulties for the management of water resources. It was found necessary to create a forum and/or mechanisms for improving coordination and cooperation at all levels, including integration of planning and data and information sharing. Improving performance of the National Water Resources Council could be one way to address the conflicts between provinces and sectors and among various water users and key stakeholders. For inter-provincial hydraulic works, establishment of a so-called “Management Committee” could be important for allocation of water among provinces, however their operation and involvement should be strengthened.

(c) <u>Human resources capacity in water management</u> are lower in the MKD compared to country’s profile both quantitatively and qualitatively. Therefore, capacity buildings should focus at the national and provincial levels via supporting different training courses for existing staff and enhancing relevant educational programs which would provide staff with sufficient knowledge.

(d) To improve irrigation management, it would also be necessary to define clearly who manages what (decentralization process) and separate state management from production management. Besides that, findings also suggest that the government should pay more attention to WUOs at grassroots level. Moreover, participatory irrigation management (PIM) models should be applied more widespread.

SECTION V: DEVELOPMENT OF ON-FARM LEVEL PILOT FOR WATER RESOURCES MANAGEMENT

33. In conjunction with the activity described in Section III, under the WPP Grant, as activity was carried out by Can Tho University in collaboration with an international consultant to design a pilot activity to help increase water productivity on-farm management. Based on a literature review, and the social study conducted as part of this Grant, a workshop was conducted on 17 February 2011, with participation of DARD from An Giang, Can Tho, Hau Giang, Bac Lieu and Ca Mau provinces. A proposal was developed and submitted to the Government through the Central Project Management Office (CPO) for consideration. The scope of pilot activities is included as part of Subcomponent 1 of the Mekong Delta Water Management and Rural Development Project (MDWM-RDP). The proposal comprises six pilot sites ($ 6 million) covering the following three areas: (a) upstream area (mainly rice cultivation); (b) mid-part area (mainly fruit trees and high value crops); and (c) low part areas (mainly shrimp farms). The pilot program would support improvement in on-farm facilities and demonstrate good practices as well as facilitate cooperation among water users and water supply providers. The activities will be implemented over a 5-year plan (2012-2016). This Annex summarizes the objectives and scope of the pilot program.

34. *Objective and Scope.* The main objective of the pilot program is to improve agricultural water resources management at on-farm/community level with the aim of improving irrigation investment efficiency, crop water productivity, and farm income and reduce poverty while also reducing potential water use conflicts in the project areas. The objectives will be achieved through participatory planning processes, cooperation among water users, and maximizing synergies of structural and non-structural water management measures at both community and farm level. It is anticipated that the pilot program would demonstrate ways to increase the robustness of agricultural irrigation management, both for better livelihoods of rural households and for ecosystem services (efficient irrigation use, profitable and sustainable farming, and workable institutional arrangement) in the southwest region in the Mekong delta.

35. Site Selection. The proposed sites were selected based on the following criteria; basic characteristics of the areas and a location map are shown below.

> <u>(a) Large-scale level:</u> (i) focus on areas where large- and medium-scale irrigation development projects were or will be implemented to maximize investment efficiency; and (ii) located on agro-ecological zones with potential challenges to agricultural water management and competitive advantages to produce key agricultural commodities in the southwest region of the delta.
>
> <u>(b) Small-scale level:</u> (i) consideration of real problems and needs that fit in the scope of the proposed project; (ii) readiness for implementing the pilot project such as canal systems (primary, secondary and tertiary levels), public and private services systems, farmer organizations, etc.; and (iii) potential to scale up successful results into other adjacent areas with similar biophysical and socio-economic settings.

36. *Scope of Activities.* At each site, the project would support the following activities:

(a) Improve institutional arrangements for more efficient irrigation management and better access to farm input and output services at community level, promote decentralization, strengthen participation and responsibility of local communities and private actors, and reduce the role of the government in agricultural water management at community level;

(b) Test prototypes for water management innovations at on-farm and small scale off-farm level and evaluate their performance and financial and economic impacts; and

(c) Learn from pilot results and analyses in order to scale-up expansion of such improvement in the Delta.

