Planning and Implementation of the Dyke Systems in the Mekong Delta, Vietnam

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Abstract

Floods are a dangerous threat and an implicit risk for farming communities in rural floodplains of the Mekong Delta (MD). The Vietnamese government decided the dyke system construction to control floods and ensure safety for life and livelihood of flood affected communities. The case study of this dissertation refers to Can Tho city, an average floodplain community of the MD, covering also 9 districts. Here a comprehensive dyke system has been constructed to control flood risks.

This thesis investigates the existing problems in the dyke system planning and its implementation, dyke impacts on the natural environment and socio-economic development as well as the adaptability of the flood affected farming communities in the protected floodplains. The study used both qualitative and quantitative research methods to collect information and data. Besides Global Positioning System (GPS) and a digital camera were used to identify the location of the most important samples in the field and during the fieldwork. Fieldwork itself was mainly based on the two rural communes of Thanh Thang and Thanh Phu, which are representative for the overall rural situation in Can Tho city and the MD.

The study found that the Vietnamese government had made a basically correct decision concerning the necessity of flood risk control by the construction of a dyke system. Dykes have practically guaranteed safety for agricultural livelihoods of the flood affected farming communities and positively contributed to agricultural farming transformation from rice into integrated rice-fish production and rural road improvement. However, a centralized top down approach was strongly applied thus not considering the experiences and all expectations of public organizations and local people. The individuals and local organizations played a very weak role in the whole planning and implementation process. Dyke system construction consequently created conflicts between central planners and local people. In addition, the negative impacts of the dyke system have become a great threat for sustainable development in terms of water pollution, natural fish exhaustion, soil fertility reduction, erosion and in some instances, also due to increasing inundation of the fields.

Thus, the dyke system construction and planning as well as implementation strategies need to be studied further to minimize the negative impacts of dyke systems and to ensure a stronger inclusion of local people and their knowledge in further planning approaches.

<u>Key words:</u> Dyke planning, implementation strategies, flood control, impact on and adaptability of rural communities

Zusammenfassung

Überflutungen sind eine permanente Bedrohung für die ländliche Kulturlandschaft, die Bewohner und ihre Aktivitäten im Deltabereich des Mekong. Die vietnamesische Regierung hat deshalb beschlossen, Deiche zur Flutkontrolle und damit auch zum Schutz der ländlichen Bevölkerung des Mekong-Delta zu bauen. Dieser Problematik widmet sich die vorliegende Dissertation am Beispiel von Can Tho city, einer typischen Gemeinde im Flutbereich des Mekong-Deltas mit insgesamt 9 ländlichen Distrikten.

Die Arbeit untersucht Probleme des Planungsprozesses und seiner Umsetzung, die Auswirkungen der Deiche auf die natürliche Umwelt und die sozioökonomische Entwicklung wie auch die Anpassungsstrategien der flutgefährdeten Reisbaugemeinden im Deltabereich. Unter Verwendung qualitativer und quantitativer Untersuchungsmethoden, von GPS und digitalen Aufnahmen wurden die für die Untersuchung notwendigen Daten erhoben. Die Geländearbeit konzentrierte sich dabei auf die Kommunen Thanh Thang und Thanh Phu, beide repräsentativ für die Region Can Tho city und das Mekong-Delta.

Die Studie kommt zu dem Ergebnis, dass die generelle Entscheidung der vietnamesischen Regierung zum Deichbau richtig war. Die Deiche haben insgesamt die Sicherheit der ländlichen Bevölkerung und ihrer landwirtschaftlichen Aktivitäten erheblich verbessert. Auch wurde die landwirtschaftliche Produktion in ihrem Übergang von einer Mono-Reis-Kultur zu einem integrierten Reis-Fisch-Produktionssystem befördert, ebenso der Ausbau der ländlichen Infrastruktur. Kehrseite der Medaille ist, dass die lokale Bevölkerung in das zentrale Planungssystem nur unzureichend eingebunden wurde, sodass Konflikte zwischen zentraler Staatsgewalt und lokaler Bevölkerung nicht ausblieben. Vor allem die negativen Aspekte des Deichsystems in Hinblick auf eine langfristig nachhaltige und positive Entwicklung werden geschmälert durch zunehmende Verunreinigung des Irrigationswassers, durch Rückgang der natürlichen Fischbestände, Verlust der natürlichen Bodenfruchtbarkeit, Erosion usw.

Ergebnis der Studie zum Deichbau ist, dass bei künftigen Maßnahmen eine stärkere Einbeziehung der lokalen Bevölkerung und ihres Wissens dringend geboten ist, um weitere negative Effekte zu minimieren bzw. ganz auszuschließen.

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Vietnamese proverbs:

"Drinking water and remembering its source

Eating fruits and remembering growers"

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List of Acronyms and Abbreviations

APMF	Associated Programme on Flood Management
ARDO	Agriculture and Rural Development Office
AW	Autumn – Winter (rice crop)
BOD	Biochemical Oxygen Demand
CCFSC	Central Committee for Flood and Storm Control
CMP	Cau Mau Peninsula
COD	Chemical Oxygen Demand
CRED	Centre for Research on the Epidemiology of Disasters
CTU	University Can Tho
DARD	Department of Agriculture and Rural Development
DoNRE	Department of Natural Resources and Environment
EEA	European Environment Agency
EM-DAT	International Disaster Database
GPS	Global Positioning System
GWP	Global Water Partnership
IFM	Integrated Flood Management
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resource Management
LXQ	Long Xuyen Quadrangle
MARD	Ministry of Agriculture and Rural Development

MD	Mekong Delta
MDG	Millennium Development Goals
MOMB	Central parts of the Mekong and Bassac rivers
MoNRE	Ministry of Natural Resources and Environment
MR	Mekong River
MRB	Mekong River Basin
MRC	Mekong River Commission
NEDECO	Netherlands Engineering Consultants
PDR-SEA	Partnership for Disaster Reduction – Southeast Asia
PGD	Participatory group discussion
POR	Plain of Reed
RRA	Rapid Rural Appraisal
SA	Summer - Autumn (rice crop)
SAARC	South Asian Association For Regional Cooperation
SAPSI	Southern Aquaculture Planning Research Institute
SIWRP	Southern Institute of Water Resources Planning
SIWRR	Southern Institute of Water Resources Research
SPSS	Statistical Package for Social Sciences
SSI	Semi-Structured Interviews
Sub-NIAPP	Sub-National Institute for Agricultural Planning and Protection in the Southern

UMB	Upper Mekong Basin
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UN	United Nations
VND	Vietnam Dong
ZEF	Center for Development Research
WISDOM	Water-Related Information System for the Sustainable Development of the Mekong Delta
WMO	World Meteorological Organization
WS	Winter - Spring (rice crop)

1: DYKE SYSTEMS IN THE MEKONG DELTA-AN INTRODUCTION

1.1 Purpose and scope of the study

Floods have the greatest damage potential of all natural disasters worldwide affecting the greatest number of people. The number of affected people and economic damages from flooding and especially from extreme floods is raising an alarming bell within the context of climate change discussions (UN 1998). The Vietnamese Mekong Delta (MD) is an extremely vulnerable and damageable flooding region compared to other countries in Southeast Asia. Mekong Delta people have coped with and adapted to a number of "natural disasters" and "human disasters." Dyke works can be considered as a potential human disaster in the flooding context of the MD because flood control measures have caused a number of negative impacts for the ecosystem and the inhabitants' daily life and livelihood in the flooded areas. In the MD, flooding is actually both a dangerous challenge and a favorable opportunity for inhabitants. Flood control therefore is a necessity in the MD. However, identifying effective flood control measures has been and still is a great challenge for inhabitants and local political decision makers. For the MD, living in line with floods is the best appropriate option for human and sustainable development. All efforts should be harmonious with floods and their impacts rather than against them. This study focuses on analyzing problems related to ecology in floodplains, flood disasters and the impacts of the dyke system planning to control floods in the MD.

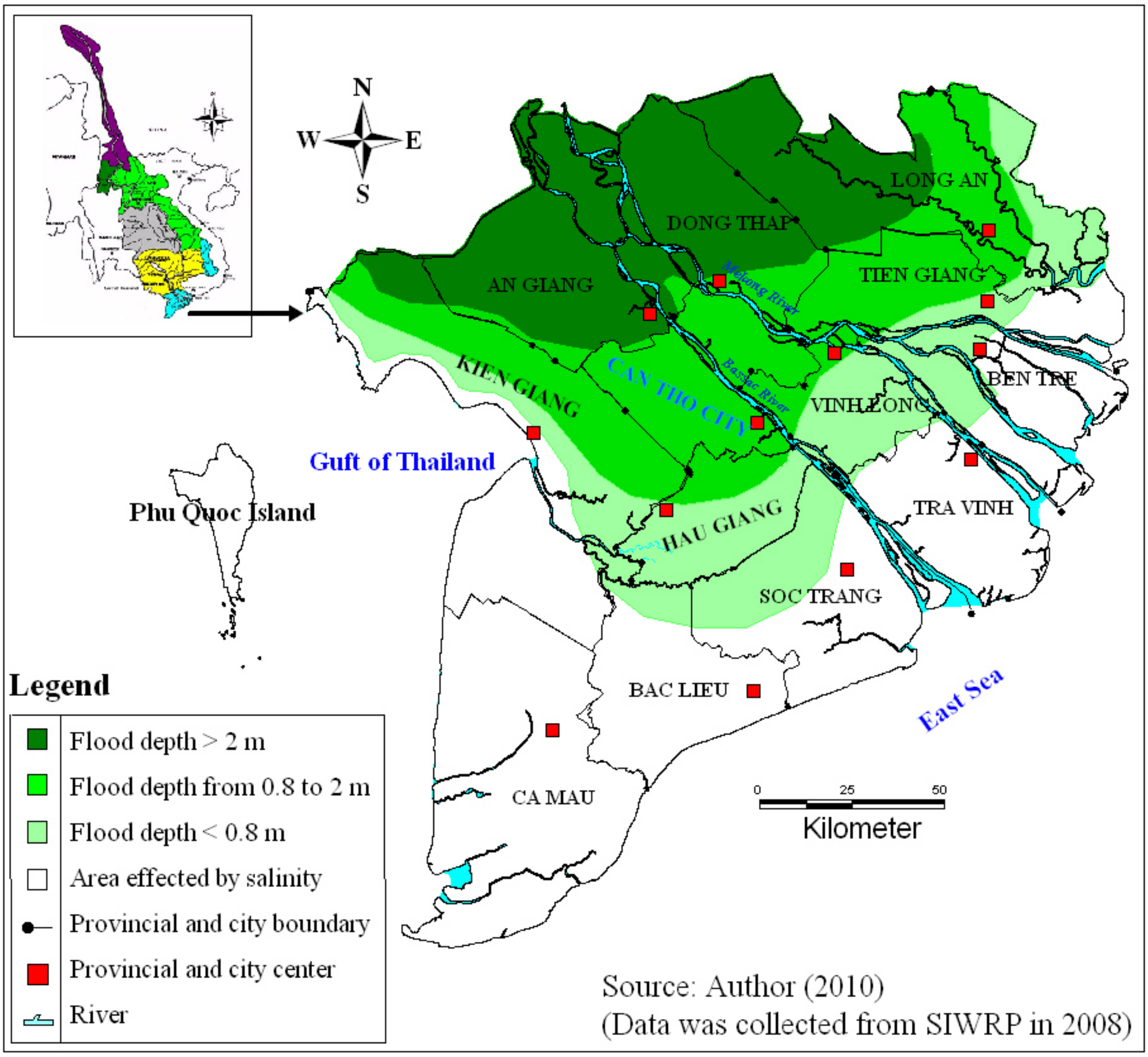
Currently, society is hit by a great number of natural disasters. Especially flood disasters leading to the dislocation and disruption in the lives of people and communities play an increasingly important role (Kumagai et al. 2006). Flood disasters usually not only cause greater losses and economic damages in developing countries than in developed countries, but they also affect a much broader part of their populations. Their occurrence is based on a number of main factors. First, there is a relation to geographical location and geological-geomorphologic settings of the flood-prone areas, sensitively affected by flooding. Second, the economic, social, political and cultural conditions of these countries and their populations are inadequate tackle the challenges (Ayala 2002). Therefore, the report on the development of the Millennium Development Goals (MDG) in 2010 emphasized that natural disaster reduction is one of the important goals to alleviate poverty because natural disasters increasingly have caused death, disability and economic loss as well as ecosystem degradation globally and especially in poor countries (UN 2010).

Floods are a natural phenomenon. They become a natural hazard and disaster in many countries in the world because their inundations cause death and economic damages in unprotected, but heavily populated low-lying plains. Because of poverty, rapid growing population and arable land scarcity, people are forced to develop their livelihood activities in these risky flood-prone areas (Cuny 1991; Plate 2002). It is difficult to predict and foresee the consequences of flood disasters whenever extreme floods occur in the flood-prone areas of the world. The main causes of extreme flood derive from the impacts of climate changes, especially due to the increase of greenhouse gas emissions and associated global warming (Dasgupta et al. 2009; Ericson et al. 2006; Nguyen Thi Thuy Hanh and Furukawa 2007). Recently, many nations have encountered floods and natural disasters, e.g. the United Kingdom, Germany, Italy, Spain, France, USA, Canada, New Zealand, Bangladesh, India, China, Philippines and Vietnam. In almost all cases developing countries suffered more severe damage than developed ones (Apel et al. 2009). In 1998, the entire Yangtze drainage area in China experienced tremendous flooding events resulting in the economic loss of 20 billion US dollars (Yin and Li 2001). In New Orleans and the Mississippi River Valley of the United States, the property damage of the 1927 flood was estimated at approximately 400 million US dollars (Gordon and Little 2009), negligeable in comparison to the heavy damage of hurricane Kathrina and its impacts in 2004. In many cases developed countries are better able to control and manage floods and their impacts. In developing countries, by contrast, floods have become a dangerous challenge due to the lack of advanced science and technology to predict them, to overcome them and to deal with their often catastrophic results, also because of technical know-how and adequate financial resources.

As a developing country located in Southeast Asia, Vietnam has annually suffered natural disasters such as typhoons, tropical storms, floods, inundation, drought, salt penetration, landslides, and earthquakes for centuries. The Vietnamese people have recently, however, experienced an increase in their numbers. In a summary report of natural disasters from 1995 to 2006, the number of deaths was 9,416 people. The total estimated damage due to storms, floods and drought was VND[1] 61,479 billion (PDR-SEA 2008). In view of these facts and figures natural disaster reduction and risk mitigation are currently priority problems of Vietnam's government.

[1] VND: 1 US dollar is equivalent to VND 18,000

Map 1.1: Flood-prone and brackish areas in the Mekong Delta



In Vietnam, the MD is the most vulnerable flood-prone region (Map. 1.1). Annual flooding is both a dangerous challenge and a favorable opportunity for life and agricultural livelihoods of people (Pham Cong Huu et al 2009; Käkönen 2008). Mekong River water is everywhere and is the basis of agricultural livelihood, transportation, communication, fishing and all kind of daily domestic uses of the deltaic people (Käkönen 2008). As a pure agricultural region, it provides food for at least 18 million residents. The MD plays an important role in guaranteeing national food security and contributes heavily to the economic and social development of the country. Natural conditions in terms of land, water and climate are favorable for agricultural development – and agriculture is still a major component of Vietnam's economy. Therefore, most of all crops, domestic animals and aquaculture are being raised in this area. Additionally, canalization and river networks have been developed to provide water for agricultural development, but also to ensure the run-off of floodwater in the MD. Annually, the MD provides approximately 18 to 21 million tons of rice and 2 to 2.7 million tons of fish (GSO 2008), thus contributing considerably to poverty alleviation and flood security in Vietnam.

Currently, the MD is considered to be an extremely vulnerable flooding region located at the downstream end of the Mekong River Basin. Annual inundations are the biggest challenge of the MD because it always threats daily life and agricultural livelihood activities of its inhabitants. Almost all people living in this region have to suffer from the inundations caused by upstream flows, tides, storm surges, storm rainfall or marine salinity intrusion (Le Thi Viet Hoa et al. 2008). The flooded area in the delta is estimated to be approximately 1.2 to 1.8 million ha in high flood years, and flooding lasts from 2 to 6 months (MRC 2001a; To Van Truong 2002). In a review of historical flood events from 1991 to 2005 specifically for the MD region, the total estimated flood damage was considered to be VND 11,842 billion, and the number of deaths was 2,032 people of which the flood of the year 2000 caused the most serious damages (http://www.ccfsc.org.vn).

In view of these facts it is understandable that floods and their disasters are considered to be the core problem of the MD. The tremendous floods (or extreme flooding) are not only the main cause of vulnerability and great damages for inhabitants in the flooding areas, but they are connected with water pollution, land fertility decline, plant diseases and other problems in the flooding areas of the MD (Estellès et al. 2002; Le Quang Minh et al. 1997; Nguyen Hung Minh et al. 2007; Duong Van Nha 2006; White 2002). Industrialization, urbanization and other human interferences are major sources of anthropogenic water pollution and ecosystem degradation leading to a significant ecological imbalance of the whole region.

Nowadays, in order to reduce flood disasters and risks in the vulnerable flooding areas, structural and non-structural flood control measures have been applied in many countries including Vietnam. Structural measures like hydraulic works, dikes and dams have been constructed for centuries to reduce flood damages, prevent overflows and ensure quick outflow of flood volumes (Poulard et al. 2010). Non-structural measures offer diverse approaches that are flexibly conducted depending on the flooding context to cope with floods rather than flood control. Canalization and river systems are built in floodplains in order to increase the natural self-restoration of floods. Besides, appropriate arrangements of land use structures and improvements of self-restoration capacities of both land and water in the floodplains are measures to create additional socio-economic benefits in comparison to traditional measures such as dike strengthening (Brouwer and Ek 2004). Drawing experiences from flood control measures in many countries, researchers propose a combination of structural and non-structural measures as the most appropriate option to mitigate floods and their negative impacts in vulnerable flooding areas (Braga 1999; Faisal et al. 1999; Sukegawa 1988; Tucci and Villanueva 1999).

In pursuit of the MDGs and in order to ensure agricultural livelihood and infrastructure in the flooding context of the MD, the Vietnamese government responded to flood catastrophes by issuing Decision 99TTg on February 09th, 1996 regarding long-term orientation in a 5-year plan from 1996 to 2000. The aim of this decree is to develop irrigation and infrastructure, transportation and construction in rural areas and to respond to the flood risks in the MD. In order to implement this decision, the Ministry of Agriculture and Rural Development (MARD) was assigned to set up and implement a program called Mekong Delta general flood control planning. In this plan, the dyke system was identified as an optimal flood control measure for the whole Mekong Delta including safety and benefits for agricultural production and for the life of people in the floodplains (SIWRP 1998b, 2005a). As a result, dyke systems were constructed in all flood-prone areas of the MD. In the upper part of the delta provinces such as An Giang, Dong Thap and Long An were included as much as the lower ones like of Kien Giang, Soc Trang, Hau Giang Tien Giang, Vinh Long provinces and Can Tho city.

So far, the dyke system has brought specific benefits to the protected floodplains in terms of increased security for people and rural infrastructure. The other side of the coin, however, have been severe increases of natural resources degradation, erosion and water pollution since the year 2000. Previous studies show that the dyke system is one of the main causes leading to erosion, plant diseases, soil fertility decline and natural degradation in the protected flooding areas of the MD (Tran Nhu Hoi 2005; Duong Van Nha 2006; Sarkkula et al 2008). Other negative impacts are changes in flow velocity and annual flooding levels with negative effects in both protected and non-protected flooding areas. Especially the high dyke system obstructs the fine-sediment flow into agricultural lands. In the long run, the flooding conditions may even worsen and estuarine siltation resulting from the construction of dams may also be negatively affected (Le Thi Viet Hoa et al. 2007; Käkönen 2008). Already now ecosystems in the floodplains have been degraded due to human intervention measures with degradation of natural fish resources biodiversity and loss of soil fertility (Hirsch et al. 2006). Besides, the new dyke system has increased risks from storm surges and catastrophes as a result of breaks and leakages of the dykes. Altogether, one may very well argue that the undoubtedly positive effects of dyke construction measures in the MD are counterbalanced by a wide range of potential and real negative impacts on people and land, of which the decrease of natural fertilization of the fields by controlled river floods (Nguyen Van Pho and Vo Van Tuan 1995) are one of the major constraints.

It is obvious that the dyke system has created unforeseeable diverse impacts on life, agricultural livelihood activities of people and ecosystems in the whole MD. Therefore, it is not surprising that the impacts of the dyke system have caused conflicts among provinces and between local people and planners in the overall context of flood control and its management. The negative impacts of the dyke system were mainly addressed from technological studies and partly solved by technical interferences. Social aspects, however, have been widely ignored in the existing scientific literature on the MD development. This is the more surprising since local organizations, grass-root institutions, farmer communities and individual farmers possess a wealth of knowledge of how to tackle the ecological impacts of the dyke system. It is therefore the purpose of this study not only to understand and discuss the "**planning and implementation of the dyke system in the Mekong Delta",** but also to investigate the reactions of the farmers and of affected farming communities with the ultimate aim and goal to include their experiences and visions into the broader social and economic context of the project area.

In view of this broad approach, the vast extent of the MD and the complexity of its recent developments and changes it is clear that the study has to be focused regionally. Therefore this study was conducted in the current flooding situation of Can Tho city. As mentioned before, it is based on social perceptions and reflections of governmental organizations and local communities, where appropriate data were collected between 2008 and 2009. Technical and engineering aspects of the MD dyke system are not part of this study.

1.2 Research objectives, research questions and hypothesis

1.2.1 Research objectives

The construction of a dyke system to control floods in the MD to mitigate disastrous consequences for life and agricultural production is one of the main political purposes of planners and of the Vietnamese government. Due to the fact, however, that this planning and its implementation has been predominantly a top-down approach by central governmental agencies without specific knowledge of regional and local conditions, new challenges beyond the dyke system have arisen for inhabitants and local organizations in the MD. Pursuing a participatory integrated research approach from a bottom-up level, all endeavors of this study aim at addressing the existing problems in the planning and implementation of the dyke system from a bottom-up perspective. This research therefore focuses on experiences and perceptions of local communities and the impacts of the dyke system on their specific ecological as well as socio-economic situation.

The research objectives of the study are:

(i) to understand the interaction, relationship and the existing problems in the decision-making process of dyke system planning by governmental organizations;

(ii) to analyze critically the impacts, barriers and constraints of the implementation process in the protected flooding areas at district level; and

(iii) to understand and analyze farmer communities' adaptation to the dyke system from social perceptions and reflections of farmer communities and grass-root organizations at commune levels.

1.2.2 Research questions

Dyke construction has threatened the sustainable agricultural livelihoods of inhabitants and effective flood management in the MD. Trade-off between advantages and disadvantages of the dyke system has not been addressed adequately in the protected floodplains. In order to understand the perceptions and reflections of farmer communities and local organizations on the impacts of the dyke system, the central question of this thesis is:

Is the dyke system a relevant flood control measure to mitigate flood risks and to guarantee the sustainable agricultural livelihoods of local people and ecosystems or has it created disadvantages for the lives and livelihood activities of local people and the ecosystems in the protected floodplains?

In the decision-making process, there are different and sometimes even contradictory perspectives, perceptions, knowledge systems and experiences of governmental organizations and local communities on flood control and management. In order to fully understand the details of the planning process, the research sub-questions are the following:

(i) How was the decision-making of the governmental dyke system planning made within the given institutional structures? - Who was involved in this decision-making?

This question is important since the implementation of the dyke system encounters a great number of obstacles and constraints because there are contradictions between practical the needs of local communities and a partly irrelevant planning design of the dykes. There are also the limitations of budget and local capacity to cope with the new structures. As a result, this implies a second sub-question which reads as follows:

(ii) How was the dyke system planning implemented in the flooding areas? - What were the barriers and constraints in the process of the governmental dyke planning implementation in the flooding areas?

The dyke system is intended to bring essential benefits for local communities as well as for the ecosystems in the protected floodplains. Therefore, perception and acceptance of local authorities and local communities are significant preconditions for the successful implementation by governmental agencies. In order to understand the adaptation of local communities to floods and to the impacts of the dyke system in the protected floodplains, a third sub-question is of relevance for this study:

(iii) How have farmer communities adapted to floods before and after the dyke system was constructed in the floodplains? - What are the assessable perceptions of farmers on the applicability and impacts of the dyke system in the protected floodplains? - Who are beneficiaries from the dyke system?

1.2.3 Hypothesis

It is part of the political reality in Vietnam that the central government decided that the dyke systems planning and its implementation is a relevant flood control measure for the MD. Thus, the Vietnamese government decided in a top-down approach and based on a politically sound decision that the dyke system has to be built to control floods and ensure sustainable agriculture development and human safety. In order to elucidate the relevance and consequences of this decision for the affected local communities and the local population as expected beneficiaries of this decision it is hypothesized that **the governmental approach is a correct and wise decision. The dyke system is seen by the government as a relevant flood control measure that needs to be implemented in the floodplains of the MD. This assumption, however, and its perception and consequences are – from a bottom-up perspective – partly adverse to the necessities and practical experiences of the local population. Therefore, farmer communities and local organizations rejected this dyke system in their practical flooding situation.**

Results of this hypothesis will provide insights and evidences in order to reflect the correct or incorrect decision-making of the government in reducing the flood risks for the agricultural livelihoods of inhabitants by the dyke system and its success or failure to achieve at least part of the MDGs. On the other hand, the experiences and knowledge systems of the local communities and local organizations in regard to improvements of the dyke system will be addressed and elucidated from the following investigations.

1.3 Theoretical and conceptual consideration

This section describes concepts and the conceptual framework that will be used to explain how floods are controlled and managed to reduce their damages and risks in the vulnerable flooding contexts of the MD. The concepts represent different approaches to tackle flood control measures, and they include the notion that flood control and flood management should include aspects of ecology, society and environment. Some concepts focus on a framework that describes and explains the interventional actions of governmental organizations and interactions between government and local people in flood control, flood risk and damage mitigation in the MD.

To the best of the author's knowledge, there are currently no comprehensive theoretical frameworks providing concrete considerations for effective flood management. Almost all theories are mainly concerned with the questions of how to prevent floods, how to cope with and adapt to them as well as how to control and manage their risks. The theoretical framework for flood management in Vietnam has largely been derived from local knowledge and traditional experiences of inhabitant communities throughout historical flood events. Thus, it is not surprising that there is actually no comprehensive flood management methodology nor models that address the concrete demands of effective flood control and management. For these reasons, different concepts of individuals and organizations are discussed in this study in order to develop a more comprehensive theoretical framework for the different aspects of flood control and management in the MD.

1.3.1 Planning theory consideration

Planning is the process for determining appropriate future actions through a sequence of choices. The planning theory must be directed to problems of practical solutions. Planning is the application of scientific methods (Faludi 1973) or a process of strategic choices and a means of managing uncertainty in decision making (Friend 1990; Friend and Jessop 1969). An important component of planning is to increase the validity of policies at the present and to anticipate future developments and consequences. It does not mean that the planners take over fields of politics (Faludi 1973). On the contrary: planning is defined as a policy choice providing options in the light of facts, projections and implications. It is a process of policy determination for orderly development to achieve given objectives (Kahn 1969). Planning is therefore an aid to policy formulation and realization through choices and rationalization. Another definition is that planning is the process of clarifying objectives, pointing up alternative solutions and their positive or negative consequences and including a continuous evaluation to improve strategies and programs (Foote and Cottrell 1955). Thus, the nature of planning is both an activity and an idea.

In order to obtain successful planning implementation, Kahn (1969) pointed out that monitoring and feedback are especially important in the process of planning implementations because planning is a continuous process, not simply a sole action. Programs and strategies may still be improved as a plan moves from the drawing board to operational practice. Precondition is a careful analysis of what is to be achieved and which means are available to reach a pre-formulated goal. The analysis must be undertaken consciously, since it does so much to shape the objective. Thus Kahn argues that a successful implementation of any planning approach would include a number of indispensable steps, namely: (i) to clarify goals, priorities and interests; (ii) to ascertain the facts, the social realities and the trends; (iii) to develop an inventory of knowledge, skills, and resources available or obtainable; (iv) to analyze the alternatives and the predictable outcomes of choices among them; (v) to formalize impressions of preference and the process of choices; (vi) to translate policies into implication for any program at different levels; and (vii) to measure outcomes of programs. In regard to the specific aspect of social planning such outcomes could include one or more of the following: (i) new policies; (ii) improvements of program and policy coordination; (iii) innovations in program; (iv) additional choices of priorities in any of the above categories or for the allocation of resources and finally (v) changes in the administrative decision-making process.