37. The scope of activities would be designed based on the following principles: (i) Focus on selected investments in integrated structural and non-structural measures at farm and community scale for improved agricultural water use efficiency, increased adaptability to natural hazards, reduced poverty rate, and better environment; (ii) consider key agricultural commodities (i.e. rice, fruit and shrimp) and livelihood opportunities for small farmers and rural poor people; (iii) build on strategic plan of local government to agricultural and rural development and climate change response, and on real needs of local communities under specific contexts of different sites; (iv) employ participatory learning in action approach to mobilize active participation of stakeholders and to maximize synergies of implemented inputs and activities in order to achieve multiple outcomes at different scales, from household to region.

Table 1: Agricultural land area and number of households of the pilot sites

Pilot No.	Province	District	Commune	Pilot size (ha)	No. house-hold	Farm size (ha/HH)[1]	Rice area (ha)	Fruit area (ha)	Aquacul-ture area (ha)[2]
1	An Giang	Phu Tan	Phu Xuan	320	426	0.8	320	0	0
2	Can Tho	Phong Dien	Truong Long	412	633	0.7	100	222	90
3	Hau Giang	Vi Thuy	Vi Thanh	500	333	1.5	500	0	0
4	Bac Lieu	Vinh Loi	Chau Hung	300	138	2.2	300	0	0
5	Bac Lieu	Phuoc Long	Phuoc Long	350	175	2.0	350	0	350
6	Ca Mau	Cai Nuoc	Tran Thoi	350	250	1.4	0	0	350
	Total			**2,232**	**1,955**		**1,570**	**222**	**790**

[1] HH (household); [2] aquaculture practiced on rice land under a rotational rice-aquaculture farming system

38. *Approaches*. Given that Integrated Water Resources Management (IWRM) forms the basis of the pilot for improving the on-farm and small off-farm irrigation management at the proposed pilot sites, the following approaches would be considered during the planning and implementation of the activities:

- *Integrated planning*: selecting different structural and non-structural measures through close consultation and/or participatory planning process so that the activities at different scale level

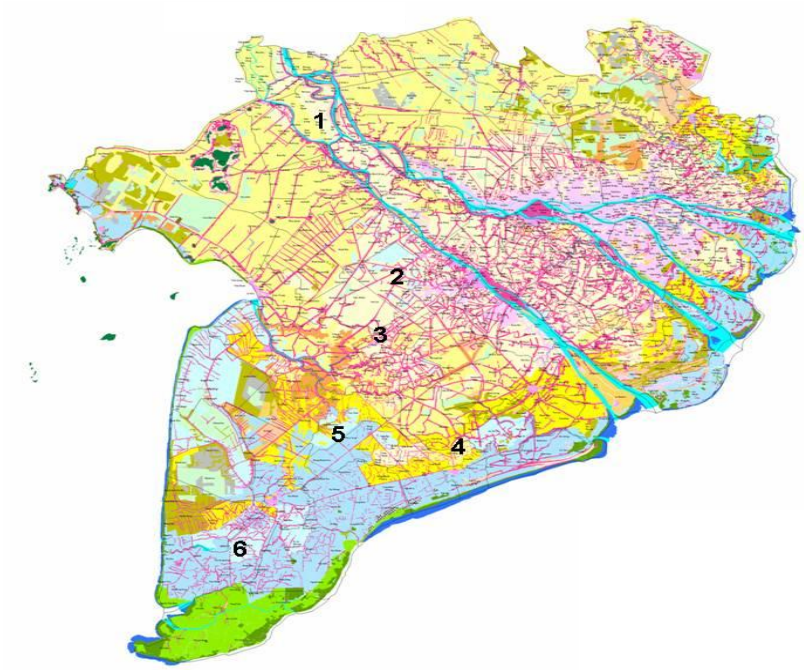
(narrow and broad scales) are complimentary so that the potential benefits could be captured and the potential conflicts could be minimized;

- *Participatory learning:* involving different stakeholders (governmental agency, farmer, service supplier and researcher) in all stages of the planning and implementation processes, from site selection, problem formulation, intervention design and testing, monitoring, evaluating and suggesting for further improvements and extension; making a continuous process of on-farm irrigation management optimization;

- *An agro-ecosystem approach:* considering the component of agricultural irrigation management is part of a broader system of agro-ecosystem management. Agricultural water management practices differ from place to place, depending upon physical and socio-economic contexts. Outputs of the agricultural water management include water use efficiency, income, poverty reduction and ecosystem services; and

- *An economic-incentive approach:* paying more attention to interventions that are economically viable to "pull" farmers taking up good practices in irrigation management and rice production.

Map 4: Mekong Delta Map showing the six selected project sites



1 (Phu Tan, An Giang), 2 (Phong Dien, Can Tho), 3 (Vi Thuy, Hau Giang), 4 (Vinh Loi, Bac Lieu), 5 (Phuoc Long, Bac Lieu)]

39. *Priority activities.* Through consultation with local agencies and farmers, two major themes proposed for the pilot program are: (1) water productivity and (2) local demand-driven needs for

agricultural and rural development. The program should consist of three basic components as follows:

- Upgrade on-farm and related small scale off-farm irrigation and/or agricultural infrastructures to ensure optimal use of water at farm through community scale. Key activities are the following: (i) Upgrade tertiary and/or quaternary canals for irrigation and drainage; (ii) Construct communal electric pumping stations and sluice-gates; (iii) Improve communal post-harvest equipments; (iv) Install communal office and information technology at community scale; and (v) Improve on-farm infrastructure (i.e. land leveling, ponds, dikes, irrigation systems, etc.

- Improve agricultural practices to increase water productivity, agricultural productivity, farming profitability, poverty reduction and environmental protection. Key activities are the following: (i) Apply good agricultural practices for rice, tropical fruit and shrimp production; and (ii) Diversify agricultural activities for further improving household's resources and hence higher income, lower economical risks and better environment.

- Improve institutional arrangements for participatory irrigation management through empowering farmers and their organizations, engaging private input and output services and building capacity of local government staffs. Key activities are the following: (i) Enhance capacity of local staff, water-use group and/or extension club managers, and farmers; (ii) Establish and/or strengthen networks/partnerships among water users and between water users and services suppliers; (iii) Reform management procedures, regulations and policies; and (iv) Pilot models at the selected sites used as demonstrations for neighbouring communities.

40. *Outputs*. The main output of the project would be successful models on good irrigation management practices on rice, fruit and aquaculture production at farm and community level. For each model, specific outputs are as follows:

- Upgraded and or rehabilitated on-farm and small off-farm structures, allowing farmers within the pilot sites to well access to reliable water supply or drainage services and to use irrigation water more efficiently;

- Improved field infrastructure and tested prototypes and processes (e.g. land leveling, pond construction, dual purpose (irrigation/drainage) irrigated electric pump stations, low pressure pipe distribution at quaternary level, etc), and provision of farm machinery (e.g. rice harvester, rice drying machine, etc.), facilitating and/or promoting farmers to make better use of implemented irrigation investments and to adopt water-saving techniques in their agricultural production systems;

- Good agricultural practices adopted by farmers and hence helping them further improve water productivity and income and reduce environmental negative impacts in agricultural practices;

- Local staff, water use group leaders and farmers with strengthened capacity in agricultural irrigation management, advanced farming technology extension and application and agricultural production management;

- Workable policy and institutional options for more sustainable management of soil, crop and water;

- Workshops and delivery materials and documents for extension and policy making in agricultural water management at farm and community.

SECTION V: CONCLUSION AND RECOMMENDATION

41. As a result of the combined pressures of further agricultural intensification across the delta and uncertainty related to the impacts of the upstream development and the climate change development of a broad regional water analysis framework is recommended which takes account of "meta-level" impacts (of agriculture as well as on agriculture) as well as impacts of the upstream developments and the climate change.

42. Despite the uncertainty with regards to climate change impacts on agriculture, the following conclusions emerged from various discussions: (a) integrated and detailed knowledge is required for all the main production systems and performance of existing water management infrastructure have to be carefully assessed; (b) climate change and upstream development will change the nature of these systems, and require changes in farming system and water management accordingly; and (c) improved, flexible and responsive institutional mechanisms need to be developed to better manage existing conditions, and more so under the impacts of climate change and upstream development.