In summary, there are different planning definitions and options depending on politicians, planners, contexts and socio-economic situations of nations, regions and/or localities. Planning is a broad and diverse concept depending on context, knowledge, experiences and the perspectives of planners and decision-makers. For the context of this study it is argued that planning is an aggregation of social and natural science knowledge, application of scientific methods in regard to given political aims in order to achieve general and specific goals in short and long terms. For the purpose of our study, i.e. the analysis of the dyke system in the MD, it means that all above mentioned considerations have to be considered as part of a comprehensive evaluation of the working hypothesis.

1.3.2 Flood control and management: Theoretical considerations

Flood management is a broad spectrum of water resource activities aimed at reducing potential harmful impacts of floods on people, environment and economy of the region (Sinosovic' 1999). There are basically two notions of flood control and management planning: (i) how vulnerable disasters and risks of floods can be controlled and managed in order to minimize the level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions (UNISDR 2009) and (ii) how floods can be appropriately managed to bring benefits and effectiveness for ecosystems, socio-economy and the environment (WMO 2009). The first intrinsic essence of flood control and management is actually to manage and minimize the disaster and risk of floods for human and property damages. As mentioned in previous sections, floods in the MD are identified as a natural hazard causing sorrowful deaths and property damages to its inhabitants. On the other hand: floods are a vital and essential need in the life and agricultural activities of inhabitants and important for the restoration of the ecosystem in the floodplains. Therefore, flood disaster and risk need to be controlled and managed to mitigate vulnerability and dangerous impacts for people in the MD.

Risk is the combination of the probability of an event and its negative consequences (UNISDR 2009). Floods are both a risk and a disaster because they usually cause unforeseeable damage and losses whenever tremendous flooding occurs in the MD. There are a number of approaches to deal with risks, such as risk disaster assessment, management and transfer. Risk management is a process of handling risks due to natural, environmental or man-made hazards of which floods are representative. Flood risk management is therefore the process of managing an existing flood risk situation (Plate 2002). Plate shows two aspects of risk flood management: (i) risk management for the operation of an existing flood protection system. It is the sum of actions for a rational approach to flood disaster mitigation. Its purpose is the control of flood disasters in the sense of being prepared for a flood, and to minimize its impact. It includes the process of risk analysis, which provides the basis for long term management decisions for the existing flood protection system; and (ii) system improvement requiring a reassessment of the existing risks and an evaluation of the hazards depending on the most recent information available, based on new data, on new theoretical developments or on new boundary conditions.

Disaster is understood as the set of adverse effects caused by social-natural and natural phenomena on human life, properties in infrastructure within a specific geographic unit during a given period of time (Serje 2002). Disaster is defined as a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope with using its own resources (EEA 2005; UNISDR 2009). Disaster risk is the potential loss of lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period (EEA 2005; UNISDR 2009). Floods in the MD become a disaster when they exceed the adaptability of local communities and cause property damages and losses of life. Therefore, the flood disaster management process should be coordinated with efforts made in closely related fields because local communities and local authorities are the ones who suffer the most and their response to these disasters has very often to be more immediate than the arrival of external help and support (UN 1998).

In addition, floods should be seen not only negatively because inundations are possibilities to rebuild a better place where people have just lived on the basis of available resources that nature provides (Kahan et al. 2006). Practically, structural measures in terms of dykes and dams in combination with elaborate irrigation systems are best practice solutions to control floods and to create a more advantageous environment for life and livelihood of local people. Over time, however, human intervention measures can become so complex and so uncontrollable that they make matters worse. However, in many instances the negative impacts of these measures are uncertain and unforeseeable and become apparent only after the negative consequences of structural measures happen in the reality.

Flood control and flood management are gradually developing towards what has been called "sustainable flood management". According to Baker et al. (2006), sustainable flood management must balance the risks of a wide range of complex human, social, economic and environmental dimensions that often interact with one another. They argue that flood management was historically not tended to do this. Instead, it was mainly focused more on economic and human safety aspects. Historical flood management methodologies are – from a present-day perspective – unsustainable because they are focusing mostly on economic impacts and pay little attention to environmental and social impacts of floods (Baker et al. 2006; Sinosovic' 1999). Therefore, the role of the environment in flooding and its interactions with other areas, where risk might be experienced, deserves more attention than in the past (Baker et al. 2006).

Nowadays, flood management is understood as a highly diversified, integrative and multi-interdisciplinary approach. Interventional measures are integral to improve the functioning of river basins and irrigation systems, to utilize the advantages of floods, to maximize the efficient use of the floodplains and to minimize loss of life and flood damage and risks in the vulnerable flooding areas. Therefore, in Program Association and Flood Management (APFM)[2], World Meteorological Organization (WMO)[3] and Global Water Partnership (GWP)[4] promote the concept of Integrated Flood Management (IFM) as a new approach to flood management. This concept has been accepted since the Dublin conference in 1992. The concept of Integrated Flood Management (IFM) is defined as follows:

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[2] APFM is a joint initiative of the World Meteorological Organization and the Global Water Partnership. It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management. The programme is financially supported by the governments of Japan and the Netherlands.
[3] WMO is a Specialized Agency of the United Nations. It coordinates the meteorological and hydrological services of 189 countries and territories and the centre of knowledge about weather, climate and water.
[4] GWP is an international network open to all organizations involved in water resources management. It was created in 1996 to foster Integrated Water Resources Management.

"Integrated Flood Management is a process promoting an integrated-rather than fragmented–approach to flood management. It integrates land and water resources development within the context of Integrated Water Resources Management (IWRM), and aims at maximizing the net benefits from floodplains and minimizing loss to life from flooding"(WMO and GWP 2004).

The view of the IFM is to maximize the efficient use of available nature resources of which land and water are identified as scarcity resources that have to be managed in a sustainable way. Obviously, IFM not only reduces the losses and damages from floods but also maximizes the efficient use of land and water in the floodplains - particularly where land resources are limited.

Altogether it is appropriate to argue that floods are connected with situations of competing claims and necessities. Under such circumstances integration of research, planning and implementation as well as coordinated reactions to floods are of utmost importance. Political commitment to IFM principles and practice is critical. Strategies developed by IFM need to be translated into specific policies for planning and the allocation and management of resources on local levels. Linking flood management with IWRM, providing inter-sectoral linkages and including stakeholder participation call for a substantial overhaul of traditional policies, laws and management institutions. The main claims of the IFM are (i) to manage water cycles, to evaluate risks and uncertainties of floods, land and water resources; (ii) to integrate land and water management; (iii) to adopt a best-mix of strategies; (iv) to ensure a participatory approach; and (v) to adopt integrated hazard management approaches (WMO and GWP 2004).

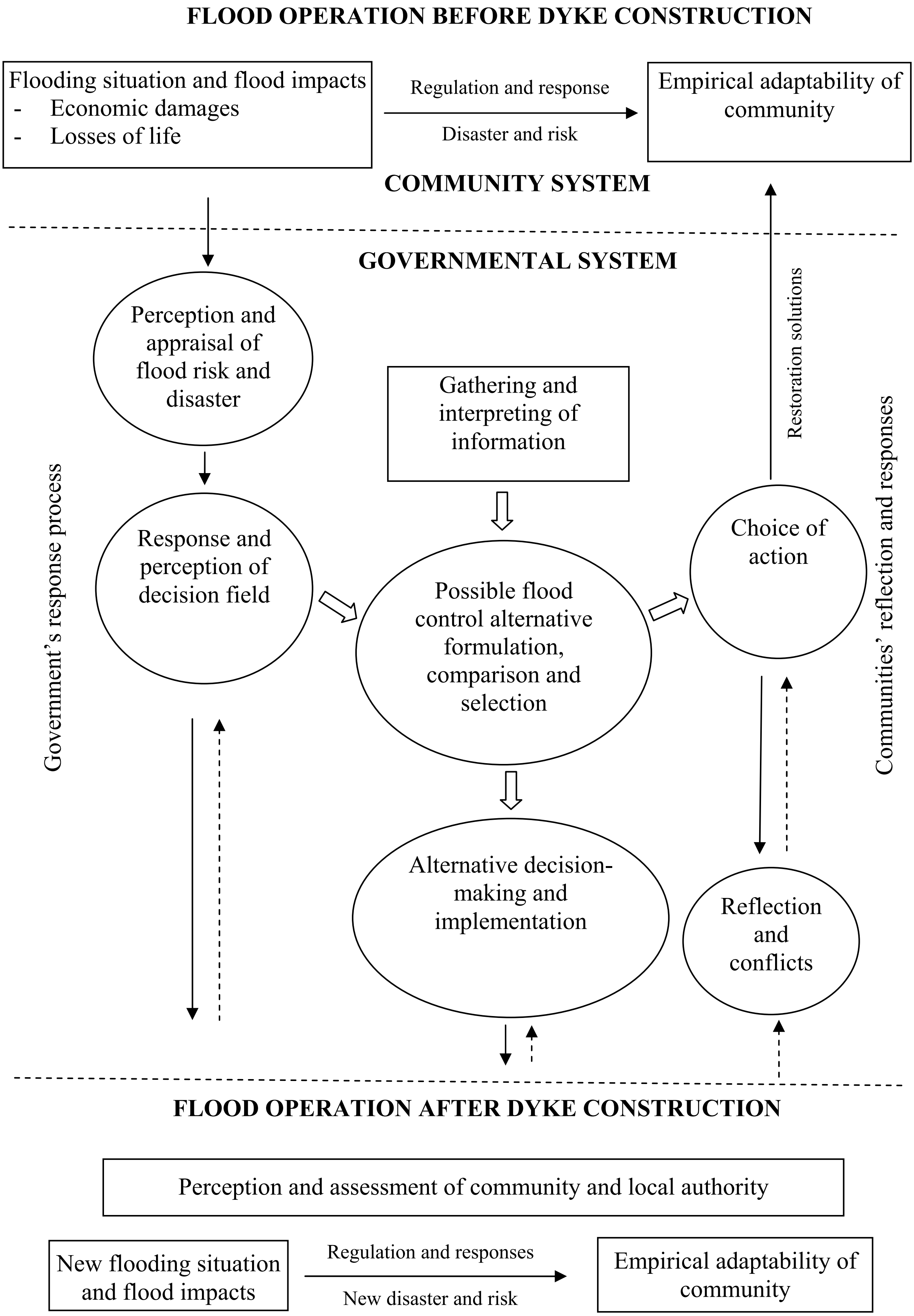
The basic aim of the IFM is to reduce vulnerability, increase people's resilience and develop a culture of prevention through preparedness rather than reactive responses alone. Flood management options have to consider constraints, risks, uncertainties, conflicting objectives, challenges and opportunities that are involved in the participatory approach towards decision-making. Options should not only be technically appropriate but should also address broader socio-political issues. The need to deal with social concerns and involve experts and civil society in the decision-making process is the main key to IFM strategies. These concerns can be qualitatively incorporated through the active participation of all stakeholders, including civil society at various decision-making levels and stages. Multi-stakeholder engagement is the key to the success of IFM as it ensures strong stakeholder support and is a catalyst for proactive engagement in flood issues (WMO and GWP 2004). On the other hand, IFM is facing many challenges. Especially after catastrophic floods there is an understandable desire and pressure to bring short-term benefits. In these cases, IFM requires certain basic inputs and a conducive environment for its effective implementation (WMO and GWP 2004).

In summary, floods should be controlled and managed to reduce vulnerability and flood damage. Flood control measures are applied to mitigate flood risks for human life. However, how to make a decision to deal with flood risks in short and long-term strategies is a key issue of flood management. The flood mitigation approach is one of essential strategies for the flood affected areas (Apel et al. 2009) and must be seen as an integral process of advantage utilization and disadvantage limitation of floods. Available natural resources in terms of land, water, natural fish source and alluvium soil must be incorporated effectively and sustainably while dangerous impacts of floods need to be controlled and managed in order to mitigate vulnerability for inhabitants in the floodplains. Effective planning measures require the understanding of all factors that can cause losses due to flooding, and multiple actions must be taken to proactively manage the flood risks (UN 1998).

1.4 Conceptual framework

The concepts described in previous sections are basic preconditions in order to set up a conceptual framework for this study (Fig 1.1). The nature of planning is a process of strategic choices at local, regional and national levels. Friend and Jessop (1969) offered a system approach considered to be an instruction of any planning process. The idea of the system approach is a basic framework that is understood as a continuing dialogue between different systems, e.g. a governmental system and a community system. In this approach, perspectives of governmental agencies and communities can be juxtaposed and considered. In regard to the governmental system, for instance, the legal aspects of the system are analyzed through a combination of social, political, economic, functional, and other frames of reference; likewise, in community systems, a rich network system of relationships between people and environment is covered. Individuals, farmer households and organizations are involved in the community system and in the governmental system. Friend and Jessop (1969) developed altogether four models of planning processes. These are (i) basic dialogue, (ii) response selection or (iii) possible action comparison and choice

Figure 1.1: Conceptual framework
(Modified from model 3: the context of operation of Friend and Jessep (1969))



and finally (iv) operational context and uncertainty response. The nature of all these models is a process of dialogue and interaction between the two parties with the aim to formulate a coherent planning process. In public planning it is difficult to identify sufficient strategies in advance in order to cope with all conceivable contingencies because of the complexities of the community and its imperfect understanding in the governmental system (Friend and Jessop 1969).

In applying the third of Friend – Jessop's models, the following operational and conceptual framework is being suggested for the purpose of this study (Fig. 1.1). It depicts the organization of traditional flood operations before dyke constructions started and tries to indicate the changes that have been effectuated as a result of communal and governmental choices of action.

Due to the size of the MD, its vast extent and the fact that the Mekong River is an international waterbody with conflicting interest in regard to the use and management of the river flow, floods in the MD are of a very complex dynamic nature. At the same time and for similar reasons, MD floods are an extremely dangerous threat that needs to be controlled and managed in order to reduce damages and losses of life. Based on the afore mentioned system approach and the planning models of Friend and Jossep (1969), the main contents of the conceptual framework study is to consider the existing problems in dyke system planning and its implementation as well as to scrutinize the impacts of the dyke system on the flooding situation of the MD. The application of the conceptual framework is based on the following observations and assumptions: The flood situation and flood disasters are reconstructed in a historical perspective before dyke system construction by governmental planning organizations was implemented. Actually, this approach is suited to gain a general insight regarding the traditional adaptability and resilience of local communities to floods before the dyke system construction. With other words: interests, adaptive experiences and livelihood activities of local communities are reconstructed, considered and evaluated carefully before dyke system planning. The historical flooding situation and flood problems influencing local communities are analyzed to identify the priority problems that had to be solved in the flooding areas of the MD. This approach also includes the analysis of preliminary studies commissioned by the government in advance in order to understand the situation.

The second stage of the conceptual framework is to consider the response processes of the government to flood problems. The contents of this stage are an evaluation of the governmental dyke system planning design and their attempts to develop alternatives and solutions to deal with flood problems. There are many flood control alternatives that have been formulated and evaluated to select the appropriate technological and engineering solutions for the problems at stake. The study wants to evaluate the decision-making process of the government, the participation of local community and local organizations in this process. It will be shown that governmental planners actually discussed with local community leaders and local governors in order to find most appropriate solutions. On the other hand, however, there are very different perspectives and obvious gaps between local people and governmental planning organizations that need to be reconciled in the process of the dyke system planning.

The final step of the conceptual framework is to examine the operational context and responses to uncertainty after the dyke system construction has been implemented. There are possible new risks and unpredictable problems that are appearing in the flooding areas after dyke construction. The new risks and impacts of the dyke system need to be considered and assessed by both community and local organizations. Therefore, reflections of local communities and local governments as well as responses to new risks and problems have to be considered and incorporated into the analysis of this study.

The conceptual framework is applied by taking Can Tho city in Vietnam as a case study. This city and its rural hinterlands as well as their political structures and hierarchies are well suited to understand the integration of various sectors and their ability and conflicting interests to address the existing problems related to the dyke system construction and the social needs of local communities. In concrete terms: Can Tho city and two of its associated districts shall serve as a transferable case study to look at flood risks and disasters, the response processes to floods by both governmental system and the local communities, to analyze the participation of organizations in the process of dike system planning and their impacts on the processes of the dyke system planning with the ultimate aim and goal to maximize benefits and reduce damages of floods to life and agriculture production of people in the protected flooding areas. This approach includes an analysis of the advantages and disadvantages of the dyke system planning under three aspects: economy, society and environment. Finally, opportunities and new challenges for the development of Can Tho city will be addressed in this study and general recommendations will be formulated in order to transfer the experiences and results of this research study to other comparable sections of the MD.

1.5 Research methodology and design

1.5.1 Research sites

As mentioned before, this study divided the MD into three flooding areas based on the different flooding levels between the floodplains (Map. 1.1):

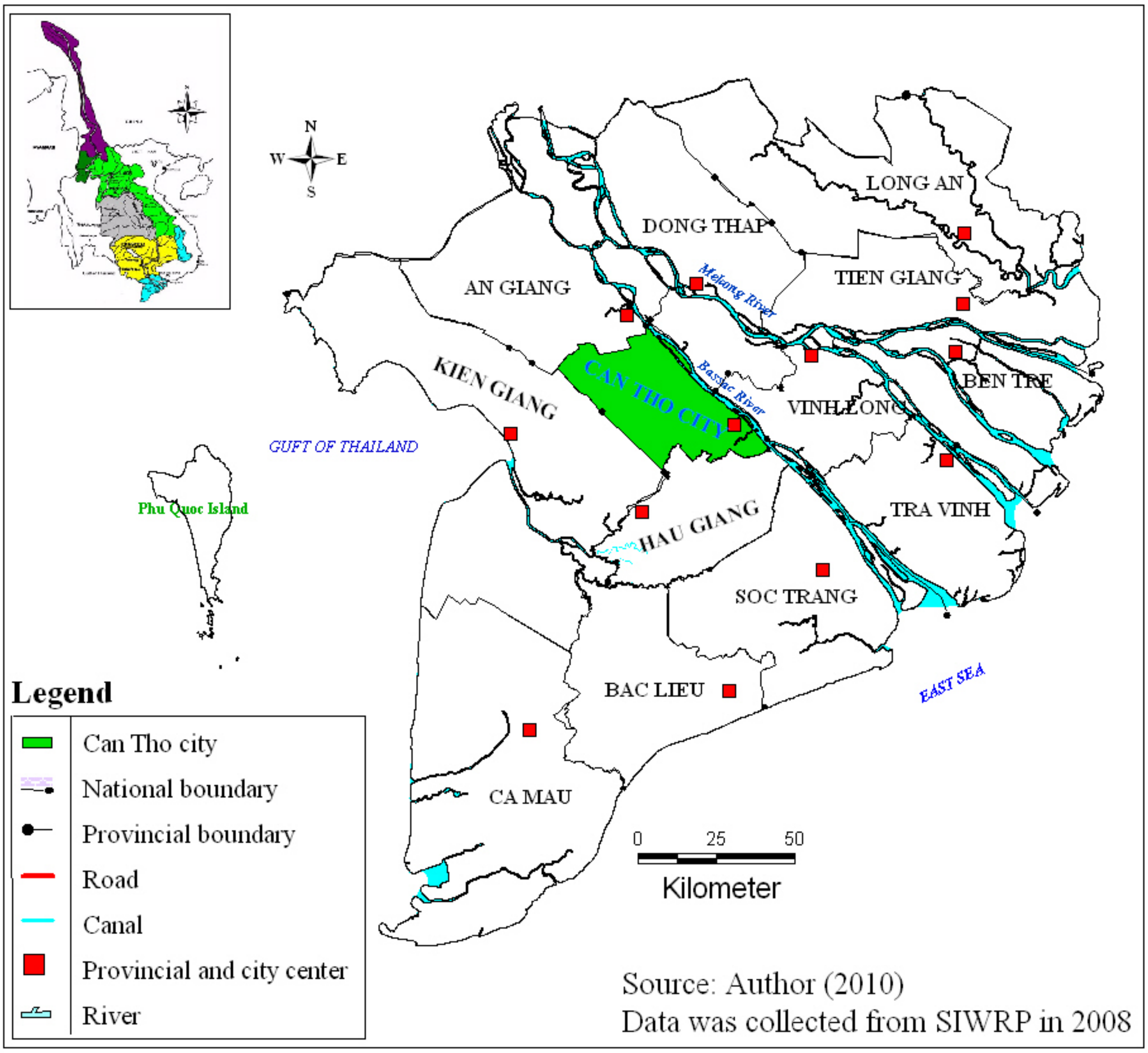
(i) deep flooded areas with flood depth deeper than 2 meters and located at An Giang, Dong Thap and Long An provinces;

(ii) average flooded areas with flood depth from 0.8 to 2 m including Can Tho city and two provinces Vinh Long and Tien Giang; and

(iii) the rest of flooded areas i.e. the shallow flooded areas consisting of Hau Giang, Soc Trang, Tra Vinh and parts of Bac Lieu and Ben Tre provinces.

Can Tho city was chosen (Map 1.2) as a representative case study for average flooded floodplains of the MD. Can Tho city is located in the center of the MD. It belongs to the section with an average flooding level. Besides, Can Tho city is considered to be an important location because the estuary system of the MD is convenient to control flood flows from An Giang province in the North and allocate floodwater distribution within Can Tho city and the lower flooding areas. Especially, the canal and river systems are advantageous to control the flooding level and flood flows from the upstream areas and their run-off to the West and the East Sea. Additionally, the dyke system has been constructed to control the flooding level for the whole of Can Tho city and for the lower flooding areas such as Kien Giang, Hau Giang, Soc Trang, Tra Vinh provinces. It is for these reasons that Can Tho city can claim representativeness for large parts of the MD and its problems. Nevertheless, the impacts of the dyke system have threatened the sustainable development of the protected floodplains and have caused conflicts between local people and planners, which also can claim representativeness for the overall situation of the MD. The planning design and the impacts of the dyke system in Can Tho city therefore are suited to draw lessons before the dyke projects will be implemented completely in the coming years.

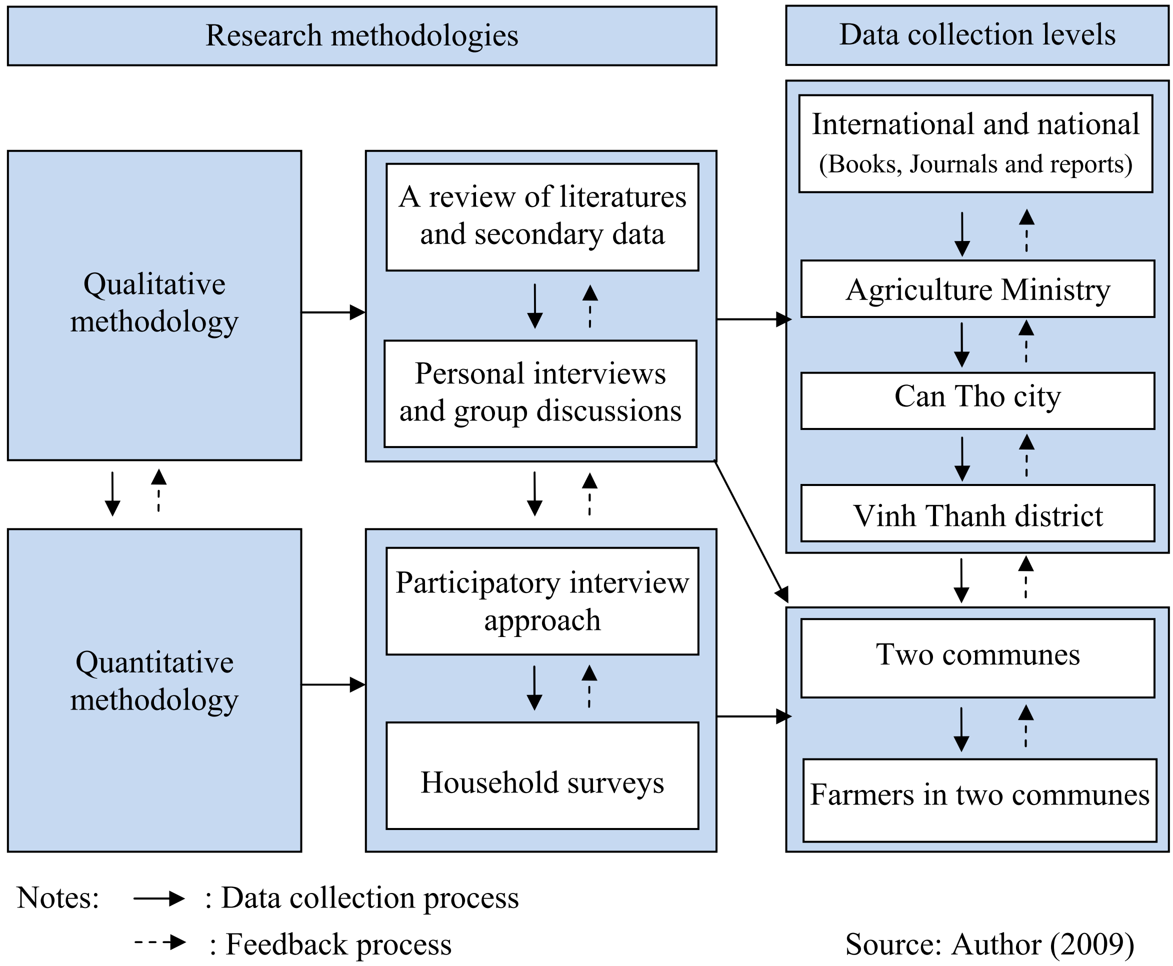
Map 1.2: The location of research site in the Mekong Delta



1.5.2 Research methodology

The research methodology of the thesis is a combination of qualitative and quantitative methodologies. These methods were alternatively employed during the process of data and information collection in the fieldwork. The qualitative methodologies are defined as a review of literature, personal interviews and group discussions to collect the information from governmental organizations, local farmers and communities and others engaged in the process of flood control and flood management measures in the MD and Can Tho city. The quantitative methodologies consist of methodologically prepared participatory group discussions and household surveys in order to generate detailed information at household levels. It is self-understood that qualitative information and data collected from qualitative as well as quantitative research methods were compared again and again in order to ensure the viability of the data. Data collection was conducted between April 2008 and April 2009 in rural research areas and governmental organizations in Can Tho city (Fig. 1.2).

Figure 1.2: Research methodologies and data collection process



Source: Author (2009)

The research approaches were implemented with the support of the Center for Development Research (ZEF) of the University of Bonn (UNI-BONN) and Can Tho University (CTU) within the framework of the WISDOM project. Can Tho University introduced researchers to local organizations by introductory letters in order to make the working arrangements and appointments with agencies and organizations within Can Tho city and the Ministry of Agriculture and Rural Development. In the first meetings, the research objectives of the WISDOM project and specific dissertations were introduced to find support and collaboration of local authorities. In the following appointments, long-term working plans were discussed and local authorities were requested to support the data collection. Finally, the existing problems of the dyke system planning and practice in reality were discussed to help researchers to focus their research and to prepare an appropriate and goal oriented data collection.

The qualitative research methodology mainly included desk study, telephone interviews, emails, Semi-Structured Interviews (SSI) and voice recording with the purpose to collect data and information from the national and international organizations and individuals related to flood control and flood management. In addition, tools of Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) such as participatory wealth ranking, seasonal calendar, matrix ranking and group discussions were applied to acquire additional data and information in communes and farmer communities.

The process of qualitative research methodology was conducted in the following sections. While relevant literature and practical observations were collected and analyzed to understand natural ecosystems, flood situations, flood impacts, human adaptability and governmental measures and policies to reduce the damages and risks of floods for inhabitants in the flooding areas of the MD, information on dyke system planning and practices of local organizations were collected and analyzed on the basis of materials and data given by planners and political decision-makers on different levels in Can Tho city. Secondary data and relative documents were mainly collected from the Southern Institute of Water Resources Planning (SIWRP), the Southern Institute of Water Resources Research (SIWRR), the Ministry of Agriculture and Rural Development (MARD) and local organizations within Can Tho city.

A series of personal interviews with different organizations from ministry to grass-root level organizations were conducted to generate additional basic information and materials. Special attention was given to the way of surface water resource management practices by government, local organizations and local communities within Can Tho city. Especially, the perspectives and reflections of local people on the current dyke system planning situation and the impacts of the dyke system in the MD and Can Tho city were explored. On the basis of these facts and figures the qualitative questions were formulated and pre-tested in advance with five interviewees at different organizations within Can Tho city to avoid inappropriate questions before implementing official interviews.

There were two kinds of the qualitative research questionnaires that were designed and used in the whole qualitative interviewing process. The first qualitative research questionnaire included a list of open questions that were used to interview official staff of governmental organizations by the "face to face" interview method. Interviewees' responses were directly recorded during discussible time. The second one was compiled with diverse questions such as open questions, open-ended and close questions. It was handed out and it guided the interviewees how to use questionnaires and fill in additional questions with responses by themselves. Instantly, an appointment in advance with each interviewee was made to gather the qualitative questionnaire with adequate responses. Furthermore, additional sub-questions were asked to verify or falsify information from interviewees when the main researcher collected the questionnaires. Thus, each interviewee was interviewed two times. The results of personal interviews were discussed in detail in order to get feedback and additional information from the respondents. In addition, personal interviews were recorded and probed in details by telephone and email communication methods.