43. Given the need to meet socioeconomic development targets of the country, it is expected that over the next several decades Delta's agriculture development would undergo major structural changes, including land consolidation, mechanization, and further diversification of land uses. Major driving forces will include changing domestic market demand, price trends and consumer preferences in international food markets, rural to urban migration, increased non-agricultural use of land and water, technological change, and changes in the water regime due to upstream developments and climate change. The following paragraphs outline key elements of future water management in the Delta in the context of these broader structural changes:

- *Infrastructure Investment.* There is a continued need for investing in water management infrastructure, particularly investment in the sluice gates at the secondary and tertiary levels to enable more responsive and flexible support to diversifying farmers' needs on water delivery. Further, major dredging works in the primary and secondary canals are also critical to fulfill their design conveyance capacity or to cope with new demands. An estimate suggests that the current conveyance is between 50 to 70 percent of the design capacity. The dyke systems also have to be reinforced to protect against salinity intrusion in the lower part of the Delta and mitigate flood risks. The current design of the dykes also has to be upgraded to allow the passage of vehicles and agricultural machinery. The use of the latter is increasing in response to rising labor costs and the need to raise product quality and reduce physical product losses associated with traditional manual practices.

- In light of the potential climate change impacts, MARD is considering a series of new major infrastructure investments, including several long coastal and river dykes and larger sluice gates at the major river mouth. In the process of planning such large scale infrastructure it is critical for the MARD to consider pertinent economic, environmental, and social aspects and to explore alternative strategies, including the introduction of adaptive agriculture and/or other adjustments in land use. Assistance is needed to screen emerging proposals and to consider alternative (and perhaps more cost-effective) strategies of climate change adaptation.

- *Increasing Water Productivity*. As fresh water during the dry season (and, to a lesser extent, during wet season) would be unreliable and scarce, the risks of conflict over water would also increase in the future. As increases in yield and agricultural area are reaching their maximum limits, the focus of water management and agriculture should turn to increasing water productivity (i.e. the value of agricultural product per unit water used). Support could include both: (a) on-farm investments (such as land leveling, water distribution channels) as well as agronomic support services, and (b) off-farm investments (e.g., installation of Surveillance, Control, and Data Analysis (SCADA) systems).

- *Updating the Mekong Delta Master Plan.* The Mekong Delta Master Plan was prepared in 1994. Since that time, there have been tremendous changes in the Mekong Delta including the structure and scale of economic activities, changes in water use by different sectors, and the development of varied infrastructure related to water resources. Additionally, many factors external to Vietnam have arisen including constructed and planned upstream dams and irrigation systems, pollution, and awareness of climate change. In updating the master plan, a pragmatic approach would be to target particular dimensions, such as infrastructure and water use by sector, and examine the 'robustness' of plan modifications in the context of various scenarios. This would subject the plan to various 'stress tests', identifying potentially vulnerable areas where agriculture could be adversely affected. Revisions to the plan could then initially focus on addressing those identified vulnerabilities across different water use sectors, including agriculture, water supply and sanitation, industrial uses and the environment.

- Given the complexity of the situation it is necessary to establish good and timely information management system and a flexible set of institutional arrangement for coordination between managers and users and amongst users with different needs so that the potential benefits can be maximized while minimizing the potential conflicts. The combined pressures of further agricultural intensification across the delta and the potential impacts of the upstream development and climate change on the water flows and water quality (mostly uncertain) will require effective coordination and cooperation among water planners, operators, and users to avoid further environmental degradation and safeguard remaining coastal resources critical for the delta.