In order to obtain and to manage data and information in the whole process of the qualitative methodology implementation, a research assistant was hired to assist the main researcher. He was trained adequately in order to have a comprehensive understanding of the research objectives, contents and purpose of the qualitative questionnaires and to have the skills of take notes and voice recordings during interview processes. After each interview, he was obliged to write a summary of all information collected, report to the main researcher and develop eventually new questions deriving from the lessons learnt from the previous interviews.

Personal interviews were mainly conducted to collect information and data at governmental organizations. Therefore, the key interviewees were selected from different organizations relating to agricultural production activities, water environment, water and flood management, dyke planning, hydrology management and planning. There were three kinds of interviewees in the selected agencies and organizations: (i). Head or director; (ii) Technician; and (iii) Normal staff at ministry level such as SIWRP, SIWRR of MARD and local organizations within Can Tho city. Altogether, there was the total of 63 individuals who were interviewed in relation to the central topic of this study.

While all the afore mentioned data and materials were collected from organizations and persons involved in the top-down oriented planning and implementation procedures of the dyke system in the MD, an equally important, maybe even more important aspect of this study is the analysis of effects and impacts of all these measures in the perspective of local people and organizations. These groups and individuals, representing the bottom-up perspective of all these measures, are basically the main focus of this research. Not only are local people and organizations intended to be the recipients of governmental “welfare”, they also possess a supreme command of local knowledge systems, above all, however, a wealth of practical experiences with traditional flood control and adaptation strategies which, however, are only hardly and partly considered in the re-organization of the MD dyke system. Their experiences and reactions are therefore of utmost interest and form the core aspect of this research.

In order to consider and to evaluate these bottom-up experiences, a special focus has been given to farmer communities at Thanh Thang and Thanh Phu communes. Personal interviews and participatory group discussions (PGD) with communal leaders and farmer communities were conducted to investigate the perceptions of local authorities, organizations and farmer households. The PGDs were implemented at each commune and covered farmer groups in different protected flooding areas. At each commune, two PGDs with leaders of communes and villages were carried out. In the first PGD, commune’s leaders together with mass organizations’ representatives of the same commune reported and discussed socio-economics, flood events, the process of dyke planning, implementation, dyke situation, application and impacts of dyke systems in their specific flooding area. The recorded results of these discussions were probed by comparing them with practical participatory observation and fieldworks in the flooding areas and at the farmer households’ fields. At the same time, some farmers were interviewed to collect more information by in-depth interviews. The data and information of these discussions were analyzed in order to compile an additional list of open questions that was used for the second PGD.

In the second PGD, leaders of mass organizations, villages and local authorities in each commune were invited to discuss applicability and impacts of the new dyke systems. Questions relating to advantages and disadvantages for agricultural production, water quality and livelihood and life of local people were also considered. In addition, initial investment and maintenance costs of dyke system and possible improvement solutions were elaborated. In order to achieve reliable and controlled results in the second PGD, participants were divided into two discussion groups. The first discussion group included leaders and representatives of mass organizations and the People’s Committee at commune level. The second group included leaders and representative staff of different organizations at village level. The list of open-questions was handed out to each participant of each discussion group. Each participant was requested to answer all questions. Each response was written on a small paper and put up on a board. After all participants in the discussion group had completed all questions, the different answers were compared, discussed and – wherever possible – harmonized with a clear and uniform message as response to the answer. On this basis, all participants of both discussion groups summarized the difficulties, constraints, gaps and conflicts among and between participants and between groups.

The following PGDs, concentrated on personal interviews with participants, leaders and representative staff of the People's Committee and the mass organizations at each commune. These interviews were conducted in order to receive more general information on the dyke planning implementation and the livelihood activities of local people. During the interview process, individuals' perception on participation in the dyke planning implementation process and their adaptability to floods and dykes as well as the impacts of dykes on the ecosystem, water environment, flood regime and livelihood of local people were recorded. To understand perception and assessment of farmers on the impacts of the dyke system in the protected flooding areas, two PGDs with representative farmers were implemented in both Thanh Thang and Thanh Phu communes. The main contents of these meetings was to identify current livelihood activities and to discuss the impacts of flood and dyke systems, empirical flood control and water management for agricultural production, and the applicability of dyke systems in the protected flooding areas. In addition, farmer's participation in the dyke planning implementation was discussed and recorded. Each PGD had between 7 and 10 farmers selected from farmer communities.

In order to generate authentic data and insights into the day to day livelihood conditions of the local people, special emphasis had to be given to the local households and their families. They – representing the bottom-up perspective of the dyke system policies – are the immediate beneficiaries and/or victims of the top-down planning and implementation processes. They are the knowledgeable and experienced persons that are gaining or suffering from all hydraulic measures in the MD.

Therefore, qualitative research was conducted at a large scale in rural households and families. Purpose of these additional and extensive interviews was to generate information and data at household level. The main contents of the quantitative methodology was to understand the existing problems of dyke system planning implementation at the very bottom of the planning process, i.e. at community level. Farmers' adaptability to floods and the new dyke system, the impacts of the new dyke system in the specific contexts of Thanh Thang and Thanh Thu communes and other flooding areas in the MD: these were the main goals of the household surveys.

Questionnaire design: The questionnaires for the household surveys were designed and based on data and information collected from earlier qualitative research results. Qualitative information was classified in information groups depending on each research objective. Each information group was coded in details of each question. Therefore, the quantitative questionnaires included many methodologically different questions such as closed, open-ended and open questions. The purpose of information group code was to quantify and crosscheck the qualitative information as well as to generate additional details from individuals on household level. The main contents of questionnaires were directed towards an improved understanding of (i) the participation of farmer households in the dyke system planning and implementation; (ii) the acceptance and adaptability of farmer communities to the dyke system planning of government; (iii) information about empirical flood and water management experience in the protected flooding areas; and (iv) the perception of individuals and households on the impacts of the dyke system regarding flood control, agricultural production, rural infrastructure, service development, social change and water pollution. In addition, the suggestions of farmer communities to improve the dyke system were recorded during the surveys. The quantitative questionnaires were pre-tested with 10 farmers in each community before they were used for official interviews with farmer households.

Household Wealth Ranking: In order to achieve a representative household survey, the farmer households were ranked in groups before data collection by establishing a so-called wealth ranking. The main goal of wealth ranking is to classify farmer households in a given community based on the wealth ranking methodology of Grandin (1988). Farmer households were classified based on their socio-economic conditions and characteristics (Grandin 1988). In order to develop a representative farmer household classification, a participatory group discussion with representative farmer groups and local authorities was carried out in the two communes of Thanh Phu and Thanh Thang and classification criteria were developed by representative farmer groups together with the participation of local authorities. These criteria were used to classify the households into three groups in terms of better-off, medium and poor households. The results of this household group classification are summarized in Table 1.

Table 1.1: Wealth ranking criteria and household groups in Thanh Phu and Thanh Thang communes

Wealth ranking criteria	Wealth ranked household groups in					
	Thanh Phu commune			Thanh Thang commune		
	Poor	**Medium**	**Better-off**	**Poor**	**Medium**	**Better-off**
Arable Land (ha/household)	0 - 0.3	0.4 – 1	>1	0 - 0.5	0.6 – 2	>2
Production capital	None	Rather enough	Enough	None	Rather enough	Enough
Experiences in agricultural production	Non	Fair-good	Good	Non	Fair-good	Good
Means of production	No	Rather enough	Enough	No	No	Yes
Income (1,000VND/capita/month)	<200	200-500	>500	<200	200-600	>600
Education (Grade)	0 – 5	5 – 9	>9	0 - 5	6 – 9	>9
Children (Head)	3 – 5	2 – 3	1 – 2	3 - 5	2 – 3	1 – 2
Kind of house	Thatch	Semi-house	Concreted house	Thatch	Semi-house	Concreted house
Professionals and jobs	Mainly off farms	On-off farms	On-off-non-farms	Mainly off farms	On-off farms	On-off-non-farms
Means of transport and entertainment facilities	None	Few of them have	Enough	None	Few of them have	Enough
Others (wealth, labour and other income)	Illness and disease	Lack of labor	Remittance	Illness and disease	Lack of labor	Remittance

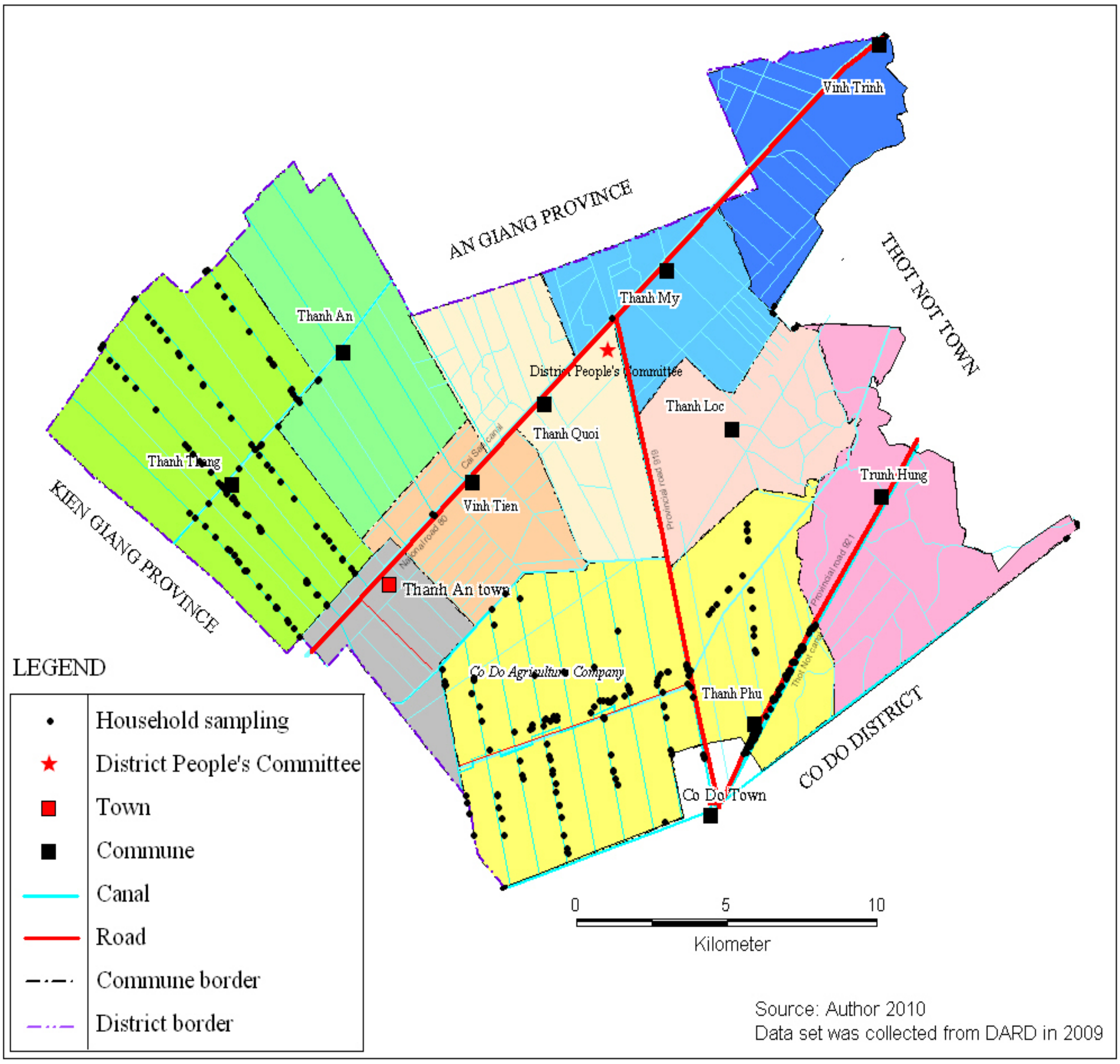
Source: Household wealth ranking in 2008

Table 1.2: Farmer household sampling selection for household survey

Household groups	Thanh Phu commune		Thanh Thanh commune
	Inside Codo Farm	Outside Codo Farm	
Poor	30	30	30
Medium	30	30	30
Better-off	30	30	30
Total	90	90	90

Source: Household survey between 2008 and 2009

Map 1.3: Household sampling in Thanh Phu and Thanh Thang communes



Sampling: The survey households were clustered by the stratified simple random sampling (Lazerwitz 1968). Households at villages were separated into homogeneous strata and then simple random samples from each of the social stratum were selected for the following detailed household surveys. In addition, optimum allocation of each social stratum was considered in order to ensure reliable information in the selected research sites. Finally, a total of 270 farmer households were identified and interviewed randomly from the two communes under investigation (Table 1.2 and Map 1.3).

Household interview implementation: 12 research assistants of the Development Research Institute of Can Tho University were selected to carry out the household survey. They were familiarized with the questionnaires' contents and were trained in interview skills before carrying out the official household interviews. The survey was implemented between October 2008 and February 2009. In addition, Global Positioning System (GPS) and Geographic Information System (GIS) software were used to identify the exact position of samples, to control hydrology and dyke systems and to design maps in the protected flooding areas at the surveyed areas. Practical observations complemented the surveys and provided additional information in regard to the activities and daily work of farmers and local administrators during the survey period.

Data analysis: All collected data and information were analyzed by Microsoft Excel and Statistical Package for the Social Sciences (SPSS). Descriptive statistic methodologies were mainly used for data analysis.

1.6 Structure of the thesis

The introductory remarks have set the stage for the following chapters and the intended problem-oriented contents of the research approach of this thesis. Without repeating the research-guiding hypothesis of this study (see chapter 1.2.3), the following outline of the structure of the thesis is meant to introduce into the main contents of the following chapters. It should be noted that the concluding chapter 6 is considered to be the ultimate aim and goal of this research study: to formulate application-oriented and transferable research results of this investigation on "Planning and Implementation of the Dyke Systems in the Mekong Delta, Vietnam".

It is before this general background that chapter 2 (**2:**) will focus on more or less traditional notions and social aspects in flood control and integrated flood management, on planning approaches and on a brief description of the natural system and its conquest by people. It will give an outlook on lessons learnt in the historical development stages of the MD. The adaptive and interventional actions of inhabitants and Vietnamese governments will also be also presented in this chapter.

Chapter 3 (**3:**) will give a brief description of the governmental dyke planning activities, of perspectives, perceptions and barriers by planners, local organizations and local authorities in the process of the dyke planning. In addition, an analytical discussion of different perspectives and perceptions between planners and local actors at city level will be presented and discussed.

Chapter 4 (**4:**) will present the actual process of dyke planning implementation, the constraints and barriers experienced by local organizations in practice at district level. Furthermore, this chapter will elaborate on the views and visions of the organizations about necessity, advantages and disadvantages of the flood control dykes.

Chapter 5 (**5:**) will show the adaptability potentials of the dyke system from the farmers' point of view. The perception of farmer communities and local authorities of advantages, disadvantages and the impacts of the dykes in the protected flooding areas are at the center of this chapter. It should be understood as the most crucial chapter of this study because – to a certain extent: for the first time! – the experiences, expectations and visions of the farmers as intended recipients of the whole dyke system program are investigated, analyzed and formulated in this study. Their bottom-up perceptions are voiced and may well serve as practical suggestions for the future improvement of the MD dyke system planning and implementation.

The final chapter 6 (**6:**) will summarize findings and discuss different viewpoints and perceptions between social levels (nation, city, district, communes and farmer community), constraints and barriers of local organizations in the process of the dyke planning formulation and implementation. The hypothesis will be discussed to address the relevance of the dykes in the flooding areas in Can Tho city. In addition, possible solutions will be discussed to reveal what should be done to improve the dykes and their impacts on the environment and the socio-economic well-being of the local communities and their population in future. Final conclusions will be presented and will hopefully be considered and included in the future activities of politicians, planners and local inhabitants.

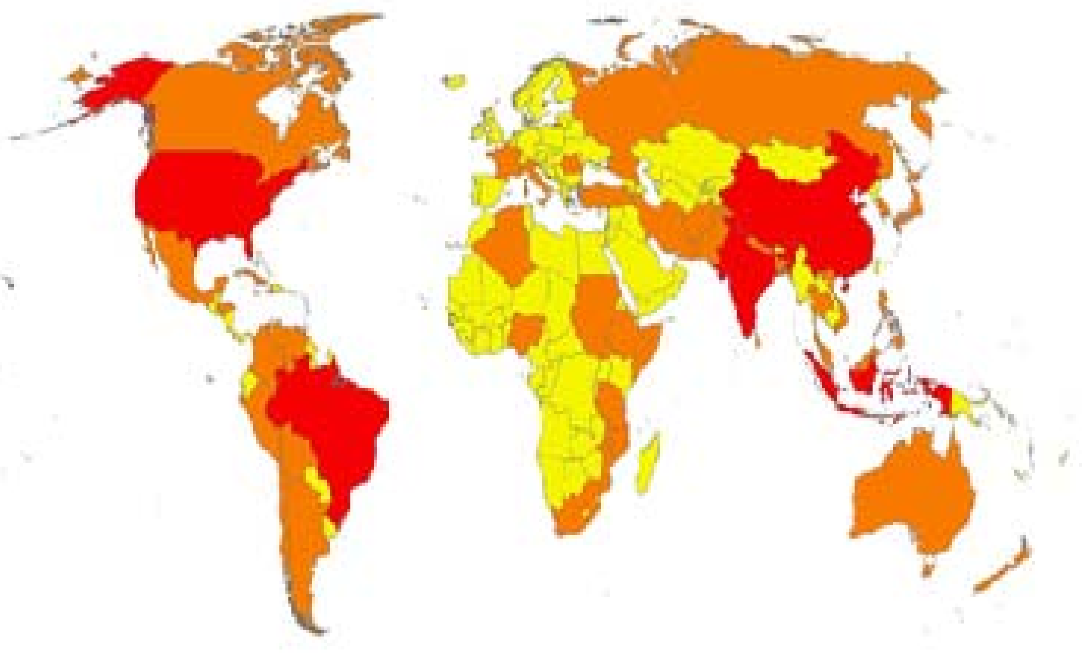
The results of this study will hopefully contribute significantly new ideas for planners, governmental organizations and local authorities of Vietnam in order to improve the process of dyke system planning and implementation in the average flooding areas. The reflections, knowledge and experiences of local communities and local authorities are hopefully valuable and relevant information to improve the methodologies of current flood control and flood management at community level. Furthermore, the perception of local communities and local organizations on the impacts of the system will address problems that need to be studied in the following years in the flooding areas of the MD.

2: FLOOD AND FLOOD CONTROL IN THE MEKONG DELTA

2.1 Flood disaster overview

In recent years, the world increasingly has had to encounter the changes and adverse impacts of climate change. The increasing natural disasters have caused substantial damage for human well-being and environment (UNDP 2007) and disruptive effects on national economic developments for both industrially developed and developing countries (IPCC 1995). Climate change has, however, specifically affected a large number of the poorest and most vulnerable countries around the world (UNDP 2007) and directly or indirectly exacerbated the intensity of droughts, storms, floods and sea level rise (SAARC 2007; UNDP 2007). In the last two decades especially floods have caused disastrous damage in different regions of the world and left millions of people dead, injured or homeless (Map. 2.1 and Table 2.1).

Map 2.1: The vulnerable flooding regions of the world



EM-DAT The OFDA CRED Intrnational Disaster Database
www.em-dat.net - Université Catholique de Louvain – Brussels - Belgium

Source: EM-DAT (2009)

Table 2.1: Flood disasters during the last twenty years in the world (1990-2009)

Regions	Number of people killed	Number of people affected	Number of people are homeless	Number of people Injured	Estimated damage in US$ (,000,000)
Central Asia	1,528	814,258	19,108	75	739
Eastern Asia	26,583	1,504,074,668	39,639,333	752,699	161,979
South-Eastern Asia	12,302	69,629,298	995,177	254,130	10,545
Southern Asia	48,078	667,662,428	13,627,299	7,120	42,546
Western Asia	1,605	3,542,675	432,520	436	4,872
Australian and New Zealand	76	92,640	6,400	87	5,588
Eastern Africa	8,240	20,190,646	1,383,935	476	1,155
Widdle Africa	851	1,623,387	336,438	722	11
Northern Africa	3,808	3,345,822	507,180	19,762	1,920
Southern Africa	625	1,011,908	64,700	49	427
Western Africa	1,741	7,896,991	1,305,126	2,052	307
South Africa	34,570	16,020,089	1,427,868	7,711	13,812
Eastern Europe	1,363	5,682,439	288,892	4,400	16,117
Northern Europe	47	363,060	30,000	8	16,491
Southern Europe	355	753,772	33,962	262	23,422
Western Europe	193	681,502	200	127	24,828
Central America	2,717	5,042,727	239,200	596	4,979
Northern America	715	12,014,491	24,800	360	45,346
Caribbean	3,853	1,835,667	82,033	348	648

Source: CRED/EM-DAT (2009)

Reviewing the flood disasters during the last twenty years (1990-2009), floods actually caused economic damage and human casualty around the world. Human casualties and economic damage in the flood affected regions of Asia were, however, greater than in other continents. Especially the Eastern and Southern regions of Asia were heavily affected. In Eastern Asia, the number of casualties caused by floods was 26,582 people, and over 1.5 billion people suffered from floods. The total of economic damage estimated was 161,979 billion US-Dollars (Table 2.1).

Table 2.2: Flood disasters in South-Eastern Asia (from 1990 – 2009)

Countries	Number of people killed	Number of people affected	Number of homeless people	Number of people injured	Estimated damage in US$ (,000)
Lao P Dem Rep	73	2,790,590	-	150	22,828
Myanmar	271	710,112	104,156	110	134,955
Cambodia	1,127	9,257,756	275,805	53	328,100
Philippines	1,587	9,312,728	185,444	258	948,388
Malaysia	143	394,482	49,000	-	1,001,000
Indonesia	3,603	5,444,680	37,000	251,177	2,290,115
Viet Nam	**4,016**	**18,210,999**	**187,289**	**1,314**	**2,758,525**
Thailand	1,477	23,503,446	156,483	1,068	3,061,256

Note: - No data Source: CRED/EM-DAT, 2009

With regard to flood disasters in South-Eastern Asia, Vietnam is obviously of the most disaster-prone country in that region (Nguyen Huu Ninh et al. 2007) (Table 2.2). In Vietnam, natural disasters like typhoons, floods, tropical storms, droughts, landslides and forest fires tend to happen with an increasing frequency Nguyen Huu Ninh et al. 2007; PDR-SEA 2008). With regard to floods, flash and river floods usually occur everywhere in the country differing, however, in regard to their intensity and impacts. The damage level of floods depends on geography, socio-economic conditions and adaptability of local people and authorities' competence and support in each flooding region and situation. In practice, flash floods usually happen in the northern and central parts of the country and mainly depend on rainfalls and storms, but seldom appear in the southern regions of

Vietnam. River floods occur in almost all regions of Vietnam, especially around the big rivers such Red, Huong, Dong Nai and Mekong Rivers. According to the flood disaster evaluation of MARD and the Central Committee for Flood and Storm Control (CCFSC), the flash floods usually cause more severe damage and losses of life for the coastal, mountainous and highland regions while river floods and inundations are disastrous for the low regions located along the big rivers such as the floodplains of Red and Mekong Rivers. As indicated in Table 2.3, the MD is probably the most problematic region of the country in regard to its exposure to all kinds of natural and also human-induced disasters.

Table 2.3: Natural disasters in different geographic areas of Vietnam

Disaster	Geographic and economic zones							
	North East and North West	Red River Delta	North central coast	South central coast	Central Highlands	Southern North East	Mekong River Delta	Coastal Economic Zone
Storm	***	****	****	****	**	***	***	****
Flood	-	****	****	***	***	****	****	****
Flash flood	***	-	***	***	***	***	*	***
Whirlwind	**	**	**	**	*	**	**	**
Drought	***	*	**	***	**	***	*	***
Saline intrusion	_	*	**	**	*	**	***	**
Inundation	_	***	**	**	_	**	***	***
Landslide	**	**	**	**	*	**	***	**
Storm surge	-	**	**	**	**	**	***	**
Fire	**	*	**	***	-	***	***	***
Industrial and environmental hazards	-	**	**	**	***	***	**	***

Key: Very severe (****), Severe (***), Medium (**), Light (*), None (-)

Source: MARD and CCFSC (2005)

The societal impacts of all these forms of natural risks and hazards in Vietnam are tremendous. Like anywhere else, especially social groups that are incapable of adapting to such challenges, are highly vulnerable and critically endangered in their livelihoods (Bohle et al. 1994). The impacts of climate change will very probably increase these dangers in a yet unknown way (Mintzer 2001).

Box 1: Basic facts on the Mekong Delta

Climate and water

- Tropical monsoon climate.
- Two seasons of river flow: high season from June to November and low season from December to May. During the rainy season, the upper parts of the delta suffer from floods. During the dry season, the coastal areas suffer from saline intrusion.

Area

- 39 200 km^2: 12% of the national area, 5% of the Mekong Basin area.

Population

- 16.365 million: 22% of the national population
- Population growth rate: 2.4% per year.
- 82.5% live in rural areas.

Population density

- 412 persons km^2: 1.75 times of the nation's average.

Mekong Delta is a vital agricultural zone of the country

- Agricultural land (mainly rice paddies) occupies 75% of the delta.
- Rice cultivation is the primary livelihood for 60% of the delta's people.
- The delta produces:
- About half of the national food volume,
- 51% of total rice-paddy production,
- 55% of the national fisheries and fruit production,
- 60% of country's exported aquacultural goods,
- 61% of the total national export value.

Source: Käkönen (2008)

The Vietnamese Mekong Delta (MD) is by its very nature the lowest part of the Mekong River (MR) system. As such it is the most vulnerable flooding region compared to other regions in Vietnam and riparian countries located in the MR system. Basic facts and figures about the MD, its importance for Vietnam's economy and society as well as its potential fragility by natural disasters and/or human interferences have been summarized by Käkönen (2008) and may serve as background information presented in Box 1.

These facts and figures not only highlight the extreme importance of the MD for Vietnam as a whole, but even more so its vital importance for the region itself. The very fact that approximately 80 percent of its population dependently live on agricultural production as their main livelihood (GSO 2009) speaks for itself. The natural resources in terms of land, water and fish are vital and important properties to the economy and social life of the floodplains in the MD. Annual floods usually inundate approximately two-third areas of the MD. Mekong Deltaic floods, which slowly rise and slowly recede, totally differ from other flooding regions in Vietnam. Thanks to these characteristics, the Mekong Deltaic people easily adapted to the predictable flooding level changes. Actually, the traditional flooding events were normally useful for people and ecosystems rather than to their disadvantages. Floods only caused damage to rural infrastructure and farming communities when their depth exceeded the adaptability of communities to cope with such extreme events. In the flooding circumstance of the MD, therefore, if there is a good preparation and a timely intervention of local authorities, floods will normally not affect the local people. The reconstruction of the hydraulic history of the MD by Biggs (2004) is testimony to the fact that in the past there seems to have been a kind of equilibrium between nature and society, however, interrupted again and again by flooding extremes. With the construction of dyke and dam systems the flooding situation of the delta has changed and new risks and vulnerable challenges have developed (Hashimoto 2001; Sneddon and Binh 2001). Additionally, also recent sea level rise poses critical ecological and economic consequences, not at least through the intrusion of saline water into the groundwater levels. The MD of Vietnam is especially vulnerable because much of the land surface is located below mean sea level. Rice and shrimp farming in the MD is currently under special threats from saltwater intrusion, but also from storm surges (Doyle et al. 2010).

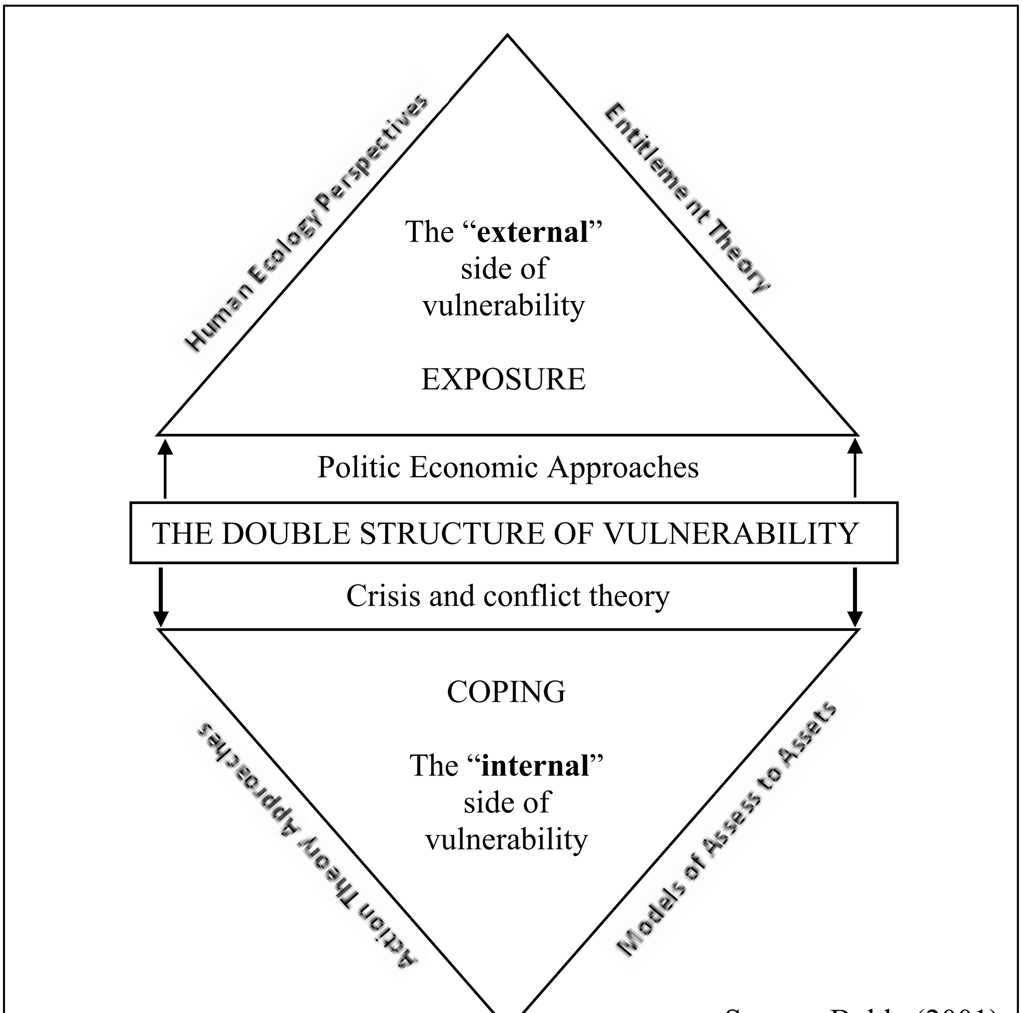
2.2 Flood disaster and vulnerability mitigation approaches

In view of the afore-mentioned close interrelationships between nature and society in the MD, floods are identified as one of the main causes of disasters and vulnerability for most farming communities in the floodplains. Therefore, the question is how floods can be appropriately controlled and managed in such a way that flood benefits are maximized while their vulnerable disasters are minimized in regard to the socio-economic development situation of the Delta. Therefore, the flood control measures in the MD do not only have to consider flood disasters but also to take into account their potential benefits for a the sustainable development in economic, social and environmental respects. This is the big challenge ahead for flood planners, local authorities, flooding communities and the Vietnamese government.

As indicated above, the Mekong Deltaic floods bring more advantages than disadvantages. This implies that flood control measures focusing exclusively on flood disaster reduction and ignoring advantages such as natural soil fertilization are not adequate and appropriate in the flooding and socio-economic development context of the MD. However, also risks and vulnerability mitigation have to be coherent aspects of any flood control scenario and are essential tasks for effective and long term disaster risk reduction (Birkmann 2007). Thus, flood disaster mitigation control measures require a full understanding in the risks and causes leading to vulnerability rather than only identifying and measuring the exposures of flood disasters in the decisions to reduce the flood impacts in short and long term strategies.

Regarding flood disaster and vulnerability mitigation measures, there are different approaches to minimize flood disasters and vulnerability for the flood affected communities. For example, flood warning systems in combination with flood prevention and control measures in short and long terms have proven to be effective approaches and measures, contributing to a remarkable reduction of vulnerability. However, neither providing necessary needs for communities to cope with flood impacts nor preventing flood disasters are sufficient and especially not sustainable control measures because communities are unable to maintain their life conditions under such pressures for a long time. Therefore, flood control measures should include a comprehensive analysis of causes and consequences of vulnerability in short and long term, of the resilient capacity of communities as well as that of individual households. Currently, there are no adequate vulnerable mitigation measures for flooding areas in any part of the world. A comprehensive survey of the versatile facets of vulnerability has been edited by Birkmann (2007).

Figure 2.1: A conceptual model for vulnerability analysis



Source: Bohle (2001)

In order to understand vulnerability of people, Bohle (2001) developed a conceptual model considering external and internal sides of vulnerability (Fig. 2.1). Vulnerability is a double-headed feature with external and internal sides (Bohle 2001; Chamber 1998). The "external" side mainly refers to the structural dimensions of vulnerability and risks while the internal dimension mainly focuses on coping strategies and actions to overcome or mitigate the negative impacts of economic and ecological changes (Bohle 2001). Additionally, the exposure side of vulnerability refers to shocks and stresses while the coping side of vulnerability is the capacity to cope with or to adapt to crises, conflicts and constraints between people and nature. León (2006) argued that the exposure side of vulnerability is influenced by (i) human ecological perspectives, which target population dynamics and capacities to manage the environment; (ii) entitlement theory, which relates vulnerability to the capacity or incapacity of people to obtain or manage assets via legitimate economic means; and (iii) political economic perspectives, which relate vulnerability to the exposure of some groups to social inequalities and to the control of assets by some upper classes, leading to conflicts including controversies between governments and local actors (León 2006). In contrast, the coping side is influenced by (i) action theory approaches, which cover the means and ways that people use to cope with societal, governmental and economic constraints; (ii) models of access to assets, which allow people to mitigate their vulnerability via command and use of remedies of different kinds and (iii) crisis and conflict theory, which focuses on the control of resources and assets, the capacity to manage crisis situations, and the resolution of conflicts. To sum up, the short and long term strategies of a country or a community to adapt to the negative impacts of floods must be envisaged in specific contexts and rooted in a full understanding of the complex structure of society and original causes of vulnerability (Bohle et al. 1994).

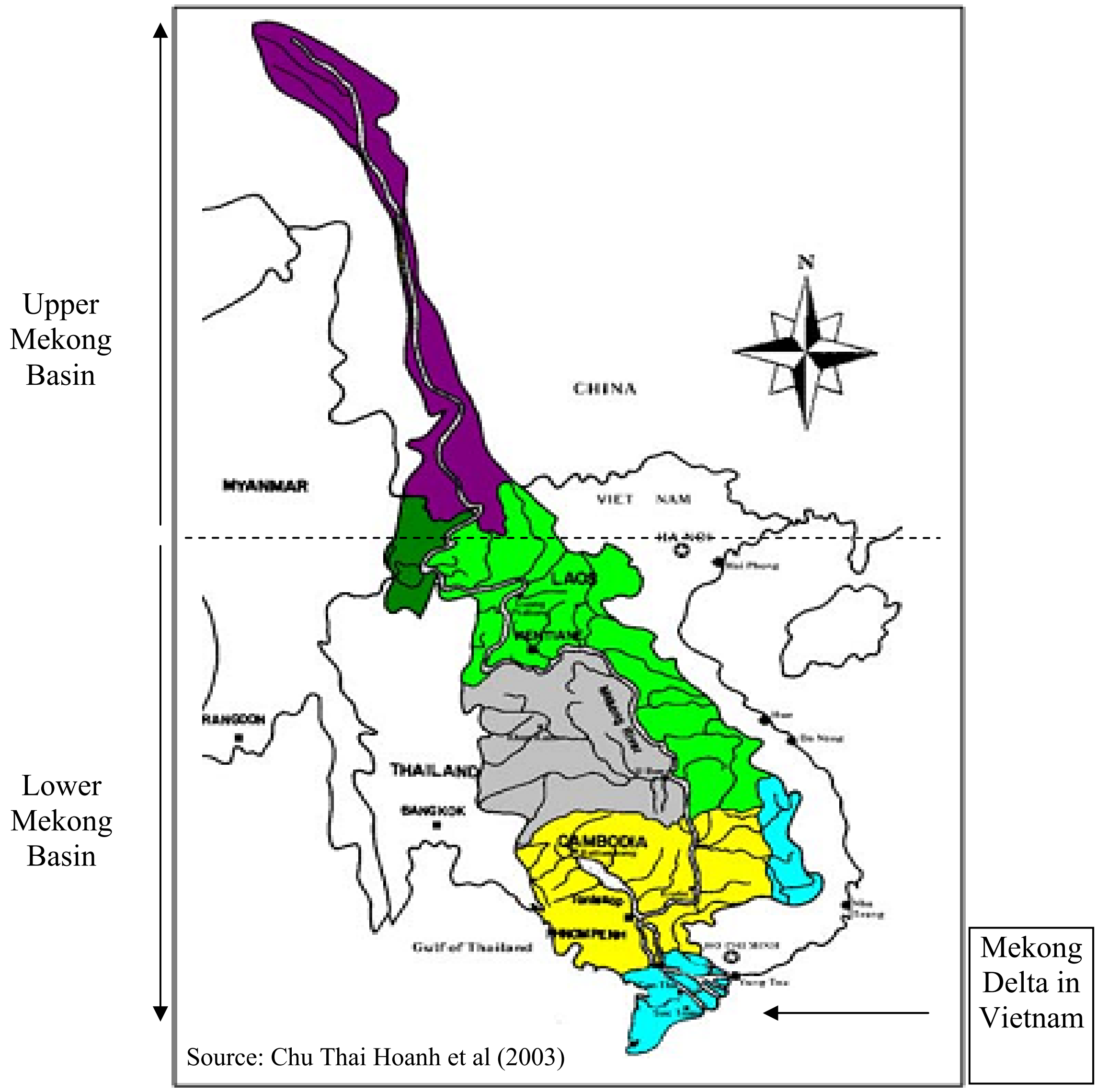
2.3 Mekong River and Mekong Delta: Geography and hydrological ecology

2.3.1 Mekong River overview

The Mekong River (MR) is the longest river in South East Asia, the twelfth longest in the world and the tenth largest by discharge (Chu Thai Hoanh et al. 2003; MRC 2005). It has its sources on the Tibetan Plateau of Chinese Yunnan Province and flows through China, Myanmar, Thailand, the PDR of Lao, Cambodia and the southern delta of Vietnam before emptying into the South China Sea (MRC 2005). The natural resources of the whole MR system provide food for approximately 60 million people living in riparian countries including China, Myanmar, Thailand, Laos, Cambodia and Vietnam. The catchment system of the MR covers an area of 795,000 square kilometers. The main river is fed by an extensive network of more than 100 tributaries that contribute 40 to 45 percent of the mainstream flow during the dry and rainy seasons respectively. The flow of the MR from its sources to the entry of the lower basin covers a distance of almost 2,200 km and an altitude of nearly 4,500 m. The lower basin is marked by the borders of Thailand, Lao PDR, China and Burma where they form the Golden Triangle. Downstream from the Golden Triangle, the river flows for a further 2,600 km through Lao PDR, Thailand and

Cambodia before entering the South China Sea via its complex delta system in Viet Nam (Map 2.2).

Map 2.2: Structure and extent of the Mekong Basin



Source: Chu Thai Hoanh et al (2003)

The Upper Mekong Basin (UMB) originates in Tibet and China, where the river is called the Lancang Jiang. Characterized by narrow gorges and high flow velocities, this very steep and narrow catchment contributes from 15 to 20 percent of the total water to the Mekong River. The major problem of this river section is soil erosion leading to approximately 50 percent of the total sediment load in the river. Due to the fact that hydropower works were constructed and 24 percent of the total area of the UMB (MRC 2005) are irrigated.

The Lower Mekong Basin (LMB) from Yunnan downstream through Lao PDR, Thailand, Cambodia and Vietnam (Chu Thai Hoanh et al 2003; MRC 2005) receives the major tributary systems. The left bank tributaries provide the main discharge of the high-rainfall areas of the Lao PDR, while the right bank tributaries are mainly the Mun and Chi rivers, draining a large part of northeastern Thailand. Altogether, the mean annual discharge of the MR is approximately 475 km^3. Of this amount, the catchment contributions of Lao PDR, Cambodia, Thailand, China and Vietnam are respectively 35, 19, 17 and 16 percent of the total and only 2 percent are contributed by Myanmar. Thus, highest runoff is observed in the Lao PDR's Anamite Mountains where annual rainfall is as high as 3,200 mm per year (Chu Thai Hoanh et al 2003; MRC 2005). All discharges flow into Tonle Sap, the Great Lake of Cambodia, where water volume and flow speed of the MR are changed dramatically. It is estimated that the water volume flowing into Cambodia can obtain 95 percent of the MR's flows (MRC 2005).

An overview of the MR, its hydrology and its complicated political ecology would be incomplete without addressing the current international political issues at stake. The fact that altogether five countries of unequal political and economic power are "shareholders" of the MR system and are claiming specific rights in the use of the water is the cause of conflicts – and has been so for many years. At present, there are two basic problems which have been pending for many years: the depletion of the natural resources of the river, its tributaries and its catchment areas on the one hand, and the unequal access and use of MR water and unsolved users' rights by the riparian countries, on the other hand.

The degradation of natural resources is mainly caused by the pressures of a rapidly increasing population, urbanization, agricultural and industrial development of riparian countries (Hirsch et al. 2006; Keskinen 2008). Besides, also the diversion of river waters for irrigation purposes, uncontrolled sedimentation processes due to environmental degradation in the catchment areas and, above all, the construction of small and large dams and their impacts on the water flow of the MR are equally threatening situations. Among these, especially the unequal water shares between riparian countries are a big problem because it has created political conflicts. Dams, dykes and hydropower plants were constructed to control water sources in the upper areas, resulting in unequal water allocations between upstream and downstream regions (Keskinen 2008). Other problems regarding water usage in the MRB include (i) irrigation development in Northeastern Thailand which has resulted in a lack of water during the dry season and a decrease in dry season crops in adjacent parts of Vietnam; (ii) intrusion of saline water into the Mekong Delta in Vietnam; (iii) hydropower developments and their impacts on downstream embankments; and (iv) growing populations and increasing economic development with decreasing water quality for agriculture and/or household uses (MRC 2001). Therefore, human interventional measures not only threaten the degradation of natural resources and ecosystems, but also create conflicts between countries sharing the same water source in both wet and dry seasons. The disadvantages and new challenges of natural systems are negatively felt especially in the lower regions of the MR.

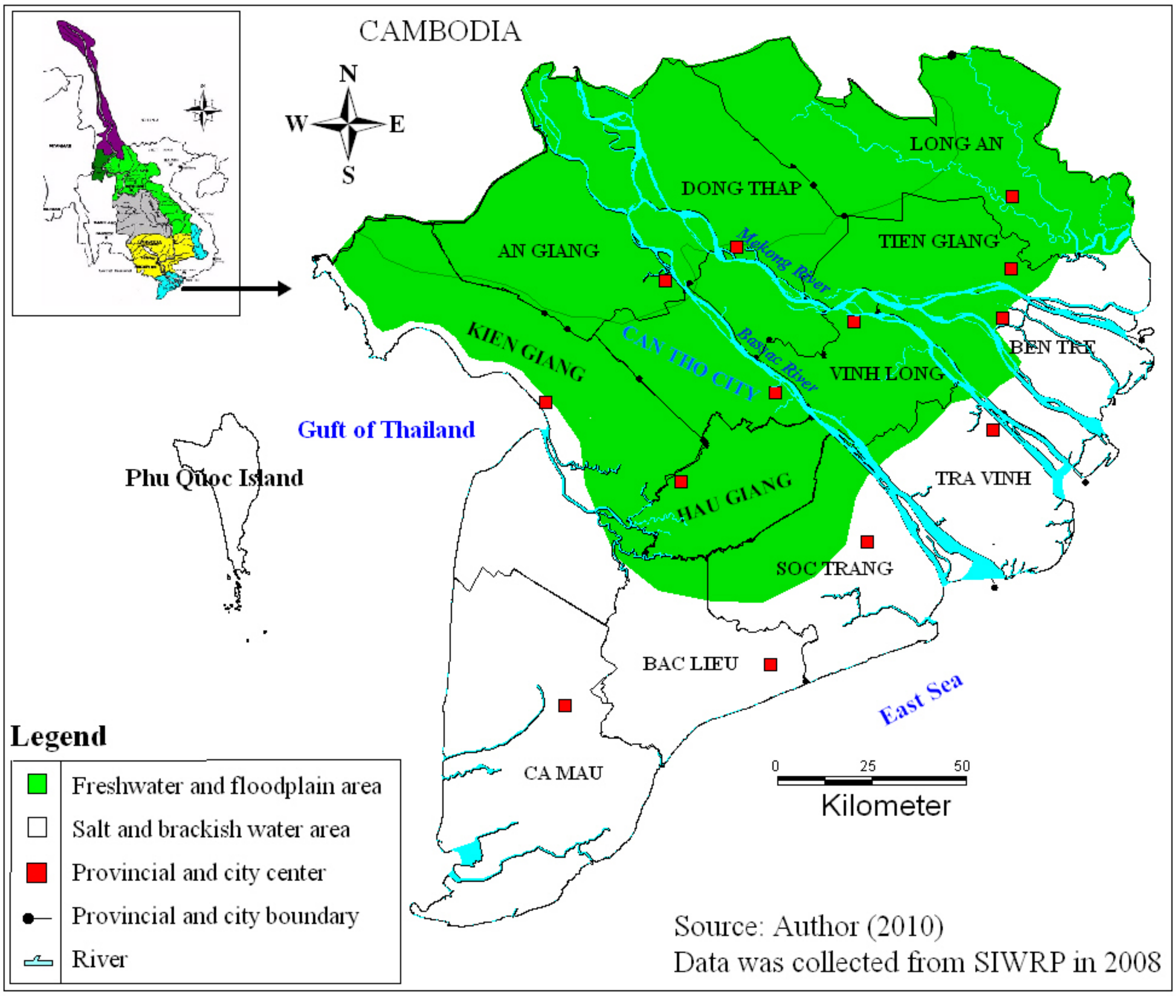
In view of the complexity of the MRB problems it is not surprising that political solutions had to be found in order to disentangle the manifold conflict situations. For many decades, from the 1950s and 1960s onwards, negotiations and conferences were held in order to find an agreement about politically acceptable and sustainable uses of the MR water or what has been called a solution to the Mekong as a "large-scale socio-ecological system (Sneddon and Binh 2001). Based on the discussions of the UN-sponsored Mekong Committee, finally in 1995 an "Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin" was signed. Ratified by Laos, Thailand, Cambodia and Vietnam, the jointly installed Mekong River Commission (MRC) was and is expected to coordinate the efforts of the signatory states to cooperate in the pursuit of the aims and goals formulated by the agreement. However, so far the MRC has not achieved the expected objectives of its member countries. According to Hirsch et al. (2006), the main reasons are due to the fact that (i) legal and institutional frameworks are inadequate to ensure good water governance in the Mekong; (ii) "national interest" of riparian countries are still predominant and do not correspond to the jointly agreed principles in regard to the Mekong's future; and (iii) China has not participated and officially supported the decision-making process of this agreement. Therefore, the implementation of the 1995 Mekong River agreement is currently a great challenge to ensure equal benefits to all partners. If this agreement is not be implemented, the lower countries will face new risks and continuous disadvantages, especially the MD in Vietnam.

In summary, the 1995 Mekong River Agreement was formed to help countries in the lower Mekong River Basin to implement appropriate measures in order to guarantee equal and sustainable natural resources exploitation. However, the legal and institutional framework of this agreement was compiled inadequately and continued uncoordinated actions by the signatory states cause disadvantages for river ecosystems and threaten life and livelihood of people in the lower areas of the MR basin and the MD. Thus, Vietnam is still the main victim of this unsatisfactory situation.

2.3.2 The Mekong Delta: The center of flooding and flood control mechanisms

The Vietnamese Mekong Delta (MD) has two main branches, namely Bassac and Mekong Rivers (or Hau and Tien Rivers), both discharging their waters into the South China Seas. Both branches cleave into a number of deltaic river-mouths and countless riverines. Thus, the MR has created an almost amphibious environment and provides plentiful water with rich natural resources by regular inundations and an abundance of natural vegetation, especially in the so called Plain of Reeds located in Dong Thap province (Map 2.3). The river discharge during the flooding time amounts to 13,708 m^3/s (volume of 432.6 billion m^3), 14,555 m^3/s (volume of 459.4 billion m^3) and 15,200 m3/s (volume of 480 billion m^3) from Kratie, Phnom Penh and the river mouths. 85 to 90 percent of the total water volume

Map 2.3: Flood-prone areas and brackish areas in the Mekong Delta



is being discharged during the flooding time with volumes of 35,000 to 38,000 m^3/s occurring in the months of September to October (To Van Truong 2002).

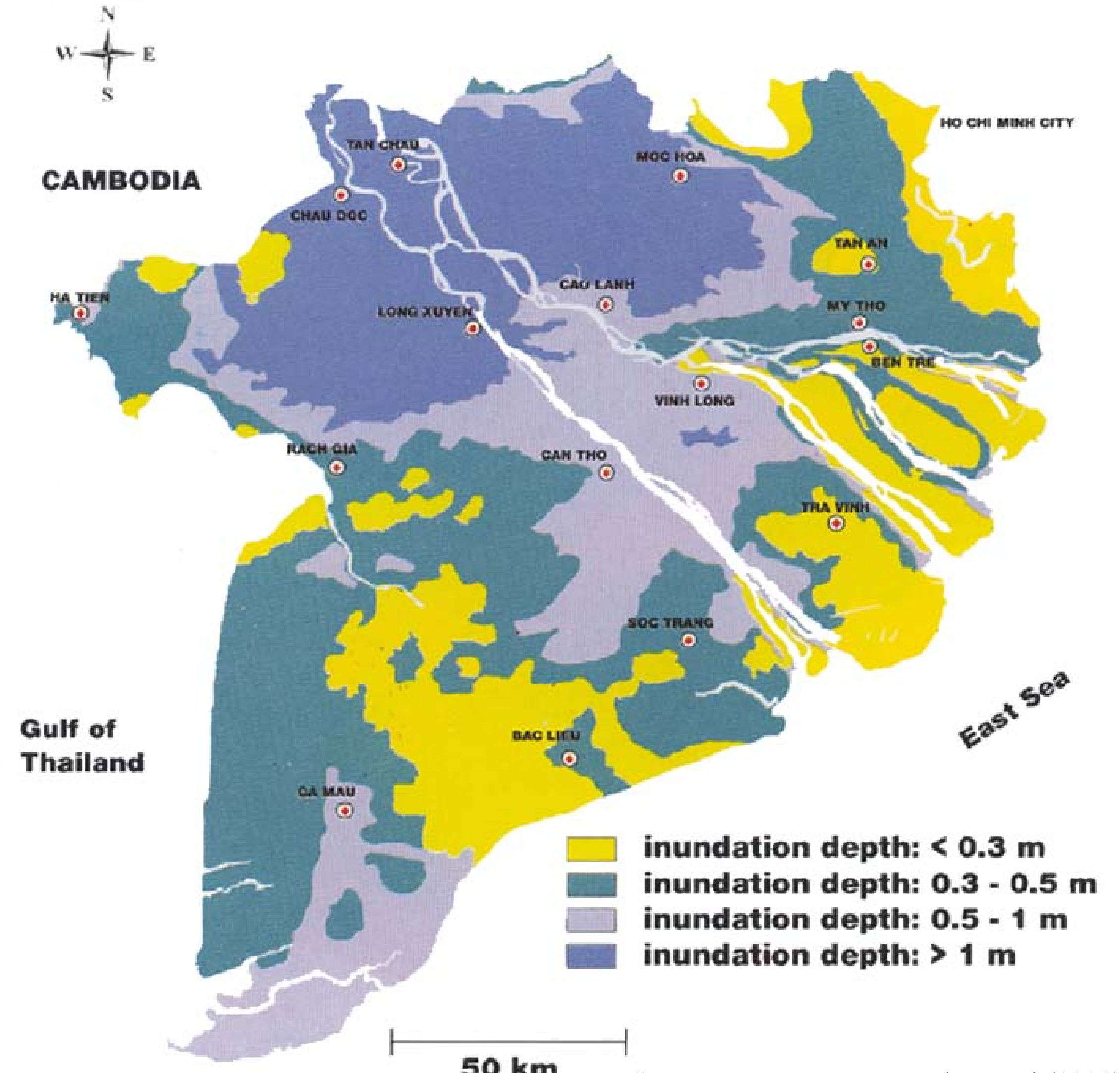
The MD, that is the central region of this study and the lowest part of the whole MR system, covers an area of 4.06 million ha (12.26 percent of the country) of which 63.4 percent is used for agricultural production (GSO 2008). Its land elevation is from 0.5 to 1.5 m sloping down from North to South. According to its topography, its role and function as a sedimentary lowland and its proximity to the ocean, its soils are classified in three major groups: acid sulphate, saline and alluvium soils. Also climate contributes to the specific ecological situation of the MD. Influenced by monsoon and tropical temperatures, the MD is characterized by two distinct seasons: the dry and rainy one. Annual rainfall is approximately 1,700 mm in average, 2,400 mm in maximum and 1,200 mm in minimum, of which 90 percent of fall in the rainy season lasts from May to October. Temperatures are not a limiting factor. With temperatures well above the freezing point all year round, vegetation growth and agricultural productivity are not hampered by any thermal limitations.

Topography, pedology, climatology: these are decisive factors for the differentiation of the seemingly uniform MD. According to To Van Truong (2002) the MD can nevertheless be subdivided into six ecologically different regions, mainly based on the more or less pronounced availability of water resources: the Plain of Reed (POR) in Dong Thap province, the Long Xuyen Quadrangle (LXQ) in An Giang province, the central parts of the Mekong and Bassac rivers (MOMB), the region of Trans-Bassac areas, the Ca Mau Peninsula (CMP) and the coastal belt in Ca Mau province. These sub-zones can be further divided into POR and LXQ recognized as the flooded sub-zones; MOMB and Trans-Bassac are the favorable fresh water supply sub-zones; and CMP and the coastal belt are the salinity intrusion sub-zones (To Van Truong 2002). The MD's flooding areas are divided into four distinct sub-areas sthat are (i) Long Xuyen Quadrangle; (ii) the Western areas of Bassac river; (iii) the areas located between the Bassac and Mekong Rivers; and (iv) the Eastern areas of the MR, named the Plain of Reeds (NEDECO 1993; SIWRP 1998b). Considering the flood depth, the MD flooding areas are classified into three zones: deep, average and shallow areas. The deep flooded areas are normally flooded from 2 to 4 m. They are located at border line along Cambodia and consist of An Giang, Dong Thap and Long An provinces. The average flooded areas from 0.6 to 2 m are located at lower areas in the provinces of Hau Giang, Vinh Long and Tien Giang and Can Tho City. The rest of the areas is flooded shallow or not flooded at all, such as Kien Giang, Soc Trang, Bac Lieu, Ben Tre and Tra Vinh provinces. Whatever flood depths are encountered, their management and control demand specific mechanisms which have been functioning traditionally, but which are exposed to new threats and challenges.

As mentioned earlier, the MD is not only Vietnam's most important agricultural production center, but also the center of controlled, but sometimes also incontrollable floods. Flood control mechanisms are therefore vital for the protection of the country's food basket. Specific constraints for the socio-economic development of the region and its sustainable agriculture productivity are – according to To Van Truong (2002) – the following threats and challenges: (i) flood and flooding and their appropriate control; (ii) salinity intrusion; (iii) acid sulphate soils; and (iv) fresh water shortage. Salinity intrusion is a challenge for agricultural production especially in the coastal regions in the MD. The average limit of saline water intrusion in the main river along the South China Sea is about 40-50 km upstream from the river mouths. In the canal system along the Gulf of Thailand, it is about 10-20 km inland from the coast. The total salinity affected area is 1.4-1.6 million ha, half of which suffers salinity impacts from one to three months per year (Nguyen Xuan Tiep 2002; To Van Truong 2002). Acid sulphate soils and acid sulphate water occurrence are additional alarming problems in the MD. The total area of acid sulphate soils is approximately 0.8 to 0.9 million ha. The affected regions are mostly in the Plain of Reed (POR) in Dong Thap province, Long Xuyen Quadrangle (LXQ) and Ca Mau Minisula (CMP). Annually, acid water (pH <5) occurs during two periods, from May to August and from November to January (To Van Truong 2002). Fresh water shortages finally occur in all saline or acid sulphate soil areas. As the large areas of central POR and LXQ are located far away from the main rivers, their appropriate supplies with irrigation water for agriculture and domestic uses are limited. The total area of fresh water shortage in the Mekong Delta is about 2.0 million ha (To Van Truong 2002).