44. While the Irrigation Divisions, IDMCs and the DARDs have basic technical and administrative capacity to operate the water management infrastructure at the provincial or lower level, their capacity and the current institutional setting has to be upgraded to be able to effectively address expected climate change impacts and the diversified needs from various water users. The current system for water management is narrowly segmented along provincial lines and there is an evident need to develop a sub-regional analytical and planning framework for improved planning, monitoring, and coordination—especially to address water use conflicts/competition and manage large irrigation and/or flood control systems which span more than one province. In particular, the study recommends that:

- *Communication with water users:* there is a need to intensify the communication between the IDMCs and DARDs and the end water users. The water resources authorities are making

infrastructure planning and management decisions based upon the 1994 Delta Master Plan and static land use considerations. Yet, water users are making strategic and dynamic decisions based on evolving opportunities (e.g., markets) and prevailing climate conditions. These differences could create conflicts between the water authorities and water users. Provincial and district water resources authorities need to improve communication with water users, providing information and forecasts about the availability of fresh water and patterns of salinity intrusion to facilitate decision making, while they also need to consider inter-provincial flows and diversions of fresh water in water resource decisions.

- *Strengthening capacity of WUOs:* establishing WUOs is urgently needed to enable community water-related decision-making and improve on-farm water use efficiency. Diversified agriculture and aquaculture have already raised the risks for potential conflicts over water use (saline water vs. blackish water) within the same irrigation schemes. While the Government has adopted a policy on irrigation management transfer (IMT) and adopted a decree to transfer the responsibilities for managing the tertiary and quaternary irrigation facilities to water user organizations (WUOs), implementation has been slow. In the Mekong Delta, with the support of AusAID, 24 groups of water user organizations (WUOs) have been established in An Giang Province on a pilot basis. The DARDs and IDMCs need to implement IMT to enable farmers to make collective decisions on water use, mitigate possible conflicts, and contribute to the overall management of the irrigation schemes. Further, attention also needs to be given to improving on-farm water productivity, especially in the context of scarce dry season fresh water availability.

- *Enhancing sustainability of investment:* In the short to medium terms, the Government will continue to finance a large part of the significant maintenance costs for irrigation systems from central and provincial budgets. Under such circumstances, there are a range of options to improve the current cost sharing arrangements, including: (i) development of clear business plans to cover the financial, operational, and technical aspects of Irrigation Divisions/IDMCs or other management institution operations; (ii) monitoring at the national/regional level the performance of Irrigation Divisions/IDMCs based on a set of benchmarks; (iii) investment in Irrigation Divisions/IDMCs' logistics and systems to reduce operational costs; (iv) formulation of WUOs at the local level to manage lower system (tertiary and below) level irrigation, and be counterparts to the Irrigation Divisions/IDMCs to monitor the Irrigation Divisions/IDMCs' performance.

- *Improvement of efficiency and effectiveness of O&M:* to improve efficiency and effectiveness of O&M performance, the study identified the need to moving toward a fully integrated management approach that effectively links provincial irrigation management agencies and water users by providing technical assistance, logistical support, and capacity building on planning and operations. This approach will also leverage existing knowledge and institutional structures and result in modern irrigation management institutions and practices that improve water management, enable higher production in agriculture, protect against flood, and increase the ability to adapt to climate change impacts. Key activities of such an approach could include (i) technical assistance for organizational and business planning (staffing, functions, financial, contracting, performance monitoring), operations (expenditures,

budgeting, procedures), and asset management, including design and training for a SCADA (Surveillance, Control, and Data Analysis) system; (ii) logistical support for the provincial irrigation management agencies (e.g. Irrigation Division, IDMCs, and Management Boards) including office renovations, equipment, vehicles; and (iii) Technical assistance on Participatory Irrigation Management (PIM) to establish and/or develop WUO in the participating provinces, including to initiate a performance based contracting process between WUO and provincial irrigation management agencies[20].

45. The findings of the local case studies further suggests that water resources interventions should focus on not only agricultural production but also water-related ecosystem services and in broader rural development, which could creates job opportunities for the poor. At the same time, farming technological measures such as organic fertilizer application for rice production or more adaptive farming systems (i.e. rotational rice-aquaculture or commercial integrated fruit-aquaculture systems) in the flood zone, appropriate adjustments of shrimp cropping season, using rice cultivars with salinity-tolerance and/or short-growth duration, other rice farming practices (i.e. potassium application), and salinity-removing ditches in paddy fields.