There are manifold and not always coherent attempts to differentiate the natural eco-systems of the MD and its seemingly uniform environment by rather intricate, yet traditionally very effective flood control mechanisms. As indicated earlier, flooding in the Mekong Delta is a regular phenomenon in the period from July to December and reaches its highest peak between September and early October each year. Mekong deltaic floods are mainly caused by the flows of upper floodwater from Cambodia and partly by tides and rainfalls and especially by storm surges. Floods from Cambodia flow into the MD through

Map 2.4: Flooding in the Mekong Delta



Source: Vo Tong Xuan and Matsui (1998)

the Bassac and Mekong rivers, which overflow their embankments and inundate the low fields of the upstream provinces such as An Giang, Dong Thap and Long An (Map.2.4). An important characteristic of these floods is that the Mekong deltaic water-tables slowly rise and fall during the flooding time. In normal days during flooding time, daily flood depth fluctuates between 5 and 7 cm and obtains a maximum of 20 to 30 cm under special circumstances when there are heavy rain and storms (SIWRP 1998b). This predictable and therefore also controllable behavior of the river regimes is a great advantage for natural fish growing and development in the rice fields. Especially, it is a great chance for local inhabitants to strengthen their adaptability to live with floods in the flooding context of the MD.

The annual flood-depth of the delta gradually declines from the border between Vietnam and Cambodia (SIWRP 1998b). Based on the floodwater level recorded at Tan Chau and Chau Doc Gauge Stations, the Southern Institute of Water Resources Planning (SIWRP) and the Hydrometeorology Bureau of Vietnam classified MD floods in three flood groups called Small, Medium (or "Beautiful flood") and Big (extreme) floods (Table 2.4). In normal flood years, the total average flood volume is approximately 38,000 m^3/s. In the big flood years, this volume climbs up to 45,000 m^3/s. The total flood volume flowing into the MD is estimated at 400 billion m^3, 80 percent of which flows in the main rivers and 20 percent infiltrates via other channels from Cambodia (SIWRP 1998b).

Table 2.4: Mekong Delta flood classification

Vietnam's flood classification		**MRC's flood classification**	
Floodwater level	Flood classification	Floodwater level	Flood classification
Lower 4.1 m	Small flood	Lower 4 m	Small flood
4.1 – 4.5 m	Medium flood	4 – 4.5 m	Medium flood
Higher 4.5 m	Big flood	Higher 4.5 m	Big flood

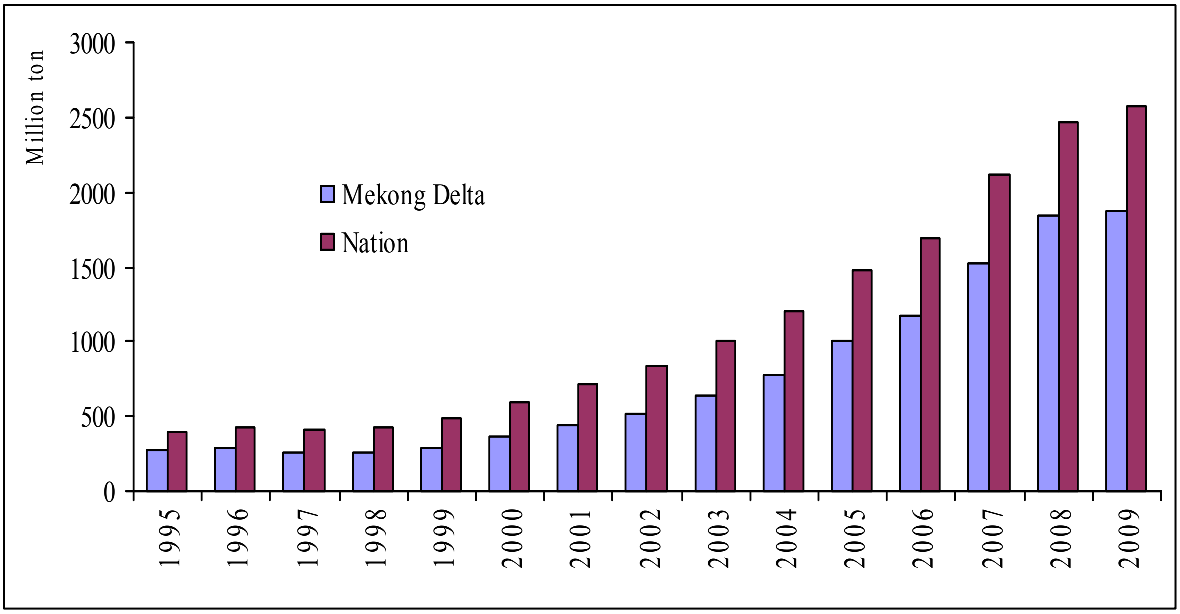
Source: SIWRP (2005b)

The flooding area of the MD varies between 1.2 to 1.4 million ha in the small and medium flood years and between 1.8 to 1.9 million ha in the big flood years (To Van Truong 2002). Small and medium floods are also called normal floods that are basically useful for agricultural livelihoods and life of the Mekong Deltaic people. In contrast, the big floods are usually dangerous and pose heavy challenges to the people, the economy and the infrastructure of the MD. It is for this reason that the MD is identified as one of the most vulnerable flooding regions in Vietnam.

Nevertheless, Mekong deltaic floods always have both positive and negative impacts on inhabitants and ecosystems in the MD. It is difficult to estimate and quantify these impacts on humans, ecosystems, environment and economics in the socio-economic development and flooding context of the MD. Positive consequences are the facts that each flood carries a large amount of sedimentation from the upstream flows with abundant natural nutrients and solids as an important natural fertilizer for fields and agricultural productivity. Estimates are that the MR's floodwater provides approximately 150 million tons of alluvium soil for the MD, of which there are 12 million tons carried in the Bassac River and 138 million tons in the Mekong River. The average amount of measured alluvium soil is 500 g/m^3 in the Mekong River and 200 g/m^3 in the Bassac River (SIWRP 2005b).

Annual flooding of the huge MD does not only provide natural nutrients for the soil and their fertility, but they are also important for aquaculture, especially for the fishery component of rural livelihoods. Each flood provides a large number of fish varieties and species where natural fish species spawn, breed and raise their next generation. Natural fish species migrate from the TonLe Sap to the Bassac and Mekong Rivers during the flooding time. In the MD over 60 fish species spawn in brackish water and 200 species in the fresh water regions (Nguyen Ngoc Tran 1990). The habitat conditions are not only ideal for natural fish populations, but also for the breeding of fish for local and regional

Figure 2.2: Fishery production in the Mekong Delta from 1995 to 2009



Source: GSO (2009)

markets. In fact, fish-farming has developed into a viable source of income for the local communities and adequate flood control mechanisms have contributed to this upswing of the local fishery sector. Fish is increasingly cultured in the rivers and the rice fields, especially during flooding time. As a result, fish production in the MD significantly rose from 267 thousand tons in 1995 (69 percent of total national fish production) to 2,570 thousand tons in 2009 (73 percent of total national fish production) (Fig. 2.2). Another advantage of the natural hydrological regime of the MR is the fact that annual floods reduce the considerable amount of toxic chemicals, dangerous pests and funguses accumulated in rice fields and in acid surface soil areas and caused by increasingly intensive use of agro-chemicals, as well as by the salinity of coastal soils on farmers' lands (Tran Nhu Hoi 2005; Käkönen 2008). In summary, one can argue that floods have brought benefits to the life and livelihood of local people, especially the rural poor who live predominantly from the gifts of nature in the flooding time (White 2002).

Table 2.5: Losses and damage of flood disasters in 10 years in the Mekong Delta

Year	Number of people killed	Number of homes submerged and broken	Paddy area inundated and damaged (,000 ha)	Fish and shrimp feeding areas destroyed (ha)	Roads damaged (km)	Estimated Damage value (Billion VND)
1991	143	278,546	133,622	-	873	590,000
1994	407	779,119	229,045	4,817	6890	2,283,858
1995	127	203,874	43,455	1,939	3893500	383,752
1996	222	836,773	181,872	45,869	14044	2,571,223
1997	7	5,191	77,536	187	13889	67,496
2000	481	891,406	401,342	16,251	11477	3,911,249
2001	393	341,614	20,691	4,580	7184	1,535,910
2002	170	286,660	14,019	2,447	3861	456,831
2004	38	690	3,426	1,068	-	34,192
2005	44	-	2,723	4.472	-	7,463
Total	2,032	3,623,873	1,107,731	77,162	3,951,718	11,841,974

Notes : - No data Source: http://www.ccfsc.org.vn

In contrast to the positive effects of the flooding cycles, there are, of course, also negative impacts of floods on humans, ecosystems, environment and economics in the MD. In recent years, floods actually caused losses of life and property damage for local people in the flooding areas of the MD. According to a flood disaster summary published by the Central Committee for Flood and Storm Control (CCFSC) in for the period 1991 to 2005, 2032 people were killed by floods; more than 3.6 million buildings were flooded and collapsed and more than 1.1 million ha of paddy fields inundated. A remarkable number of fishponds, fish hatcheries and roads were damaged by floods. The total estimated damage was approximately VND 12 billion (Table 2.5). In view of these alarming figures it is justified to call the MR floods both a curse and a blessing for the region. Floods are especially disastrous to those who have not been able to adapt to their challenges. And again, that are mainly the poor who suffer most from the negative impacts of uncontrolled and so far incontrollable extreme floods. Therefore, flood control measures need to be considered and flood control mechanisms have to be developed that are able to exploit fully the benefits of floods and minimize their negative impacts.

Flood control measures are necessary in the flooding context of the MD, however, the impacts of human interventional measures are taken into account in order to ensure sustainable development of the MD.

2.3.3 History of flood adaptation and current flood control measures: An overview

Much has been written and published about the natural and cultural history of the MD (Cummnings 1978; Pham Cao Duong 1985; Nesbitt et al. 2004; Tylor 2001; Nguyen Khac Vien 1984) and its hydraulic development (Biggs 2004). In view of the fact, however, that the present dyke system planning, its problems and its impacts are the specific focus of this study, a rather short review of flood protection measures and flood control mechanisms from 1930 onwards may suffice.

Before 1930 large parts of the MD were still shaped by water and natural forests. Inhabitants mainly lived on the basis of a hunting and gathering economy and exploited available nature resources in terms of natural fish, wild animals and vegetation for their daily life. Although first canals were built already by the end of the 18th century and major canal-building activities started from the 1820s onwards (for instance Vinh Te, Thoai Ha, Xa No, Cai San, Cai Lon, Cai Be Canals) it took until 1901 to connect Can Tho and Rach Gia. This was a provincial project, requested in 1898 by the administrators of Rach Gia and Can Tho, and it aimed at taking fresh water for over 10,000 hectares of forests and brackish swamps from Cai Lon River and the Gulf Coast. Xa No Creek (top/North-East) emptied into Can Tho River and the lower branch of Mekong River. The southwest terminus of the canal ended at Cai Tu Creek, a tributary of the Cai Lon River that emptied into the Gulf of Thailand. It successfully flushed saltwater from Cai Lon and maintained a steady current. The black line running across the map represents the provincial boundary between Can Tho and Rach Gia (Biggs 2004). Altogether, however, only a few canals were built in this first phase of human interference into the natural systems of the MD.

From 1930 onwards, the conversion of marshes and forests of the delta gained momentum and initiated the transformation of the MD into a landscape dominated by highly productive rice paddies. The rice farming depended entirely on the regulation of floods without human interventional measures, although a number of public works drained marshes, swamps, and forests and transferred them into a highly productive rice production area. Historical reconstructions show that the inhabitants knew how to build canals to control flood flow, mitigate flood impacts and promote agricultural irrigation. However, irrigation is unlikely to protect agricultural production and the inhabitants' life. The irregular big floods caused a series of severe damage for inhabitants. As Biggs (2004) states the flood level rose up to 5.8 m on September 6, 1923 at the Chau Đoc water station and rushed over banks and dykes. It covered 80 percent of the provinces. A major flood in 1929 made thousands of people homeless and suffering from famine for one year before the fall in rice prices began leading to social unrest and death casualties.

Due to the impacts of colonial rule, World War II and the long periods of the struggle for independence it took until 1975 and the foundation of the present state, that a steady and systematic development of the whole MD region took place. Slowly at first, but with increasing intensity the irrigation systems were built and expanded to mitigate the flood disasters, to increase agricultural production by appropriate irrigation and drainage and to allocate surface water source throughout the MD. Also the network of roads and the social infrastructure (schools, hospitals etc.) received increasing attention and were accompanied by additional measures of infrastructural developments.

The conversion of swamps, marshes and forests together with the expansion of irrigation and drainage systems led to a strengthening of floating rice cultivation in combination with aquaculture. Floating rice varieties were mainly cultivated in the flooding time because these varieties were able to adapt to floods and changes of tidal regimes due to their vitality. They were harvested after the flood receded in these areas. The areas in lower rain-fed areas along the coast, influenced by the brackish water tide regime and annual rainfall, were sown when the rains began and were harvested before salinity intrusion appeared at the end of the rain season (Käkönen 2008). From 1990 onwards, there was a shift from poor flooding rice varieties to high yield rice crops and an intensification of land use by transformation of rice cultivation from a single rice crop into two or three rice crops per year. It was by all these measures that the human impacts on the natural ecosystems shifted strongly from adaptation to control. Engineering works in regard to large-scale hydraulic control structures mainly targeted the floods in the delta's upper parts and tried to counterbalance saline intrusion areas along the coastal lines. Finally, also "non-structural" measures such as flood warning systems and community education and training programs were implemented to raise public awareness and skills of the community to cope with flooding situations.

Altogether, one may summarize the period from 1975 onwards as a transformation process in which local communities in the MD adapted to a change from "living with floods" to strategies of "flood avoidance, flood adaptation and flood control" (To Van Truong 2000).

"Flood avoidance": Its main function is to alert people who are at risks in flooded areas. To implement this strategy, the government built residential clusters and moved inhabitants susceptible to floods to new locations. This was done with the aim at protecting people and avoiding damage and risks posed by floods (Dang Quang Tinh and Nguyen Thi Hang 2002).

"Flood adaptation": It can be understood as an integrated approach to assist people in inundated areas to come to terms with floods and also to gain potential benefits of floods while avoiding negative impacts on economic development and people's lives (Dang Quang Tinh and Nguyen Thi Hang 2002; To Van Truong 2000, 2006). Flood adaptation thus can be interpreted as a situational solution. Though it is very beneficial in economic and environmental aspects in the short run, it is questionable if lasting developments can thus be achieved. People in inundated areas remain basically endangered and face continuing and unsolvable problems, because they are vulnerable - especially the poor.

"Flood control": This measure is to be seen as the ultimate aim and goal in the domestication process of the MR waters and the MD. Floods are to be controlled by dyke and dam systems that are constructed to deviate flood-flows and flooding levels in the field with the purpose of protecting aqua-agricultural production, increasing the land-use efficiency and improving people's lives (Dang Quang Tinh and Nguyen Thi Hang 2002; Nguyen Van Truong 2006). To adapt better to floods, planners argue with three main flood control models for the MD:

Firstly, living with flood without structural flood control measures: Inhabitants select their own ways to live harmoniously with natural circumstances and regulations of floods without governmental interventions at the flooding regions. They decide what kind of animals and plants should be farmed to utilize floods advantages and avoid their negative impacts. This model is mainly valid in natural swamp and saline and acid areas.

Secondly, flood control in case of early floods: Floods usually cause damage for the summer-autumn rice crops when they appear too early between July and August. Therefore, in this model, low dykes are identified as the major measure to control floods. The low dykes are enclosing the flooded areas in order to protect summer-autumn rice crops at the beginning of floods. In addition, these constructions are used to control the flooding level at the ending of flood seasons to produce the winter-spring rice crop before floods recede in October or November in order to avoid flood impacts on the summer-autumn rice crops.

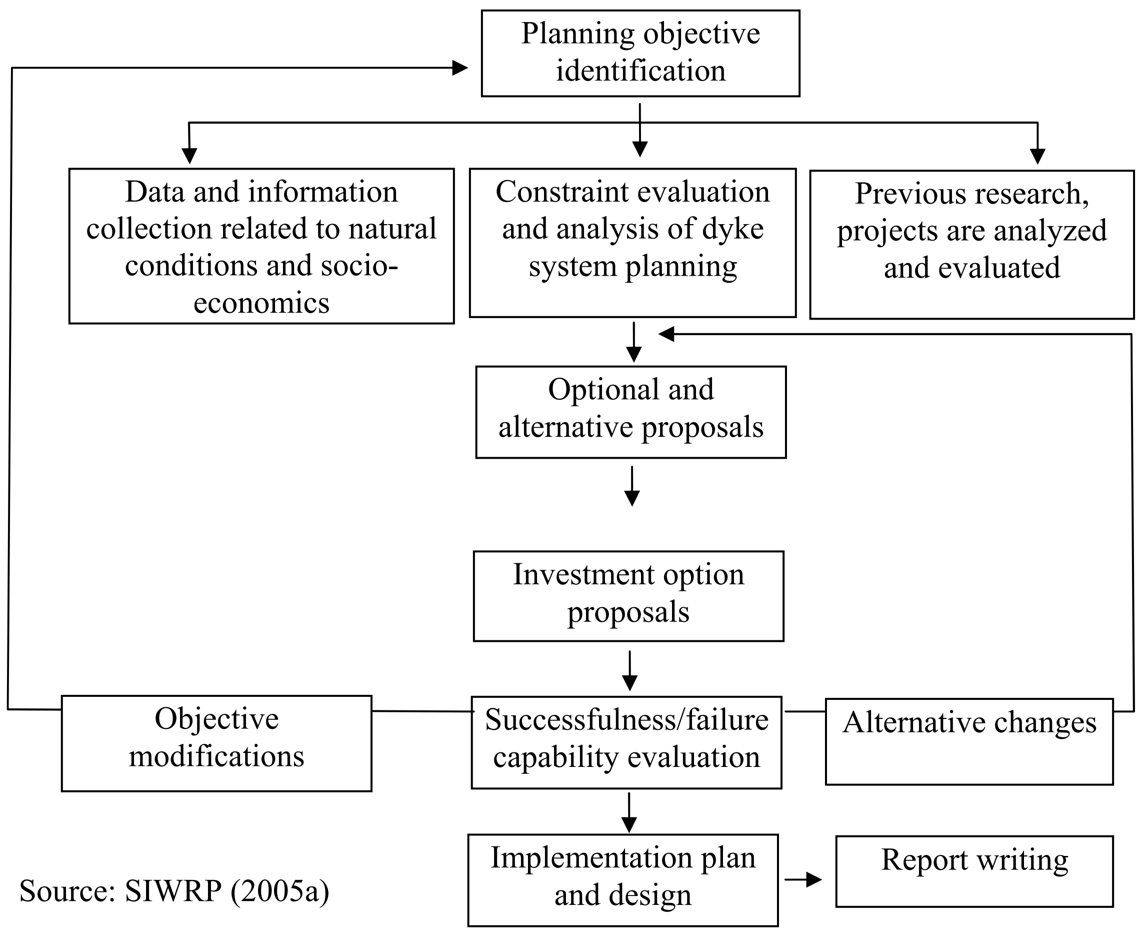
Thirdly, full flood control model: Floods are controlled entirely by the full dyke systems, which are built to enclose the flooded areas to protect agricultural development and the lives of the inhabitants. This model is mainly implemented in the shallow flooded areas.

In summary: Mekong deltaic floods are now being controlled by an integrated approach with a combination of structural and non-structural measures in the floodplains. The non-structural measures are mainly used to assist the communities in short-term situations in case there is a recurrence of floods. Structural measures have been applied to control floods in the long term and have the greatest influences on the whole Mekong Delta. The flood control dyke system in the MD has thus from 1975 onwards developed as the most important structural measure to tackle the flooding problems in the MD.

2.4 Dyke and dyke system planning

In one of the first post war plans in 1968 and based on the Mekong Basin Plan Report in 1970, America and the Mekong River Commission suggested to build a series of retention dams and reservoirs in the upper parts of the Mekong. These suggestions referred especially to the large Pamong and Stung Streng reservoirs at the Mekong River's upstream to control and to modify floods of Mekong and Bassac Rivers from Kongong Cham to Can Tho City and Cai Be district in Tien Giang province. However, this plan was not implemented because the experts predicted and estimated that this reservoir would cause more negative effects than ecological and social benefits (SIWRP 1998b). In 1974, The Mekong Delta Development Group of Netherlands studied and suggested full flood control in the shallow flooded areas in Cai San, the South of Vam Nao and Nguyen Van Tiep rivers (SIWRP 1998b). In 1976 – 1987 period, the SIWRP suggested flood control measures in August based on farmers' local knowledge to control temporary floods and onward full year floods for the shallow flooded areas located in the Southern of Cai San, Vam Nao, Nguyen Van Tiep Rivers. As a result, the canals were excavated to ensure sufficient flows into the fields. During around 20 years (1976-1996), the August flood control dyke systems were built. They protected from 900,000 to 1,000,000 ha of two rice crop fields and nearly 200,000 ha of three rice crop fields. Thanks to low dyke (or the August flood control dyke systems), rice production increased from 2.4 million ton in 1976 to 9.5 million ton in 1996. In the 1990-1994 period, the NEDECO Consultants (Netherlands) implemented the master plan project in the Mekong Delta. According to the flood experts of the Netherlands, dykes or embankments in conjunction with sluice gates are adequate flood protection works to be applied at regional levels. To be built along the main rivers, the primary and secondary canals connecting the main rivers and the primary as well as the secondary canals controlling floods (NEDECO 1993), a long-term adequate solution could not be found to ensure the overall protection of the MD. However, the Netherlands experts recommended that the early flood control (August flood control) and year round protection should be applied in the shallow flooded areas and temporary flood control measures were suitable for most of the deep-flooded areas. The recommendations addressed specifically that (i) full flood control measures should be applied to control floods in the shallow flooded areas; (ii) semi-full flood measures are used in the deep flooded areas to control floods between middle July and middle-August for upstream areas; (iii) especially non- structural flood control measures are applied for the other deeply flooded areas in severe acid sulphate soils in the Plain of Reeds and Ha Tien plain as well as other areas; and (iv) finally, towns and cities are protected by villages and urban infrastructure systems as embankment or dykes and pumped drainage.

Figure 2.3: Dyke system planning process in the Mekong Delta

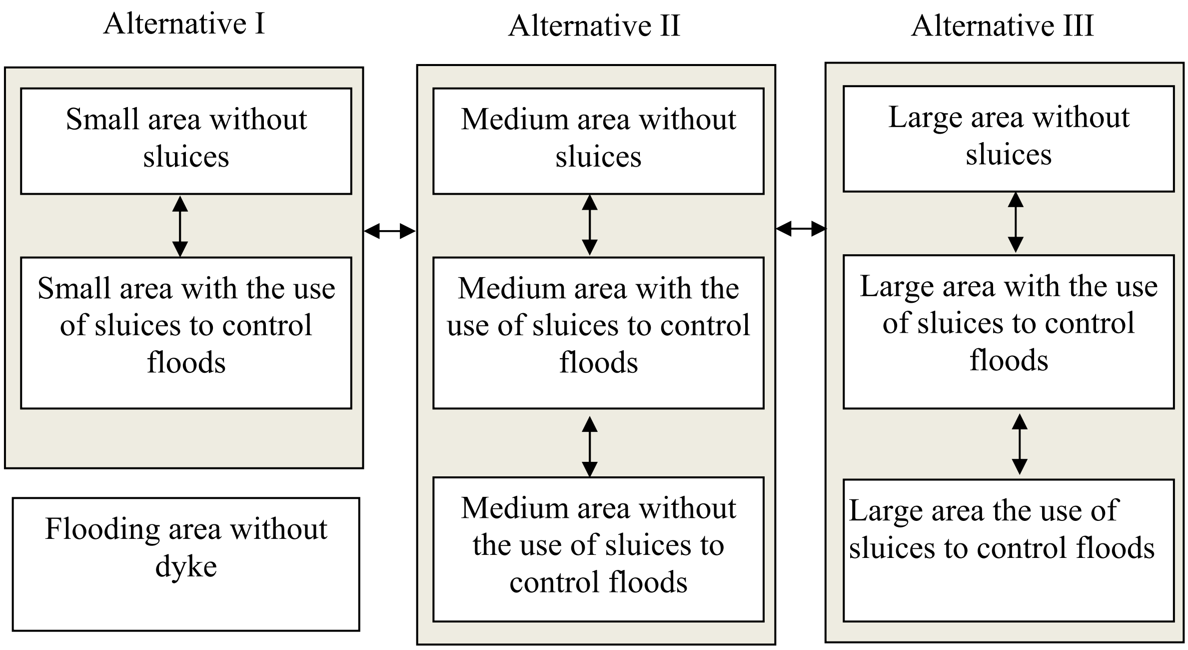


Source: SIWRP (2005a)

The dyke system planning was studied and implemented in several steps (Fig. 2.3). Firstly, data and information collection from ministries and related organizations in the governmental system together with the exploitation and evaluation of previous research projects were analyzed to identify the planning objectives for the following steps. Secondly and based on the existing structures, dyke planning alternatives were proposed to select an optimal solution for the future. Also, an analysis of investment costs and different options of financing planning were considered in this step. Thirdly, one selected alternative was evaluated as a detailed scenario in terms of investment cost, success or failure of planning under the given environmental and hydrological circumstances. This third step was considered to be a very crucial one, because each alternative had to be analyzed and evaluated in order to compare the pros and cons of potential implementation consequences.

The different planning alternatives were grouped into small, medium and large scale scenarios in order to design and select appropriate alternatives for each flooding zone. Sub-alternatives included (i) the closed flooding zone without sluices; (ii) the closed flooding zone with the use of sluices to control floods; and (iii) the closed flooding zone without the use of sluices to control floods. The dyke planning alternative 1A was finally identified as the most appropriate solution (Fig. 2.4).

Figure 2.4: Dyke planning alternatives



Source: SIWRP (2005a)

According to the flood control and dyke system planning reports of SIWRP (1998b and 2005a), the flood control zoning was finally presented as follows:

Flood control for Long Xuyen Quadrangle: The dyke system was divided into eight sub-zones. The planning purpose of this zone is to reduce floodwater level from 20 to 30 cm at the beginning and ending of floods to avoid flood's impacts on the summer-autumn rice crop (SA). The winter – spring rice crop (WS) is produced earlier before building the dyke system. Therefore, the SA will be harvested in July before floods appear in August. This zone includes the flooding areas of Can Tho city.

Flood control for the Western flooding zone of Bassac River*:* The dyke and sluice system was mainly constructed along National Road 80 to control floodwater sources from Long Xuyen Quadrangle flows in the western flooding zone of Bassac River. The dyke system is built up in the inner fields to control floods for agricultural production activities. Especially, drainage systems need to be excavated to discharge floods.

Flood control between Bassac and Mekong rivers: The dyke system encloses all the flooding areas. Therefore, agricultural farming models are protected entirely from flood impacts during the flooding time. The sluice system under the dyke system is built to manage floods and water for agricultural production models in the inner fields.

Flood control for Dong Thap Muoi zone: This is a deep flooding area in the MD. The dyke system is constructed to control floods and protect the Summer-Autumn rice crops. In addition, floodwater level is considered to reduce at the beginning and ending of flood in the protected flooding areas to reduce the negative impacts of floods on rice production.

3: DYKE SYSTEM PLANNING PRACTICE AND THEORY AT CITY LEVEL: A CASE STUDY IN CAN THO CITY

3.1 Introduction

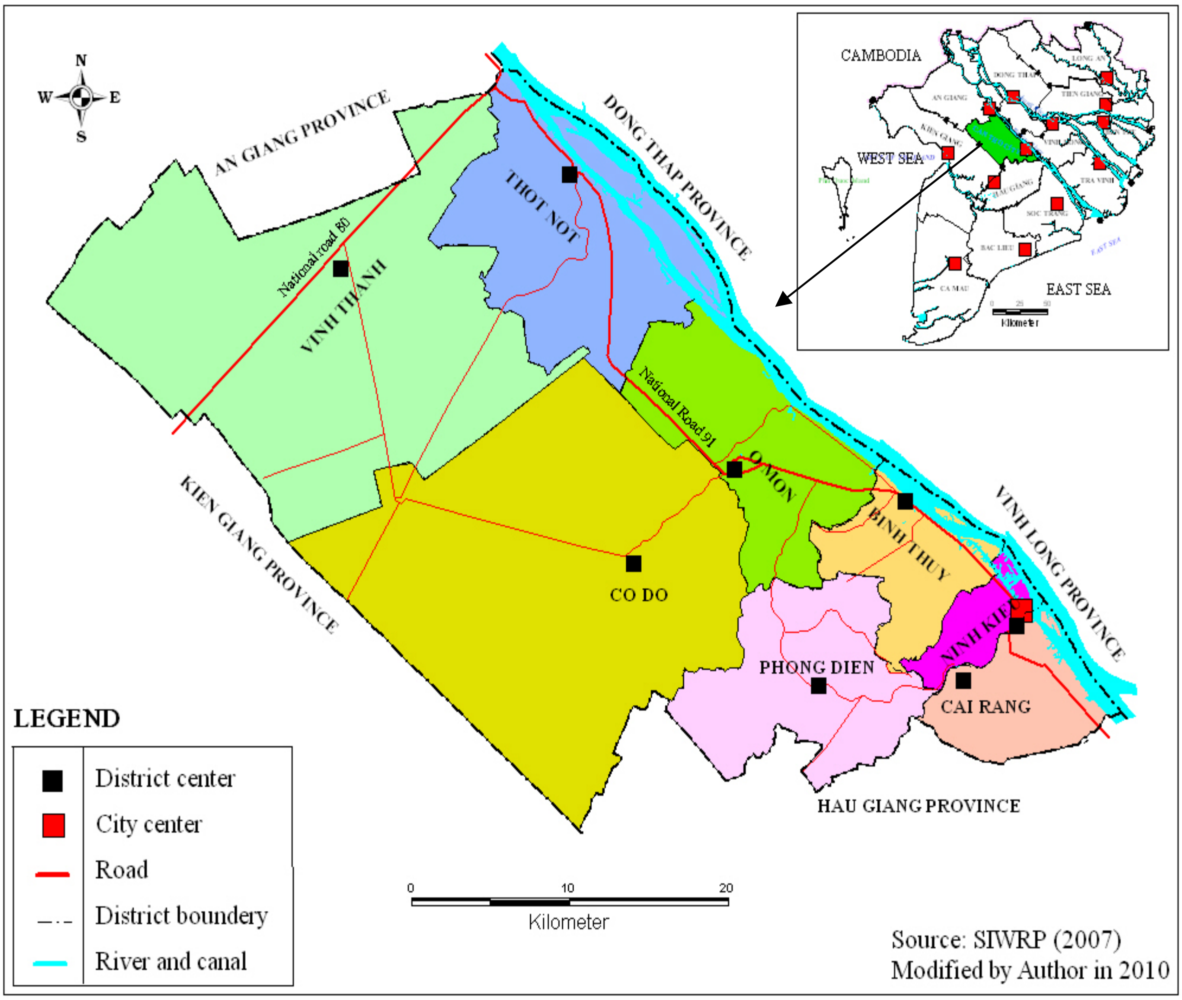
Floods are a great challenge for life and livelihoods of inhabitants in Can Tho city because they seriously damage agricultural production and infrastructure both in the city itself and in rural areas. In order to reduce flood disasters, the Vietnamese government and city authorities constructed dyke systems to control floods for all floodplains in Can Tho city. However, natural resource degradation, water pollution, erosion and unemployment of large parts of the rural poor are currently important problems and larger challenges for local communities – all these problems have contributed to contradictory perspectives and perceptions of the role and importance of effective flood control and management patterns between flood planners and local organizations in the practical flooding context of the city. The main objectives of this chapter are to understand and analyze the inherent problems of governmental dyke system planning and its problems. The research on this chapter is based on literature, secondary data within Can Tho city and personal interviews with governmental organizations. The concepts and theories of integrated flood management and vulnerability (see chapter 1 and 2) are basic preconditions to analyze problems related to the dyke system planning of the city.

3.2 Can Tho city: Its physical and socio-economic setting

3.2.1 Administration, topography and land use

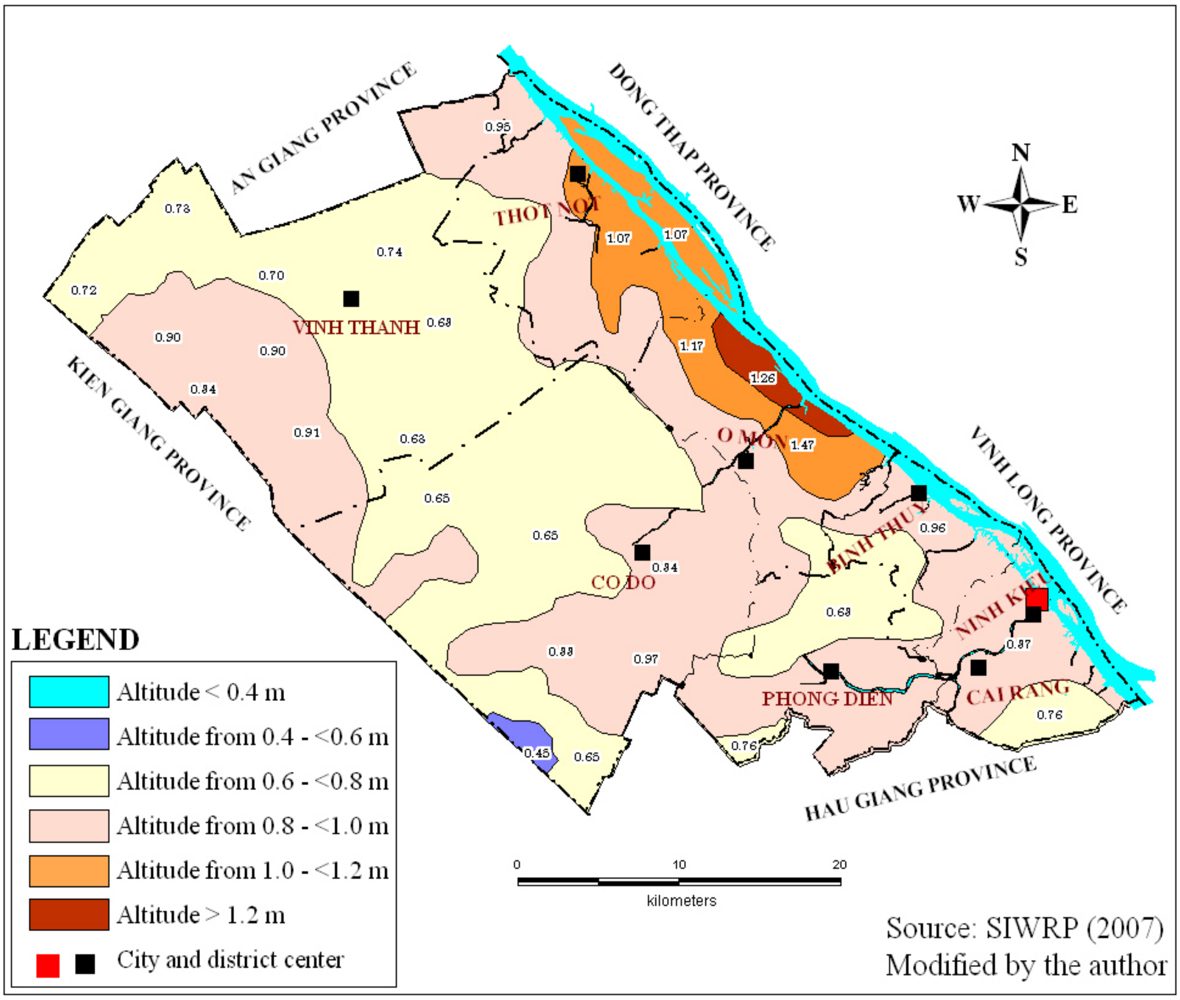
Can Tho city is located at the center of the Mekong Delta (MD) and limited by the Bassac River on the Northeast, Kien Giang province on the West, Hau Giang province on the South and An Giang province on the Northwest. The administrative boundaries of the city have undergone several changes over the last ten years (Waibel 2010). Before 2009, the city was divided into eight administrative units. Of these, four are urban districts consisting of Ninh Kieu, Cai Rang, Binh Thuy and O Mon and four are rural districts, namely Phong Dien, Co Do, Thot Not and Vinh Thanh (Map 3.1). In the mid-year 2009, Thoi Lai district was separated from Co Do district and identified as a rural district of the city. Therefore as of today (2009), Can Tho city has nine administrative units of which there are five urban and four rural districts. However, the study and its data as well as information gathering were carried out and collected between April 2008 and April 2009 and therefore reflect the former administration units of the city.

Map 3.1: Can Tho city administration map in 2008



In 2008, the population of Can Tho city was 1,171,100 people of which there were 578,700 males and 592,400 females with an average population density of 836 people per km. This comes up 6.6 percent of the total population of the Mekong Delta. In recent years, the annual average population growth has increased from 0.83 percent in 2003 to 1.04 percent in 2008. The average urban population was still higher than that of rural areas: 607,000 people in urban areas compared to 563,100 people in rural areas (GSO 2008). 63 percent of the total population live on agriculture while approximately 37 percent of Can Tho's residents earn their living by non-agricultural activities (SO 2008). In the rural areas, residents' houses are mainly concentrated along the two sides of rural roads or on the higher embankments of rivers, primary and secondary canals to avoid flood impacts while the city itself is a congested and densely populated urban center right on the banks of the MR.

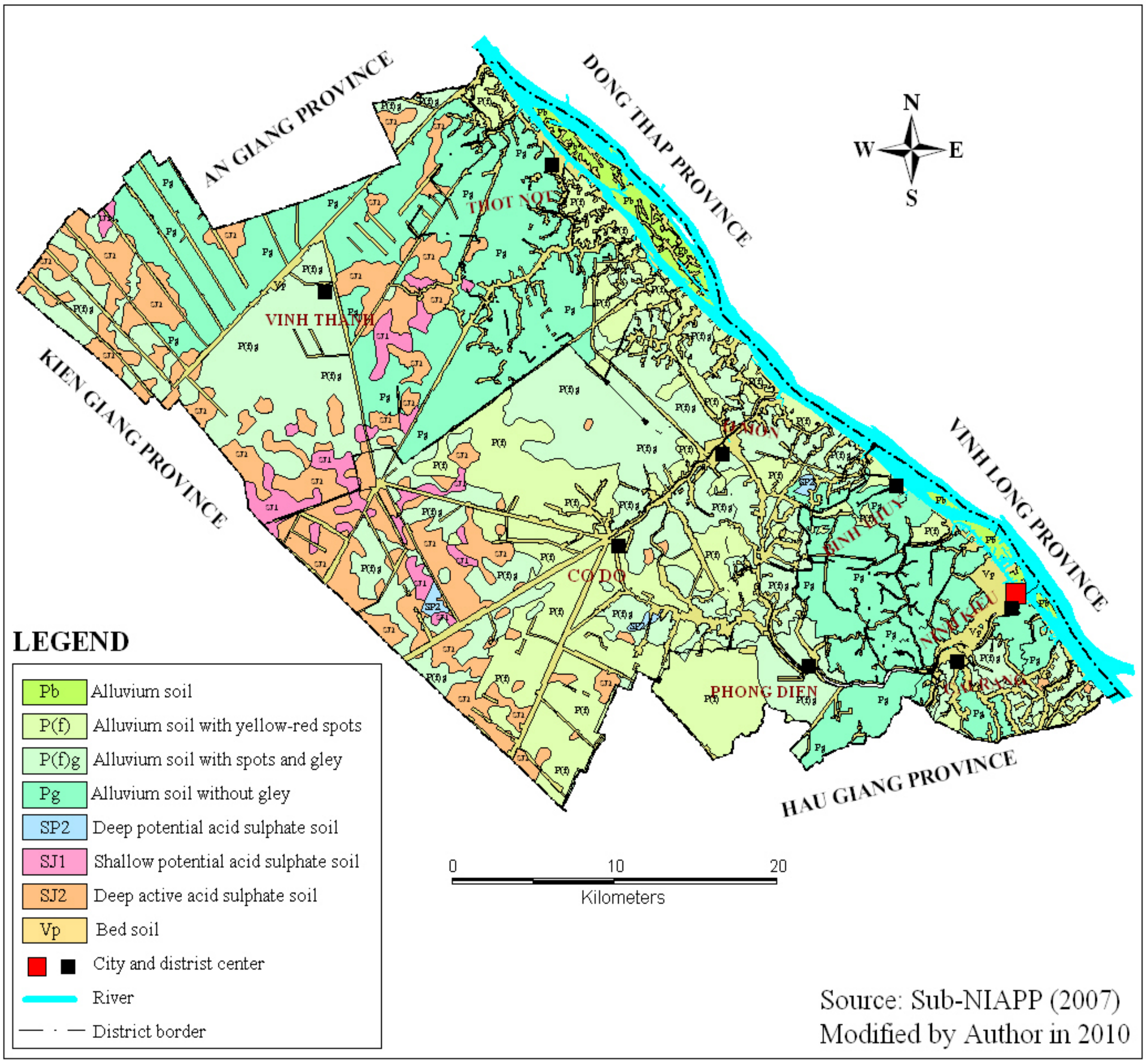
Map 3.2: Topography map of Can Tho city



The topography of Can Tho city is rather low with an average altitude varying from 0.6 to 1.2 m (Map.3.2). The total land area of the city covers 140,161.6 ha, of which 115,556.28 ha are agricultural land, 24.282.12 ha non-agriculture and only 323.2 ha waste land (Map. 3.3). In the agricultural land use structure, rice production land dominates with almost two thirds of the whole area. Land for perennial crops and trees, for aquaculture and animal husbandry covers only approximately 15% of the agricultural land (SO 2008). Thus, rice production is the major economic activity in Can Tho city.

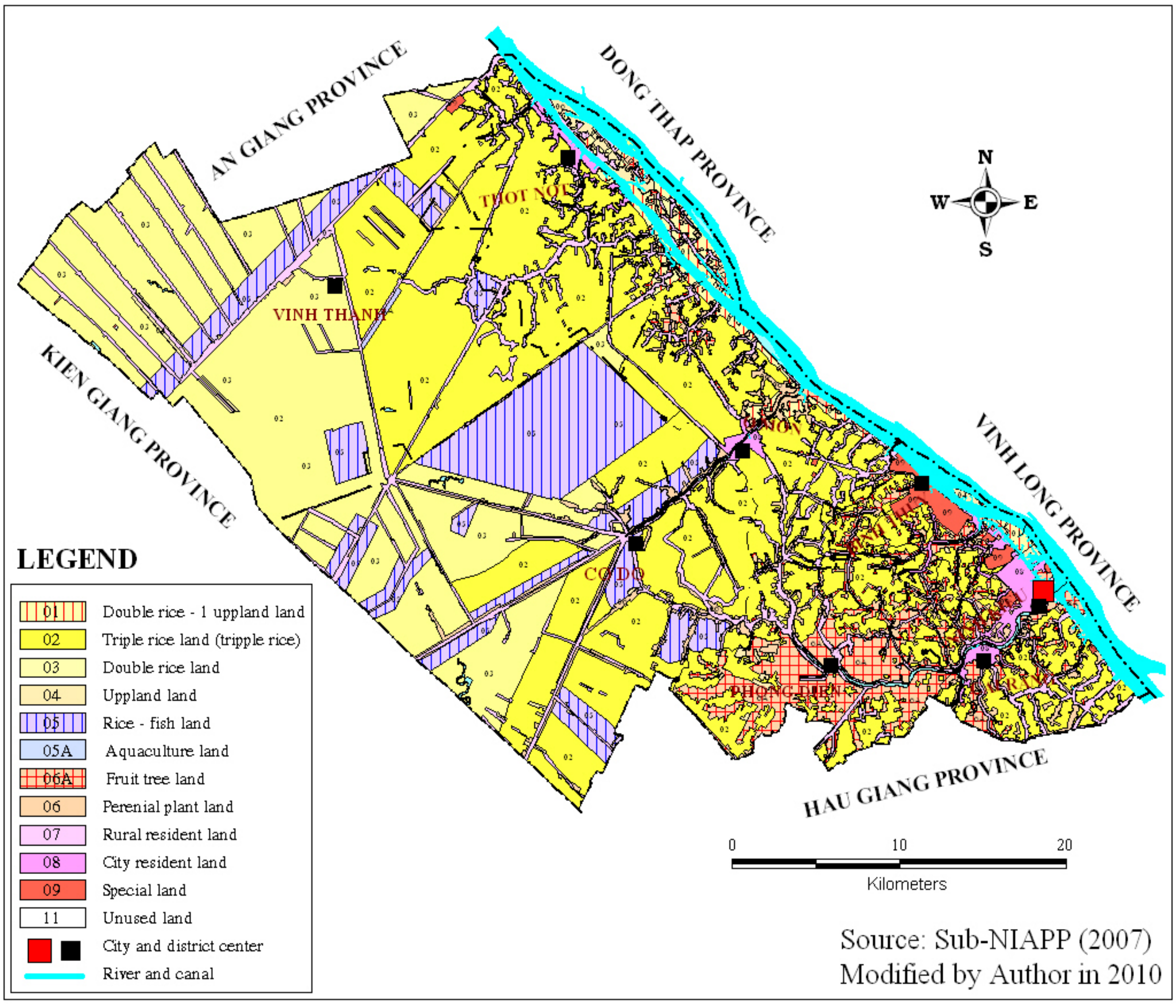
Maps 3.3 and 3.4 give additional information about the precarious ecological situation of Can Tho city. Due to the fact that most of the city's hinterland is located at a height of less than 1 m (Map 3.2), it is not surprising that alluvial soils, almost annually covered by new sediments of the MR, are dominating (Map. 3.3). Flooding proves to be a reliable natural fertilizer of the land, although – as indicated earlier – catastrophic floods and increasingly polluted waters can also be of negative influence for the agricultural productivity.

Map 3.3: Soil map of Can Tho city



Topography and soil conditions together with favorable temperatures are basic preconditions for the great fertility of the rural hinterland of Can Tho city and for the correspondingly high intensity of land use in the immediate neighborhood of the city itself and the whole MD. The comparison of the land use map (Map 3.4) with those of topography and soil demonstrates that almost everywhere two rice harvests per year, in some areas even three harvests per year can be generated. This positive aspect has to be borne in mind if we analyze and discuss the importance of an appropriate system of dykes, their roles and functions.

Map 3.4: Land use and agricultural production situation map in Can Tho in 2008



3.2.2 Water and irrigation systems

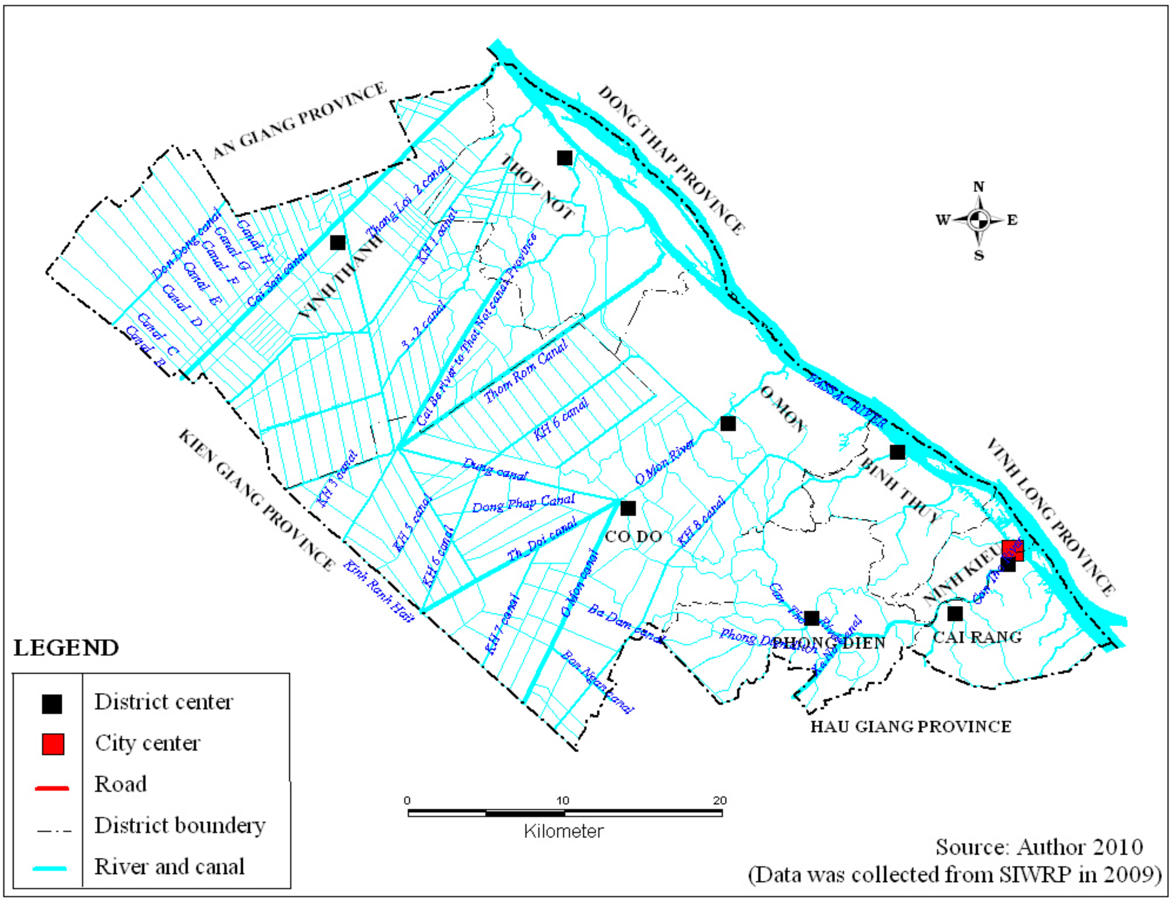
In Can Tho city, water is an omnipresent element. It serves all aspects of human life and natural ecosystems. Both surface water and groundwater are abundant and the main sources to serve agricultural production and the lives of people in the city all year round. The groundwater is mainly used for people's daily activities and the main source of household supply. Partly it is also used for industrial developments of the city. The surface water is provided by Bassac River and annual rainfall. It is mainly used for agricultural and industrial purposes. In the dry season from January to June, the surface water is derived directly from Bassac River via elaborate canal systems to serve for agricultural irrigation and industrial development of the city. However, its quality and quantity are not sufficient for agricultural production and industrial development from March to April so that some rice fields in Vinh Thanh and Co Do districts suffer from water shortage because canal systems are unable to deliver water into the remote farming fields. In contrast to the dry season, water becomes abundant in the rainy season from July to December and causes inundations within the city. Water in this time is not only provided by Bassac River, but also by rainwater and floodwater flows from Long Xuyen Quadrangle. During this time, river and canal systems are incapable of discharging all the surface water, causing rapid inundations in the farming fields.

Generally, there are many factors that influence the regime and change the surface water in Can Tho city. The semi-tide regime of East Sea with amplitudes from 3 to 3.5 m and the full tide of the West Sea with amplitudes from 0.6 to 0.8 m directly influence and temporally inundate land areas located along the Bassac river and the primary canal system. Inland areas are only affected by the tidal changes of West Sea (SIWRP 1998b). The annual rainfall causes the temporary inundations and flooding within Can Tho City. The average annual rainfall fluctuates between 1,700 and 2,000 mm with rainy season's peak from May to November, contributing up to 95 percent of total annual rainfall (SIWRP 2007). Flood flows from Long Xuyen Quadrangle cause additional inundations for all farming fields in the city. Finally also the pressure of population growth, intensive agriculture, industry, urbanization and infrastructure developments such as rural roads and bridges, sluices, flood control dyke systems are all contributing to the hydrological regime and its permanent changes in Can Tho city.

River and irrigation systems have constantly been improved to provide water for agricultural production, to regulate and discharge flood-flows from Long Xuyen Quadrangle into Can Tho city and finally to discharge water within the city (Map 3.5). There are two main rivers in Can Tho city: Bassac and Can Tho rivers. Bassac River is approximately 60 km long, 1500 – 2000 m wide and 14 – 18 m deep. The river flow reaches 1,800 – 2,000 m^3/s in the flooding season, and 300 – 400 m^3/s in the dry season (SIWRP 1999a, b, 2007). In addition, there are a series of other smaller natural rivers such as Can Tho, Binh Thuy, Tra Noc, O Mon, Cai Cui and Cai Dau connected with the Bassac River. Total length of these rivers is 310 km. All these rivers form a connective network for water distribution, flood drainage and waterway transportation within Can Tho city. However, they are inadequate to meet the increasing rural agricultural development demands as well as to serve as flood discharges to mitigate flood disasters. For this reason, a series of new canals has been built and connected with rivers to form a comprehensive irrigation and drainage network to meet these demands. By now, the canal systems of Can

Tho city are basically completed and able to irrigate for agricultural purposes and to ensure the discharge of surplus water (SIWRP 1999a, b).

Map 3.5: Irrigation system map of Can Tho city



The irrigation systems of the city are classified in a hierarchy of three canal systems of diminishing capacities:

The primary canal system: It is known as the main canal system, directly connected with the Bassac River to provide fresh water sources for all fields. It includes: Cai San, Thot Not, KH1, KH3, KH5, KH7, KH9, O Mon, Thi Doi and Xa No canals. These canals were excavated at a distance of 5 to 6 km between the primary canals from the North to the South. In addition, these canals were connected with Cai Lon and Cai Be rivers where they form the borders to Kien Giang and Hau Giang provinces. They empty floodwater into the Western Sea (Map 3.5).

The secondary canal system: It is a combination between primary and tertiary canals in order to take water into the tertiary canals to provide water for the fields. The secondary canal system spreads out more for than 2,000 km with an average length of each canal from 1.5 to 6 km (Map 3.5).

The tertiary canal system: It is formed within the fields and plays the role of water provision and drainage for the fields. Besides, it is an intermediate connection between the secondary canal system and the farming fields. It directly receives water from the secondary canal system to provide the fields and take it back to the secondary canal system. There are about 120 to 150 tertiary canals in each district. The tertiary canals were built at Co Do and Song Hau State Farms and areas where three rice crops are produced annually (Map 3.5).

Thus, natural rivers and canal systems form a connective hydrology system network within Can Tho City and with other neighboring provinces such as Kien Giang, Hau Giang, Soc Trang and Bac Lieu. Their double purpose is to allocate fresh water to the city of Can Tho and its rural hinterlands and to drain flood waters of for the Western areas of the Bassac River and the Mekong Delta (Map3.5). Altogether, one can say that the hydrology system of Can Tho city has contributed positively to agricultural irrigation, to the reduction of acid sulphate soils and to industrial development. In addition, it plays an important role in regulating rainfall impacts, flood drainage and waterways within Can Tho city and the Mekong Delta. Currently, the hydrology system in Can Tho city is still being improved to increase fresh water supply and reduce inundations within the city.

3.2.3 Floods and their impacts

As mentioned in previous sections, Can Tho city is an annual flooding area. The majority of the city's area is flooded from 1 to 1.5 m (Table 3.1 and Map 3.6). The annual floods begin in July and actually inundate the city from August to December. Floods reach their peak from mid-September to October. The daily flooding level varies from 5 to 7 cm during the flooding season. Floods are mainly caused by floodwater flows from Long Xuyen Quadrangle in combination with rainfall with the effect of tides. Generally, the flooding level of the city gradually reduces from North to South of Can Tho city with floodwater flowing one-way from North to South and from Northeast to Southwest through the fields, rivers and canals. Based on the average depth of annual flood, the floodplains of Can Tho city can be divided into five sub-zones with different flood depth. The shallowest flooded areas are lower than 0.5 m and the deepest inundated areas are higher than 1.5 m of seasonal water coverage (Table 3.1).