46. Integration, participation and decentralization are key elements for successful management of water resources in the future of Mekong delta. The main purpose of water resources management projects should be not solely agricultural production improvement but crop water productivity, household livelihoods and in broader perspective – rural development. To achieve this, attention should be paid to promote a combination of structural and non-structural measures through close consultation among key stakeholders through a participatory planning process. Activities in the Delta should be designed to meet the local needs and contexts and be integrated with local development plans to maximize investment efficiency. Local farmers and stakeholders should actively participate in the project life cycle, from planning to implementation, monitoring, evaluation, improvement and extension. Enhancement of public-private partnerships is of great importance.

[20] These recommendations were incorporated into the design of the Mekong Delta Water Management and Rural Development Project, Subcomponent 1-2

BIBLIOGRAPHY

Be, T.T., Dung, L.C., Brennan, D., 1999. Environmental costs of shrimp culture in the rice-growing regions of the Mekong delta. Aquaculture Economic and Management 3, 31-42.

Brennan, D., Clayton, H., Be, T.T., 2000. Economic characteristics of extensive shrimp farms in the Mekong delta. Aquaculture Economic and Management 4, 177-184.

Bui, T.M., Phan, L.T., Ingram, B.A., Nguyen, T.T.T., Gooley, G.J., , V.H., Nguyen, T.P., De Silva, S.S., 2010. Seed production practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta region, Vietnam. Aquaculture 306, 182-190.

Can Tho's DONRE (Department of Natural Resources and Environment), 2003, 2006 & 2008. Results of environmental monitoring in Can Tho city. An Internal report.

CSO (Can Tho Statistics Office), 2010. Statistical data of the Mekong delta 2000-2008. Can Tho Statistics Office, Can Tho.

De Silva, S.S., G.J., Ingram, Nguyen, T.P., Bui, M.T., Gooley, G.J., Turchini, G.M., 2010. Estimation of Nitrogen and Phosphorus in Effluent from the Striped Catfish Farming Sector in the Mekong Delta, Vietnam. AMBIO (DOI 10.1007/s13280-010-0072-x).

Dore, J., Xiaogang, Y., Li, K. Y., 2007. China's Eneragy Reforms and Hydropower Expansion in Yunnan. In: Lebel, L., Dore, J., Daniel, R. & Koma, Y. S. (Eds), Democratizing Water Governance in the Mekong Region. Chiang Mai: USER Mekong Press.

General Statistics Office (GSO), 2000, 2010. Statistical data. Statistical Publishing House, Ha Noi.

Hens, L., Vromant, N., Tho, N., Hung, N.T., 2009. Salination of surface water, groundwater, and soils in the shrimp farming areas of the coastal Cai Nuoc district, South Vietnam. International Journal of Environmental Studies 66, 69-81

Hoa, L.T.V., Shigeko, H., Nhan, N.H., Cong, T.T., 2008. Infrastructure effects on floods in the Mekong River Delta in Vietnam. *Hydrological Processes* 22, 1359–1372.

Hoanh, C.T.; Guttman, H.; Droogers, P.; Aerts, J. 2003. Water, Climate, Food, and Environment in the Mekong basin in Southeast Asia. Contribution to the project ADAPT: Adaptation strategies to changing environments. Final Report. International Water Management Institute (IWMI), Sri Lanka, Mekong River Commission Secretariat (MRCS), Cambodia and Institute of Environmental Studies (IVM), The Netherlands.

Joffre, M.O., Bosma, R.H., 2009. Typology of shrimp farming in Bac Lieu Province, Mekong Delta, using multivariate statistics. Agriculture, Ecosystems & Environment 132, 153-159.

Kakonen, M., 2008. Mekong Delta at the Crossroads: More Control or Adaptation? Ambio 37, 205-212.

Khang, N.D., Kotera, A., Sakamoto, T., Yokozawa, M., 2008. Sensitivity of Salinity Intrusion to Sea Level Rise and River Flow Change in Vietnamese Mekong Delta-Impacts on Availability of Irrigation Water for Rice Cropping. Journal of Agricultural Meteorology 64, 167-176.

Le Coq, J.F., Dufumier, M., Trébuil, G. 2001. History of rice production in the Mekong Delta. In the 3rd Euroseas conference, 6-8 September 2001, London; European Association for South-East Asian Studies. *Environmental change and livelihood politics : linking labour and environmental agendas*.