Map 3.6: Inundation map in Can Tho city

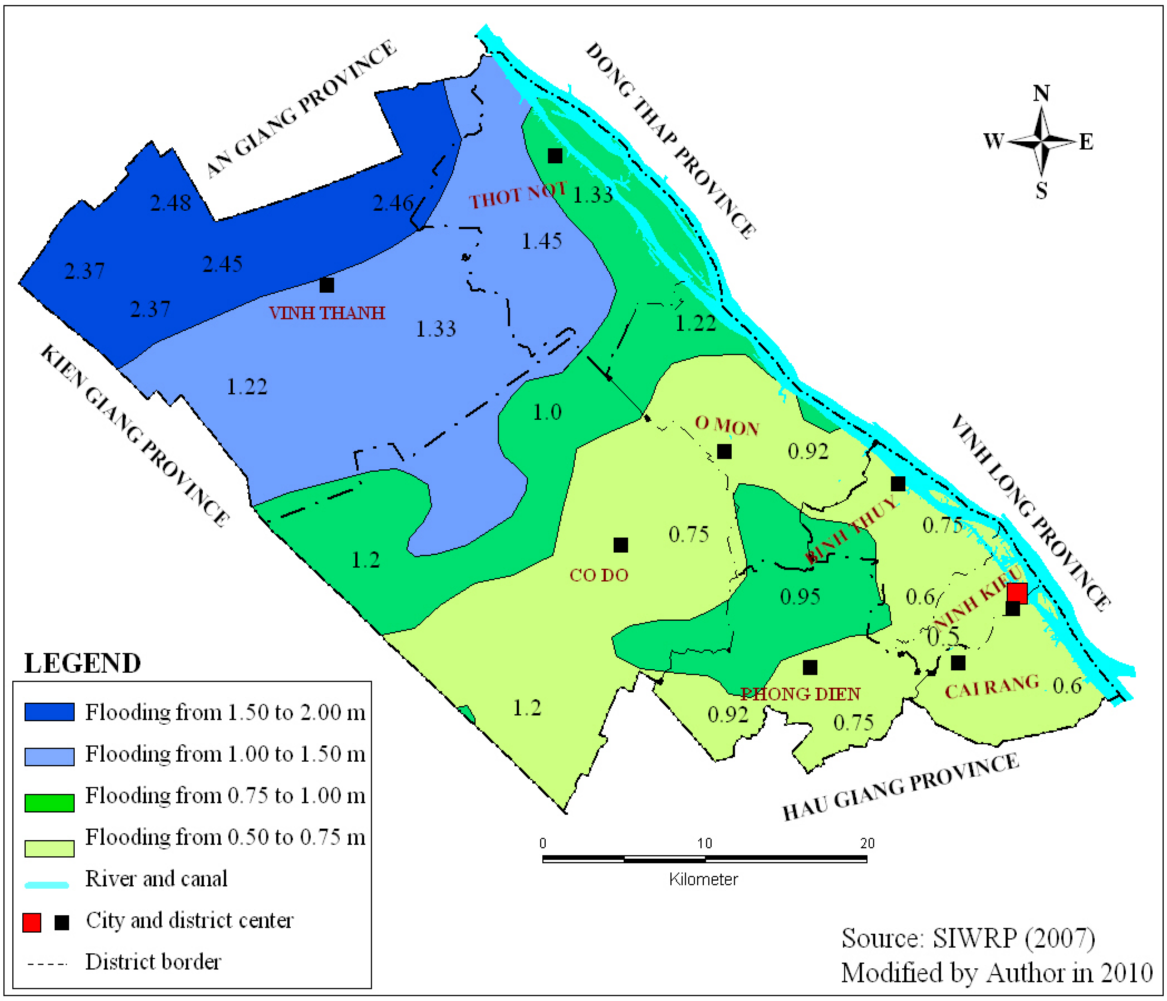


Table 3.1: Inundation area at different levels in Can Tho City in the 2000 flood

Items	Flood depth				
	< 0.5m	0.5- < 1.0 m	1.0- <1.25 m	1.25-1.50 m	>1.5 m
Area (ha)	77,957	129,350	69,200	17,000	2,750
%	25	43	23	7	2

Source: SIWRP (2007)

Generally, floods in Can Tho city offer benefits for agricultural livelihoods of rural people in the flooding plains. They directly provide crucial fresh water resources not only for agricultural production, but also serve as recharge for the groundwater, which is an important and essential source for drinking water and daily life of local people. Besides their benefits for the permanent renewal of the fertility of soils through natural siltation, floods in Can Tho city offer additional benefits to the farming communities in form of aquacultural activities, which are of major importance for Can Tho city. This holds true especially for natural fish growth, but even more so for fish and shrimp breeding during the flooding time. In addition, rice fields are also used to raise fish and ducks to improve income and broaden the nutritional basis of rural households. Especially rural poor people can earn additional income by catching natural fish during this period.

Table 3.2: Flood damage in Can Tho City from 1991 to 2001

Unit: VND billion (USD 1 = VND 15,000)

Items of damages	**1991**	**1994**	**1995**	**1996**	**2000**	**2001**
Rice production	38.70	52.18	7.00	27.20	86.25	21.50
Vegetable and industrial plants	13.71	15.50	2.00	5.00	15.60	4.60
Fruit tree	147.50	242.66	28.80	60.06	206.40	58.65
Fishery	6.50	8.20	2.16	0.03	1.25	0.50
Transport and irrigation	72.50	38.32	26.25	40.40	138.60	38.28
Education	3.50	8.46	0.15	2.90	6.90	2.60
Health care	1.70	1.50	0.03	0.14	1.50	0.70
Housing and others	35.00	21.37	1.20	65.80	145.80	55.20
Total	**319.11**	**390.19**	**67.59**	**201.53**	**602.30**	**182.03**

Source: SIWRP (2005b)

On the other hand, floods can develop into dangerous challenges and disasters for people in the floodplains. Again and again floods seriously damage agriculture and infrastructure in Can Tho city. The extreme flood of the year 2000 caused more serious damage than other floods because it exceeded the adaptability of local households and the coping capacities of governmental institutions. The total estimated economic damage of the city in this flood was approximately VND 602.3 billion and higher than equally dramatic ones in 1991, 1994 and 2001 (Table 3.2). Particularly rice and fruit trees were damaged and more seriously affected than fishery, vegetable and industrial plants because the farming areas of these plants are usually located in the lowest parts of our research area.

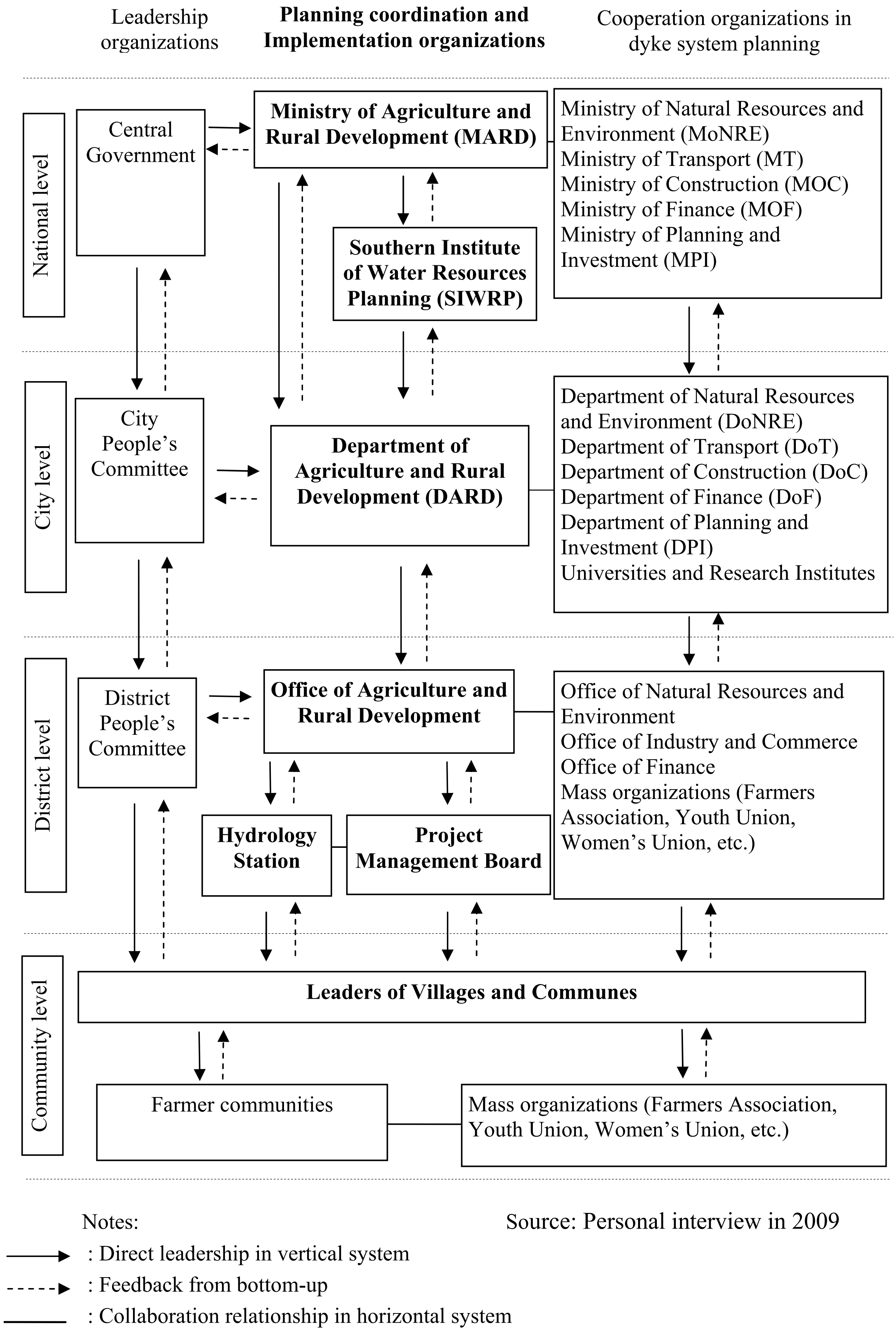
Although rural people in the floodplains of Can Tho city have gained plenty of experiences in living with floods and adapting to their changes in several decades, flood damage is still a serious challenge to the inhabitants of Can Tho city. Evidence shows that "living with floods" is always a risk whenever extreme floods exceed the adaptability of local people and local authorities. Considering all information presented above, the vulnerable flooded areas of the city are mainly concentrated in Vinh Thanh and Co Do districts because these places are always inundated deeper than other ones and additionally affected by acid sulfate soil as well as waste water from Thot Not and O Mon districts (Maps 3.3 and 3.6) – making our case study Vinh Thanh (see Chapter 4) a very appropriate research area.

3.3 Dyke system planning in Can Tho City

3.3.1 Organizational structure of the planning process

Highly bureaucratic political institutions, complicated administrative organizations and difficult decision-making processes are major burdens for an effective and goal-oriented planning structure, especially in a hydraulic environment. This is especially true when these institutions are undergoing restructuring processes and are confronted with new responsibilities and tasks. Evers – Benedikter (2009) have recently presented a valuable survey on the "development of a modern hydraulic society", taking the MD as a representative case study. Focusing specifically on water resource management issues, Waibel (2010) has recently published a comprehensive overview of the very volatile restructuring process of responsibilities in Vietnam's water management sector. Other authors, both Vietnamese and foreign, have produced similar analyses (Waibel 2010 and Vormoor 2010). All these studies point to the fact that the planning of hydraulic structures and their implementation is a highly complex, time-consuming and sometimes even contradictory process between national, regional and local institutions and decision-makers. This holds also true for Can Tho city and the MD.

Figure 3.1: Leaderships and relations among organizations in the dyke system planning



Source: Personal interview in 2009

As indicated in previous sections, the river and the traditional irrigation systems are inadequate to prevent disasters and risks of floods in the floodplains of the city because they are constructed primarily to serve agricultural production. Nevertheless, damage to agricultural production and infrastructure is a continuous threat as indicated by the persuasive evidence of flood disasters in 1991, 1994, 1995, 1996 and 2000 (Table 3.2). For these reasons, the Ministry of Agriculture and Rural Development (MARD) and local governmental agencies in Can Tho city decided in 1998 that a new dyke system should be built as a technical solution to control floods and protect rural fields and settlements. In addition, the new dyke system should ensure the controlled flow of floodwater from Long Xuyen Quadrangle into Can Tho city and its discharge into the Western and Eastern Seas.

According to flood planners' calculation, 86 percent of floodwater with low silt from Cai San canal flow into the Southern floodplains while only 14 percent of these come from Bassac River (SIWRP 1998a, b). In order to improve this situation increased water flows from Bassac River should provide additional silt loads for the inner fields of the Southern floodplains. According to the planners' prediction, flood-flow velocity in canals and rivers would increase and cause additional erosion along the banks of rivers and canals, especially the Cai San canal. Besides, and the flooding level in the Northern areas of road 80 were expected to be higher in the farming fields if dyke systems are constructed (SIWRP 1998a, b). However, so far no studies have been implemented to address the significant difference of silt and the change of flood flows between Cai San canal and Bassac River and within Can Tho city. This is remarkable because it shows to what extent flood situation assessment as well as analysis of the planners is obviously not embedded in an overall planning strategy. All this is highly subjective and lacks scientific evidence. Therefore, the flood control dyke system and its planning resp. implementation process need more coordinated and more coherent action between national, regional and local authorities. It is necessary to have closer cooperation among ministries and local organizations and to develop a viable dyke system planning under the umbrella of national law and legislation in order to fully implement its general provisions (ADB 2001). Especially, the participation of ministries, professional organizations and local people is essential in the process of dyke system planning, but also and likewise their coordinated cooperation with clear responsibilities for all parties involved. Based on Article 7 of Decree 99/TTg dated on 9 February 1996 the Ministry of Agriculture and Rural Development (MARD) was assigned to develop an overall flood control strategy for the

MD and to prepare the dyke system planning in Can Tho city. In regard to the latter, MARD appealed for the cooperation with other ministries as well as with local organizations at city and district levels to share their experiences and professional knowledge. Thus, many organizations from central to local levels were involved in the preparation of a coherent planning strategy. At central level, there were cooperations between MARD and other ministries such as the Ministries of Water Resources and Environment, Finance, Planning and Investment, Transport and Construction. Similarly, there was collaboration and connections between DARD and other departments of Can Tho city, however, with obviously decreasing intensity and incorporation of local communities and especially their rural population.

The governmental management system is a uniform structure with a clearly defined top-down strategy from central to local. While Waibel (2010) has published a detailed survey of Vietnam's state management structures with special reference to the water resources sector, others have focused more specifically on the corresponding structures for the Southern part of the country and esp. the MD region (Vormoor 2010). All these studies correspond in their evaluation of governmental top-down structures. In order to ensure this hierarchy, governmental political and professional organizations have formed sub-organizations at local levels to implement and manage the professional tasks assigned by the government. Fig. 3.1 tries to represent the highly complex and intricate system of decision-making processes for Can Tho city and its dyke construction process. It shows that bottom-up influences are comparatively weak although rural households and farmer communities are the main target of all decisions and their consequences – and although these groups have a wealth of knowledge and experience at their disposal. It should be added to Fig. 3.1 that all final decisions are made by the Prime Minister of Vietnam.

At city and district levels local professional organizations serve as consultants in professional commissions for People's Committees. Similarly, the functions and tasks of each professional organization depend on their standing and rank within the governmental management systems.

Table 3.3: Functions and tasks of organizations relating to dyke system planning

Name of organizations	Level	Major functions and tasks
Ministry of Agriculture and Rural Development (MARD)	National	- Managing and planning floods, dam, dykes, river and irrigation systems, agriculture and rural development.
Southern Institute of Water Resources Planning (SIWRP), belongs to MARD	National	- Managing and planning hydrology system and flood management for Southern provinces and cities
Department of Agriculture and Rural Development (DARD), under MARD	City	- Managing, planning and implementing projects related to the hydrology system, agriculture and rural development
Ministry of Natural Resources and Environment (MoNRE)	National	- Managing and planning of water and land resources
Department of Natural Resources and Environment (DoNRE), under MoNRE	City	- Managing water and land - planning land use and water resources
Ministry of Transport (MOT)	National	- Managing and planning infrastructure in rural areas and city related to road and waterway transportation
Department of Transport, under MOT	City	- Managing, planning and implementing of rural and city road infrastructure and waterway system projects
Ministry of Construction (MOC)	National	- Managing and planning infrastructure and construction
Department of Construction under MOC	City	- Managing, planning and implementing infrastructure and construction projects

Source: www.isgmard.org.vn/; www.mt.gov.vn/; www.moc.gov.vn/; and www.monre.gov.vn/

Considering the horizontal functions and tasks of ministries, a glance at Table 3.3 shows that there are, not surprisingly, overlaps between different Ministries in the governmental management system. These overlaps have caused and are still causing difficulties and constraints for the whole dyke system planning program. For example, MARD and the Ministry of Construction have similar functions and tasks related to the rural infrastructure planning and implementation. In addition, there is also an overlap between MARD and MoNRE. For instance, MARD is in charge of planning functions related to hydrology, dam and dyke works while MoNRE is responsible for managing land and water resources. Therefore, all decisions of MARD have to be considered and approved by MoNRE because dyke system planning related to land resources and water environment is under the responsibility and jurisdiction of MoNRE. These and many other overlaps have created obstacles leading to a series of constraints, contradictions and postponements in the realization of these and other projects. Thus, coordination and cooperation of MARD with other Ministries is very complex. It weakens coordination and collaboration among Ministries, agencies and local authorities (ADB 2001). And these problems are similar to the planning situation at city level. Here, for instance, the provincial Department of Agriculture and Rural Development (DARD) has to ask for the approval of its counterpart, the Department of Natural Resources and Environment (DoNRE), before determining and implementing planning projects.

In essence, MARD assigned the Southern Institute of Water Resources Planning (SIWRP) to develop a comprehensive dyke system for the MD, especially Can Tho city and to prepare a master plan for its planning and implementation. In order to get the project started, SIWRP directly cooperated with four other governmental organizations including the Southern Sub-National Institute of Agriculture Planning and Projection of MARD, the Southern Transportation & Economy Science Centre of the Ministry of Transport, the General Construction Consultant Company of the Ministry of Construction and the Southern Economy Center of the Ministry of Planning and Investment as well as hundreds of other organizations throughout the country. The planners of SIWRP organized hundreds of meetings, seminars/workshops at ministry and local levels to gather information and reach agreements in flood control strategies among the representative leaders of ministries and different organizations together with individuals from central to local levels. A draft of a dyke system planning approach for the floodplain in the city as the result of all these deliberations and activities was formulated and sent back to the related ministries and local organizations in order to get additional comments, ideas and suggestions before completing the main report. On the basis of this procedure, MARD and local organizations reached a reasonable level of agreement. Finally, MARD organized workshops to reach final agreement between the ministry and local authorities, as a result of which an official planning report was submitted to the Prime Minister. Finally, the main report of flood control dyke system planning of the city was approved in 1998 after 5 years of consultations between the different institutions.

Considering the participation of different organizations and individuals in the dyke system planning process, our own research confirms that there was inadequate cooperation at ministry level during the process of dyke planning formulation. Personal interviews with staff of SIWRP and SIWRR found that the main actors of the preparatory process were members of the staff of SIWRP. They formed a professional planning group in charge of designing scenarios or planning alternatives for the flooding areas in Can Tho City. Therefore, it is fair to say that the main contents of the documents was developed and formulated by this expert group. Regarding the participation of non-planning organizations at ministry level, almost all interviewees reported that they could only contribute opinions in seminars and workshops or make minor individual contributions to improve the suggested documents. They were not considered to be official partners and were not able to take part in discussions and debate during the process of dyke planning formulation, an indication that the whole process can be seen as a top-down event in which local experience and expertise play only a minor role.

The same observation holds true for the participation of local organizations in Can Tho city. There was no attendance of local planners. Also local organizations within Can Tho City were not involved directly in the dyke system planning. In fact, they mainly provided information and secondary data for the planners and only organized seminars and workshops when there was a specific request from MARD. Likewise, non-planning organizations such as the Fishery Resources Protection Agency, Plant Protection Agency, local research institutes, universities and other organizations from city to commune levels were not invited in the process of dyke system planning although they have knowledge and relevant experience. In practice, there were only the representative leaders of departments and political organizations involved in the seminars and workshops organized in Can Tho city who contributed their ideas in the drafts of dyke system planning. Worst of all, however, no studies were implemented to understand the livelihoods and needs of local people. The very obvious disregard of local knowledge of the people living in the floodplains and equipped with a wealth of experience vis-à-vis the challenges and necessities for improvements is surely the biggest deficit of the whole planning process. Their disregard, expressed also by the fact that hardly any socio-economic inventories have been commissioned, is probably also one of the main reasons for the negative perceptions by the local communities today (see Chapters 4 and 5).

In summary, the reconstruction of the planning process and the results of own research substantiate our hypothesis that the whole planning and implementation process of the dyke system has been a top-down activity by the central government and its bodies. Professional knowledge, experience and voice of organizations and residents, especially that of planners at local level, were not asked but rather ignored in the dyke system planning process. This implies that a strict top-down, state-centered planning approach was applied in the dyke system planning without the bottom-up participation of local people and specialists in non-planning organizations whose experience and knowledge would have been profound enough to contribute to the reduction of potential risks for life and livelihood of people in the floodplains of Can Tho city. The flood control dyke system planning in Can Tho city mainly reflects the perspectives of political organizations and the planning expert group of SIWRP rather than that of local communities and residents.

3.3.2 High Dykes and low dykes: the selection process

In order to control floods effectively, low and high dyke systems were designed. Based on the annual average flooding level, the low dyke system (Fig. 3.2) was designed to protect the Sumner-Autumn rice crops at the beginning of the annual flood seasons in August and to control the flooding level at the end of floods around November or December when the Winter-Spring rice crops are planted. The high dyke system (Fig. 3.3) was based on hydraulic calculations and the combination of the highest crest of the historical flood of the year 1961, the tidal regime in 1994 and frequent rains (P = 10%) because this flood was the biggest with the highest flood depth resp. water table on record. Therefore, the height of the high dyke system was designed to be half a meter higher than the peak of the 1961 flood (SIWRP 1998a, b).

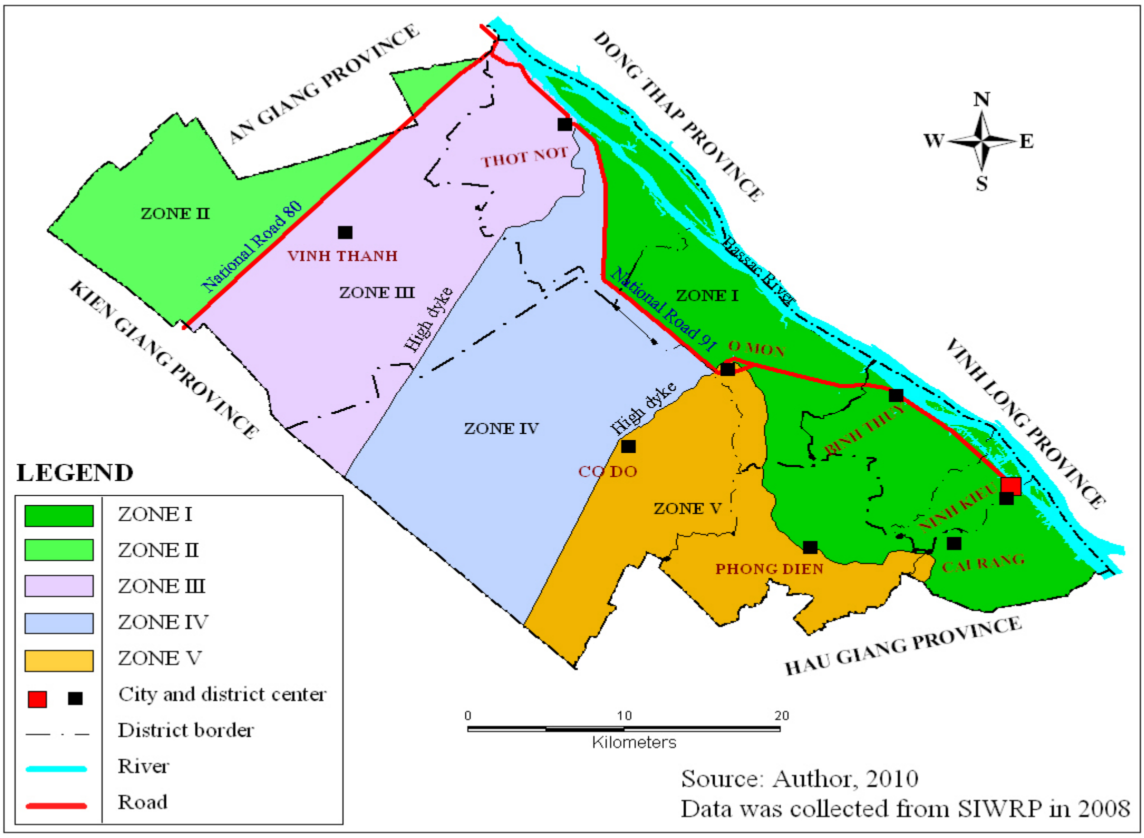
Figure 3.2: Low dyke

Source: Author (2008)

Figure 3.3: High dyke

Source: Author (2008)

Map 3.7: Dyke system planning map of Can Tho city (Alternative II)



Dyke construction was accompanied by the development of a zoning concept for Can Tho city. Purpose of this concept was to identify flooding zones and their specific characteristics while considering topography (Map 3.2), soil quality (Map 3.3), existing irrigation (Map 3.5) and drainage networks as well as the very important inundation depths

(Map 3.6) of Can Tho city. Besides, also the existing infrastructure and especially that of the city itself had to be taken into consideration. Based on these preconditions, the floodplains of the city were divided into two main sub-zones. These are the Northern and Southern flood control zones isolated by National Road 80 (SIWRP 1998a, b). The Southern flooding zone was divided into two smaller flooding sub-zones that are Eastern and Western zones of National Road 91. National Roads 80 and 91 were used as the main dykes to control floodwater from Bassac River. According to the flood management consultants of the Netherlands, the full flood protection should be built in the low flooded areas and the high dykes should be applied in the deep flooding areas (NEDECO 1993). In control floods in Can Tho city, the flood planners set up four different dyke planning alternatives and carefully analyzed them to select the optimal one. According to the flood control reports of SIWRP (1998a, b), dyke system planning alternatives were presented as follows:

Alternative A_0: flood control without the dyke systems within city

In this alternative, the main canal system is dredged to connect with Bassac river in order to irrigate water for agriculture in the dry season and drain off floodwater during flooding season. The irrigation system can also be used to control floods and allocate water among the different zones. Disadvantage of this solution is that agricultural production activities can be influenced by floods.

Alternative I: control floods over National Road 80 (or Cai San canal)

There are only a few differences in this alternative in comparison with alternative Ao. National Roads 80 and 91 are used as dykes to prevent floods from Long Xuyen Quadrangle and take floodwater into the farms in the hinterland of the Bassac River. A sluice system is built along the National Roads 80 and 91 to control the inflow and outflow of floods to the farms. The high dyke system is built along primary and secondary canals to form enclosed basins. Floods are actively controlled to protect agricultural production activities in the enclosed dyke areas.

Alternative II: floods are controlled in sub-zones (Map 3.7)

Here, the primary difference from alternative I is that the areas at the South of the National Road 80 are divided into two sub-areas to form smaller enclosed dyke sub-areas. The first sub-area is located at the East of National Road 91 along the Bassac River (Zone I). It is enclosed by the high dyke system to protect fruit tree areas and low dyke for rice farming. The second sub-area is located at the West of National Road 91 and divided into three enclosed dyke sub-areas such as Cai San - Thot Not (Zone III) , Thot Not – O Mon (Zone IV) and O Mon – Xa No (Zone V) (Map 3.7). In this alternative, floods are actively controlled to protect agricultural production activities in the enclosed dyke areas.

Alternative III: Flood controls for the whole flooding area of Cai San - Xa No

The contents of alternative III is nearly the same as that of alternative II. A different point is that the three sub-areas: Cai San – Thot Not, Thot Not – O Mon and O Mon – Xa No in alternative II are designed as one Cai San – Xa No enclosed dyke sub-area in alternative III. In this alternative, floods are actively controlled to protect agricultural production in the enclosed dyke areas.

In order to identify the optimal alternative, seminars and workshops were organized with the participation of international and national experts and leaders of local organizations to evaluate advantages and disadvantages of each alternative (Table 3.4).

Table 3.4: Summary on advantages and disadvantages of dyke system planning alternatives

Alternatives	Advantages	Disadvantages
Alternative Ao	Acid sulfate soil, agrochemicals and toxicity in floodplains are eliminated by floodwater. More natural fish Easily accessible waterway Low investment cost	Floods threaten agricultural production Fields are flooded deeply
Alternative I	Flooding level is reduced in sub-zones by 0.6 - 1.0 m in Cai San - Thot Not; 0.1 - 0.4 m in O Mon - Thot Not; and 0.05 - 0.1 m in O	Acid sulfate soil, agrochemicals and toxicity in floodplains are not eliminated by floodwater Less natural fish

	Mon - Xa No. Infrastructure and agricultural production are protected safely.	Medium investment cost
Alternative II	Flooding level is reduced in sub-zones by 0.4 – 1.3 m in Cai San - Thot Not; 0.3 – 0.7 m in Thot Not – O Mon; and 0.2 – 0.4 m in O Mon – Xa No. Infrastructure and agricultural production are protected safely.	Acid sulfate soil, agrochemicals and toxicity in floodplains are not eliminated by floodwater Less natural fish Longer flooding time High investment cost for dyke system construction.
Alternative III	Flooding level varies from 1 to 1.2 m Easily accessible waterway	Acid sulfate soil, agrochemicals and toxicity in floodplains are not eliminated by floodwater Less natural fish High investment cost for dyke system construction.

Source: SIWRP (1998a, b)

The comparative and analytical conclusions of WIWRP (1998a,b) show that the advantages of alternatives II and III far outweigh those of alternatives Ao and I in terms of agricultural production development and main road protection. Comparing alternatives II and III, it is recognized that construction investment costs of alternative III are lower than those of alternative II, but alternative III needs to be simultaneously implemented. Alternative III has more advantages than alternative I, but it was rejected because the entire budget would have to be provided at the same time while alternative II can be implemented step by step. For these reasons, alternative II was proposed to be implemented in Can Tho City. The floodplains of the city were divided into five sub-zones to control floods by the dyke systems. These flood control zones include the Eastern zone of National Road 91 along Bassc River (zone I), the Northern zone of National Road 80 (zone II); Cai San –

Thot Not (zone III); Thot Not – O Mon (zone IV); and O Mon – Xa No (zone V) (Map 3.7). Based on the described evaluation process, the overall characteristics of the dyke system as well as the role and functions of the five sub-zones in Can Tho city are summarized in Table 3.5. It shows that the low dyke system was applied in zones I and II, and the high dyke system was suggested and implemented in zones III, VI and V. The low dyke system is used to control floods in the deep flooded zones while the high dyke system aims at managing floods all year round and ensuring safety for all agricultural production activities in the low floodplains.