Label, L. and Bach Tan Sinh, 2007. Policies of Floods and Disasters. In: Lebel, L., Dore, J., Daniel, R. & Koma, Y. S. (Eds), Democratizing Water Governance in the Mekong Region. Chiang Mai: USER Mekong Press.

Molle, F., 2007. Irrigation and Water Policies: Trends and Challenges. In: Lebel, L., Dore, J., Daniel, R. and Koma, Y. S. (Eds), Democratizing Water Governance in the Mekong Region. Chiang Mai: USER Mekong Press.

MONRE, 2006. National water resources strategy towards the year 2020. Ministry of Natural Resources and Environment, Ha Noi.

Nguyen, T. P. L., 2010a. Legal framework of the water sector in Vietnam. ZEF working paper No 52, Center for development research, University of Bonn, Germany.

Nguyen, T. P. L. 2010b. Problems of law enforcement in Vietnam: The case of wastewater management in Can Tho city. ZEF working paper No 53, Center for development research, University of Bonn, Germany

Nhan, D.K., 2009. Rice yields and economic returns in the Mekong delta in the period of 1996-2006. Scientific Journal of Can Tho University 12, 212-218..

Nhan, D.K., De, N.N., Thanh, D.N., 2002. Socio-economic and environmetal impacts of rice intensification and opportunities for rice production in the Mekong Delta, Vietnam. Paper presented in workshops on "rice marketing liberation with its socio-economic and environmental impacts"" held on 8-9th November 2002 in Hue city of Vietnam by Hue University and UNEP.

Nhan, D.K., Be, N.V., Trung, N.H., 2007. Water use and competition in the Mekong Delta. In: Be, T.T., Sinh, B.T., Miller, F. (eds), *Chalenges to sustainable development in the Mekong delta: regional and national policy issues and research needs*. Sumernet, pp. 143-188.

Nhuan, T.N., 2010. Farming practices, yields and economic returns in Pangasius catfish farming in Ben Tre province: Planning and policy implications for sustainable development. Msc.Thesis, Nha Trang Fishery University, Viet Nam (in Vietnamese).

Nijssen, B., O'donnell, G.M., Hamlet, A.F., Lettenmaier, D.P., 2001. Hydrologic sensitivity of global rivers to climate change. Climatic Change 50, 143–175.

Pham, C. H., Ehlers, E., and Saravanan, V.S., 2009. Dyke system planning: Theory and practice in Can Tho city, Vietnam. ZEF working paper No 47, Center for development research, University of Bonn, Germany.

Phan, L.T., Bui, M.T., Nguyen, T.T.T., Gooley, G.J., Ingram, B.A., Nguyen, V.H., Nguyen, T.P., De Silva, S.S., 2009. Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta, Vietnam. Aquaculture 296, 227–236.

Phuong, N.T., Oanh, D.T.H., 2009. Striped catfish (*Pangasianodon hypophthalmus*) aquaculture in Viet Nam: an unprecedented development within a decade. In: De Silva, S.S., Davy, F.B. (Eds.), Success Stories in Asian Aquaculture. Springer, NACA and IDRC, pp. 133–149.

Sam, L., 2006. Saline water intrusion in the Mekong delta. Agricultural Publishing House (in Vietnamese).

Sanh, N.V., Xuan, V.T., Phong, T.A., 1998. History and future of farming systems in the Mekong Delta. In: Xuan, V.T., Matsui, S. (Eds.), Development of farming systems in the Mekong Delta. Ho Chi Minh Publishing House, pp. 16-80.

Trang T. T. Q., 2005. Water Resources Management in Vietnam. Workshop on the Water in Mainland Southeast Asia, Siem Reap, Cambodia, 30th November – 2nd December, 2005.

Truong, T.V., 2009. Water Resources Development Strategy in the Mekong Delta. An internal consultant paper.

Vinh, K.Q., 2009. Changes in Hau river's water quality and hydrological regime. Presented in Forum on Mekong environment and livelihood: the changing situation and transboundary implications 3-4 Feb 2010

Weibel, G. (2010). State management in transition: Understanding water resources management in Vietnam. ZEF working paper No 55, Center for development