Table 3.5: Dyke system planning in the floodplains of the city

Dyke system planning zones	Area (ha)	Flood depth (m)	Flooding time (month)	Dyke system design	Main purposes
Zone I (along Bassac River)	37,549	1-2.5	4-5	Low dyke and high dyke	Protecting rice crops, fruit trees and aquaculture
Zone II (the North of Cai San)	15,843	1-2.5	3-4	Low dyke	Protecting rice crops
Zone III (Cai San-Thot Not)	30,346	1-1.5	3-4	High dyke	Protecting rice crops, fruit trees and aquaculture
Zone IV (Thot Not - O Mon)	35,048	0.6-1.2	3-4	High dyke	Protecting rice crops, fruit trees and aquaculture
Zone V (O Mon – Xa No)	21,272	0.5-1	2-3	High dyke	Protecting rice crops, fruit trees and aquaculture

Source: SIWRP (1998a, b)

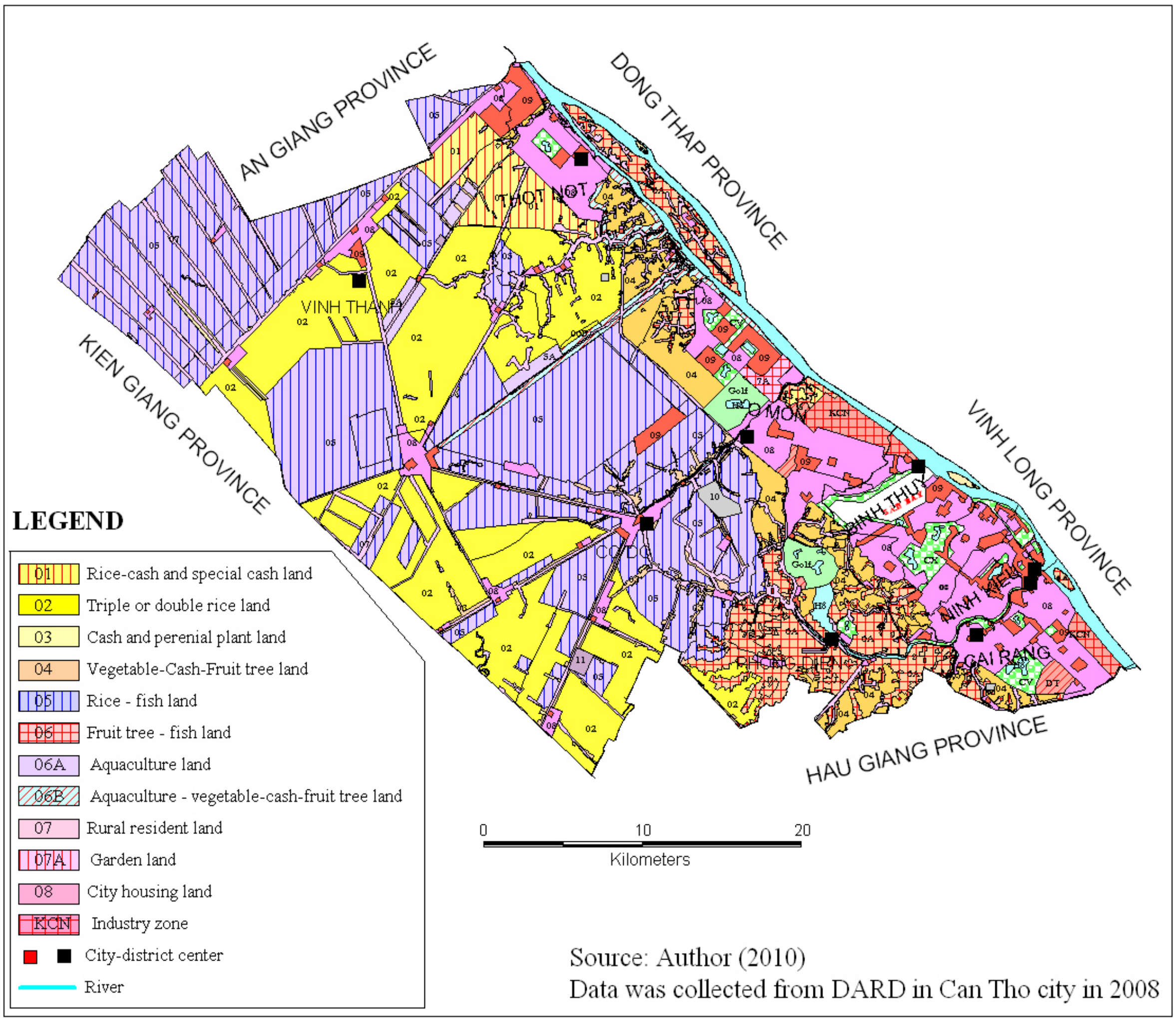
3.4 Dyke systems: Advantages and disadvantages

The dyke system of Can Tho city has been implemented since 2004. Currently, dyke systems are constructed to control floods in zone II (the North of Cai San) and zone V (O Mon – Xa No). These dyke works are conceived to test their feasibility in the flooding context of the city. However, there are different opinions and also first differing experiences between local people and planners about the advantages and disadvantages of these first dyke systems. The following sections present those experiences based on literature reviews, secondary data collection and personal interviews with officials and farmers in Can Tho city and with representatives of other organizations belonging to MARD and MoNRE.

3.4.1 Advantages

As mentioned above, agriculture is the basic livelihood and income of local people in Can Tho city. A feasible planning of the agricultural system has been a major concern at all

Map 3.8: Agricultural land use planning in 2006-2020 period of Can Tho city



Source: Author (2010)
Data was collected from DARD in Can Tho city in 2008

times, especially, however, after the renovation of land policy in 1986. In view of the importance of the agricultural sector not only for the local economy and rural households, but also for the whole country, it took a long time to decide on the most appropriate, ecologically adapted, economically promising and socially acceptable strategy for the future development of Can Tho city and its agricultural production. After many years of discussion, finally in 2006 the land use planning of the city was officially implemented (Sub-NIAPP 2007). In line with ecological parameters and in anticipation of future land use changes due to changing demands of the Vietnamese society in regard to agricultural products, scenarios of land uses and their changes until 2020 were developed (Map 3.8 and Table 3.6).

Table 3.6: Land use planning in 2005 – 2010 period and orientation to 2020 in Can Tho city

Unit: ha

Items	Years			Comparative interval areas		
	2005	2010	2020	2010/05	2020/10	2020/05
I. Total agricultural land	115,705	110,387	99,527	-5,318	-10,859	-16,178
1. Agricultural production land	114,380	106,860	94,300	-7,520	-12,559	-20,080
1.1 Annual plant land	94,833	82,860	68,300	-11,974	-14,559	-26,533
a. Rice land	92,913	79,780	64,360	-13,133	-15,420	-28,553
- Special rice land	92,889	79,780	64,360	-13,109	-15,420	-28,529
- Other rice land	24			-24		-24
b. Grass land for animals	23	180	550	157	370	527
c. Other annual plant land	1,898	2,900	3,390	1,002	490	1,492
1.2. Perennial plant land	19,547	24.000	26.000	4,453	2,000	6,453
2. Forest land	227	227	227			
3. Aquacultural land	1,098	3,300	5,000	2,202	1,700	3,902
II. Non-agricultural land	24,070	29,709	40,569	5,639	10,859	16,498
III. Unused land	321			-321		-321

Source: Sub-NIAPP (2007)

Table 3.6 and Map 3.8 indicate that – according to plan – the agricultural land use of the city will be reduced by 5,318 ha between 2005 and 2010 and by another 10,859 ha between 2010 and 2020, i.e. a total of approximately 16,000 hectares. Most of these reductions will be on account of drastic decreases of rice lands. On the other hand, the total area for aquaculture, animal husbandry and non-agriculture activities will be expanded from 2010 to 2020 (Table 3.6). Although these transformations are an opportunity to improve the effectiveness of land use, it is a threat for water pollution in rural areas. Besides, special agriculture farming models are envisaged to be transformed into integrated farming models in order to improve the effectiveness and the diversity of agricultural production in the protected floodplains (Table 3.7).

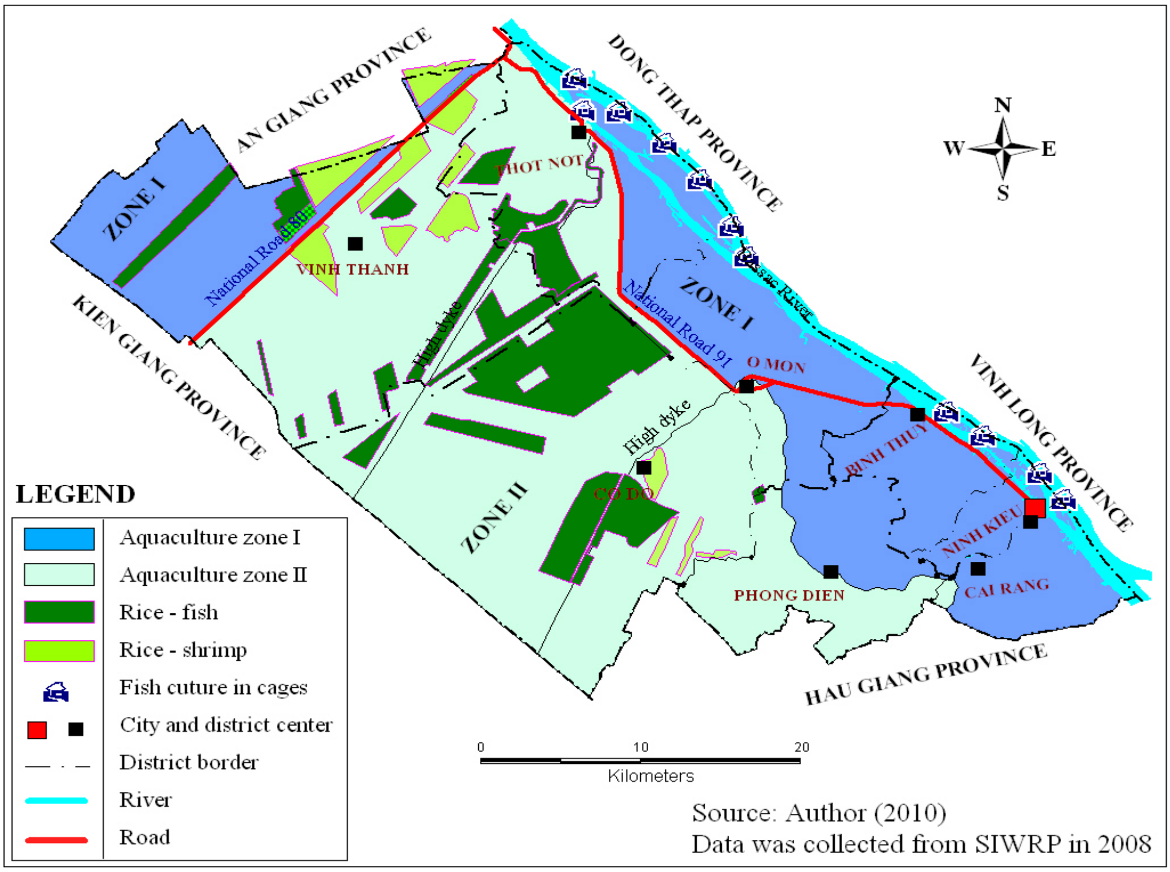
Table 3.7: Agricultural farming model transformation and redistribution in protected floodplains

Dyke planning zone	Area (ha)	Before dyke construction	After dyke construction
Zone I (along Bassac river)	37,549	Two rice crops, vegetables, intensive fish	Two-three rice crops, fruit trees, rice-cash crops, vegetables, intensive fish and shrimp culture, and industrial development.
Zone II (the North of Cai San)	15,843	Two rice crops, vegetable and extension fish culture	Two rice crops and rice-fish/shrimp
Zone III (Cai San-Thot Not)	30,346	Two rice crops, vegetable and extension fish culture	Two-three rice crops, rice-cash, vegetables, intensive fish and shrimp culture.
Zone IV (Thot Not - O Mon)	35,084	Two rice crops, vegetable and extension fish culture	Two-three rice crops, rice-cash, vegetables and special fish culture in ponds
Zone V (O Mon – Xa No)	21,272	Two rice crops, vegetable and extension fish culture	Two-three rice crops, rice-cash, vegetables, intensive fish and shrimp culture

Source: Sub-NIAPP (2007) and personal interview in 2008

Thus, one of the long-term benefits and advantages of the dyke system will be the transformation and modernization of traditional farming patterns: the land for mono-rice farming will be reduced while the area for vegetables, perennial fruit trees and aquaculture will be expanded until 2020. Integrated farming models such as rice – cash, rice – fish, fruit tree – fish, special fruit trees and intensive fish culture are envisaged in each flood control sub-zone. Diversification in the agriculture production is expected to generate employment and income for local people. Thus, from an agricultural and planning perspective, the dyke system combines the advantages of an increased flood control mechanism with the creation of innovative forms of agriculture and an improvement of economic and social security of the rural population in Can Tho city.

Map 3.9: Aquaculture planning map of Can Tho city



Another positive aspect of the dyke systems is to be seen in great opportunities for aquaculture development. Before the dyke construction, the floodplains were not utilized to raise fish and shrimp during the flooding time because of negative and uncontrollable flood impacts. Therefore, farmers only caught natural fish to earn additional income or to provide food for their family. However, after the dyke construction and better control of floods, a large number of farmers began raising fish and shrimp in their fields during the flooding time. In order to help farmers, floodplains were designed in such a way that aquaculture, partly based on the nutrients of the flood waters, became possible. A specific plan for aquaculture in the floodplains in Can Tho city was set up in 2007. The floodplains were divided into two aquacultural sub-zones based on dyke system planning (SAPSI 2007). The first Sub-zone (zone I) includes zone I and II of dyke system planning located along the Cai San canal in the North of National Road 80 and along the Bassac River in the East of National Road 91 stretching from Thot Not district to Cai Rang district. Its total natural area is 94,150 ha. It is appropriate for fish and shrimp culture because the water is directly taken from nutrient-loaden Bassac River. Almost all aquaculture activities are concentrated in this area. Aquaculture models include intensive fishponds, cage fish culture, rice-fish/shrimp combinations and others like fruit tree - fish, rice – fish, fish culture in the rice fields. The remaining floodplains of the city, namely Cai San – Thot Not, Thot Not - O Mon and O Mon – Xa No belong to the second aquaculture sub-zone II (zone II) of the dyke system plan (Map 3.9). Its total natural area is 45,946 ha. Semi-fish culture models in the rice fields were designed for these areas. Integrated fish culture models such as fish culture in ponds, fruit tree - fish, rice - fish/shrimp combinations as well as special fish cultures. It is the planners' expectation that this will lead to an intensification from semi-fish culture into intensive culture in both ponds and rice fields during the flooding time in the districts of O Mon, Thot Not and Vinh Thanh. Furthermore, fish culture in cages has also been implemented in big rivers, especially the Bassac River.

Altogether, it is fair to say that the construction of dykes has not only changed the potentials of rural production and productivity, but it has also created favorable advantages for the rural infrastructure development in Can Tho city. Before the construction of dykes rural roads were usually flooded. Waterways in terms of rivers and canals were then the major transportation routes for local people in rural areas. However, after high dyke system construction, the dykes along with primary and secondary canals in the floodplains were improved and became vital arteries in rural transportation systems. National Road 80 with 30 km stretching from Lo Te to Kien Giang, National Road 91 with 50 km from Can Tho to An Giang province, Road 921 with 25.53 km from O Mon to Vinh Thanh district- all were upgraded and raised higher than the crest of the flood in 1961, providing not only safer connections with Can Tho city but also ensuring better transportation facilities to neighbouring provinces. According to the annual report of Can Tho Hydrology and Planning Agency in 2009, there were also 25 "dykes and resident clusters" with 2,835 houses built to provide shelters for those who used to be vulnerable to the attack of floods in Can Tho city. Furthermore, canals and rivers were excavated to improve the waterway systems. Rural canals, Cai San and Can Tho Rivers have been excavated and upgraded.

Other new canals and dykes have been constructed in order to create a connective transport network between rural areas and city center, offering better opportunities for exchanging commodities and services between cities and their hinterlands than before. All these improvements mark considerable advantages, since agricultural products such as vegetables, fruits, rice, fish and pigs are mainly transported to cities by the road system. In return, household goods, necessities and agriculture materials from cities are transported to rural areas in order to satisfy local needs. Consequently, as services in rural areas have developed rapidly, locals have better living standards.

Table 3.8: Flood damage on agriculture and infrastructure in Can Tho city from 1991 to 2007

Year	Number of people killed (Person)	Number of houses submerged and damaged (House)	School submerged and damaged (room)	Paddy area inundated and damaged (ha)	Fruit tree and vegetable damaged (ha)	Road damaged (km)	Fish and shrimp raising areas destroyed (ha)
1995		28,431	127	24,525		1,425	870
1996	15	136,213	1,464	14,034	8,358	2,220	2,064
2000	32	114,526	1,299	28,964	909	1,927	1,833
2001	31	24,670	254	7,667	294	781	575
2002	9	38,789	345	3,481	7,039	979	378
2004	2	7,805	45	351	3,198	205	516
2005		5,420	20	9,565	1,741	115	509
2006	10	469			315	31	
2007		6,050	13		2,871	162	1

Source: DARD (2009) and www.ccfsc.org.vn

However, there have also been severe setbacks during the planning and implementation period of the dyke system in Can Tho city. The most serious catastrophe took place in the year 2000 when floods reached unforeseeable heights and volumes causing more serious damage than any other flood in history. The statistical data for Can Tho city (Table 3.8) and their comparison with the overall damages in the MD (Table 2.5) reveal the extreme physical vulnerability of the region as a whole, but also the related socio-economic impacts and consequences for local people and for the regional economy. Nevertheless and in spite of the still considerable losses of life and material values, the damages would have been even more serious without the dyke system preparatory measures.

For instance, the flood damage on agricultural production and infrastructure has been reduced quickly since the dyke systems were constructed to control floods in the floodplains in 2004. The dyke systems have positively contributed to controlling floods and reducing their risks in the floodplains within the city (Table 3.8).

Table 3.8 shows that the flood damages on rice farming, fruit trees, fish and shrimp culture as well rural roads were quickly reduced in the protected floodplains of the city. Summer-Autumn rice crops are always safe in the protected floodplains while Autumn-Winter rice crops are sometimes damaged by floods. Generally, floods have been controlled better in the protected floodplains compared to the flooding situation of unprotected floodplains before 2000.

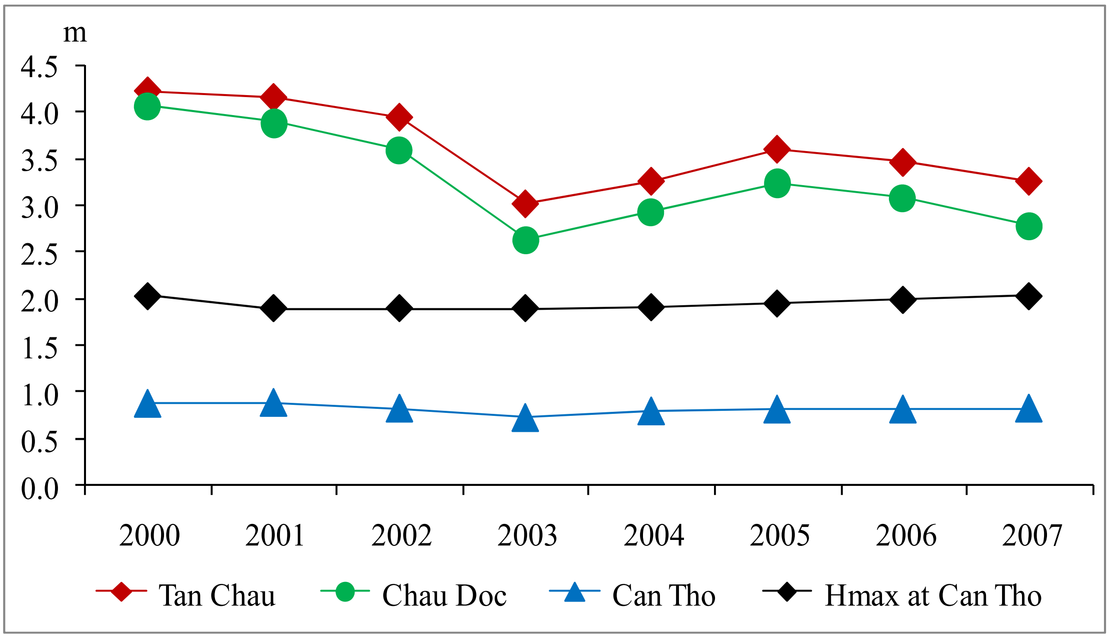
3.4.2 Disadvantages

It would be a miracle if the tremendous efforts of the melioration measures in the MD and in Can Tho city would be only positive ones. On the contrary: unquestioned advantages of the new system are counterbalanced by negative impacts. Such an observation holds true especially from a bottom-up perspective, i.e. a perspective in which the traditions and experiences of the local people are touched. Disadvantages of the new dyke system are both an environmental issue as well as a kind of “emotional” perception by rural households and individuals.

The dyke systems have changed the inundation levels between regions. Referring to results of personal interviews with locals, the inundation time has been prolonged in the protected floodplains. In recent years, floods have usually inundated sooner and receded later because the sluices built under the dyke systems failed to discharge water completely and timely out of the fields. As a result, rice fields are normally flooded earlier and covered longer with water at the end of the rainy season. Infrastructure changes during the period 1996–2002 had massive effects on the flood regime. Concretely, dyke systems along rivers, canals and roads reduced the drainage of floodwater in the paddy fields (Le Thi Viet

Hoa et al. 2008). They found that inundations last approximately 5 –10 days longer and are 0.2 – 0.3 m deeper in some regions near or between high embankments. In addition, the

Figure 3.4: The highest flood peak and average flooding level from September until November at Gauging Stations in the Mekong Delta



Source: Can Tho Hydrometeorology Center and Agriculture and Rural Development Department of Can Tho City in 2009

dyke system in the upstream provinces decreased the overbank inflow to Vietnam and increased the water flow in the canals. According to Le Thi Viet Hoa et al (2008), this is consistent with the analysis of varying trends that wwere based on the hydrological data from 1961 to 2004: flood peaks tend to increase with progression downstream. Thus, the dyke system is one of causes affecting to flood regime and inundation levels among different regions in the Mekong Delta.

In fact, the flooding level has slightly increased in the lower areas after the dyke systems were constructed in the Mekong Delta (Fig.3.4). The collected secondary data analysis at the Gauge Stations shows that the annual average flood levels at Chau Doc and Tan Chau Gauging Stations in the upstream areas have decreased from 2000 to 2007. On the other hand, the annual average flood level at Can Tho Gauge Station increased in the same period. Furthermore, the highest flood crests recorded in Can Tho city after 2000 occurred after the dyke construction. The highest flood crest was recorded in 2007. It was equivalent to the highest peak of the 2000 historical flood (2.03 m). Therefore, the continuous increase of the flooding level in the coming years may become a severe threat to lives and livelihoods of people, especially those who live in such a low area as Can Tho city. It is clear that the dyke systems constitute one of the main factors causing deeper inundation levels for the lower flood areas of the whole Mekong Delta.

Another disadvantage of the new dyke systems is the fact that natural fish resources have been reduced rapidly for the following reasons: (i) the dyke systems have prevented migration of wild fish from rivers and canals into the protected flooding plains; (ii) the main gates of sluices along the dyke systems hinder the fish from migrating and they are closed during the flood season; and (iii) triple rice crops have been implemented in some of the protected flooding areas, causing the loss of fish habitats during the flooding season. Fish production in the dyke system at Vinh Loi and Vinh Hau communes of An Giang province was 533.2 kg and 1,126 kg per year respectively in 2004 and fell to 230.96 kg per year in Vinh Loi and 472 kg per year in Vinh Thuan in 2005 (Tran Nhu Hoi 2005; Duong Van Nha 2005). Since both communes are located in the high dyke areas, this system is adverse to wild fish proliferation. On the other hand, fish occurrences have not been reduced in the low dyke system because this system allows direct exchange with floods, rivers and irrigation systems.

A serious problem of the new dyke systems is that it is leading to water pollution and soil fertility reduction because intensive farming has been encouraged in the protected flooding areas. Three-rice-crop farming causes the increase of pests and plant diseases. Furthermore, the uncontrolled use of agrochemicals contributes significantly to water pollution. The high dyke systems have limited water exchange capacities among rice fields and rivers and canals, resulting in silt reduction together with toxicity and agrochemical accumulation in the fields. According to the research results of Duong Van Nhat (2006) and Tran Nhu Hoi (2005) at An Giang and Tien Giang provinces, there was a distinctly smaller proportion of silts in the protected flooding areas in comparison with the unprotected ones. In addition, they found that the volumes of BOD and COD in the protected floodplains were 4-5 times (BOD) higher than those in the unprotected flooding areas - and 6 – 8 times (COD) higher than the allowed standard of Vietnam´s case study in Tien Giang province.

In addition to all these constraints, the new dyke systems cause increased erosion of rivers and canals. According to the experience of rural people and measurements by official government institutions, the flow velocity in the rivers and canals has risen during flooding season in comparison with the period before the construction of the dyke systems. The deepening of the water channels causes erosion on both sides of the river banks. In recent years, a large number of river and canal segments have been eroded. Hereby also the failure of the dykes in the protected floodplains has increased (Le Thi Viet Hoa et al 2007) because they were easily eroded in the flooding time by water waves and heavy rainfall. However, also human interferences contribute to damages and destruction of the new dyke systems. Inappropriate behaviour especially by fishermen, who use the fragile alluvial embankments of the rivers and canals as platforms of their fishing activities, is a major destructive factor. The costs for annual repair of broken dykes are high and exceed the affordability of local people and local authorities.

3.5 Summary: Dyke system planning in Can Tho City

A review of all the pros and cons of the flooding situation in the MD in general and of the specific situation in Can Tho city must come to the conclusion that on the long run floods bring more advantages than disadvantages for rural people in Can Tho city and beyond. However, governmental dyke system planning has dramatically changed the natural flooding regime and its impacts on the cultural landscape of the region and traditional economic structures of land use and agricultural production. And this outcome of dyke construction can be seen differently, depending on a perspective from top-down or bottom-up. The governmental perspective focused mainly on protecting and improving agricultural production while the practical needs and insights of the poor and non-agricultural people groups were ignored. It has to be acknowledged that the flood planners have wisely prioritized those measures that need quick solutions to protect life and livelihood of the majority of rural people, especially farmers whose crops (rice and fruit trees) were seriously damaged in big floods during recent years before. However, a small amount of rural poor population, who live on floods, was not taken into account or ignored in the dyke system planning process. As mentioned, most information and data were secondary data collected at city and district levels while primary data and information from local communities were hardly sought. Therefore, the practical needs of local people in the floodplains did not receive the appropriate attention. Practically, no studies on socio-economics or on the expectations, attitudes and hopes of the beneficiaries were carried out. Thus, the dyke system planning focused almost exclusively on solving flood disasters in short term, but overlooked the practical needs of different social groups in rural society. It would have been a worthwhile additional endeavour to incorporate views and visions from the bottom of the whole process. The combination of the top-down approaches by the central and the provincial governments and their discussions with the recipients and – in a positive sense – “victims” from a bottom-up perspective would surely have contributed to the elimination of avoidable negative effects and to additional improvements of the results and outcome of the dyke system planning and implementation process.

Thus, one may argue that a considerable constraint of the city is the lack of democracy in the whole process of dyke system planning. The participation of civil society in planning issues towards the decentralization and devolution of many areas of natural resource policy and state responsibility are an international trend. Democratic decentralization is obviously more efficient and equitable than state-centered control, especially when local issues and problems are at stake (Lane 2003). In Can Tho city local people and especially non-governmental organizations were not involved in dyke system planning formulation. The coordination and management mechanisms of governmental institutions were and are concentrated on state centered power structures. And until today the political element and decision-making of governmental organizations strongly dominates in all social and public aspects. The right to make decisions in dyke system planning is based on a hydrological bureaucracy and monopoly in dyke system planning from central to local levels (Evers and Benedikter 2009; Vormoor 2010), while the participation of local people and non-organizations is hardly discernable. This monopoly offers favorable opportunities for the planning organizations, which benefit from investment budgets for planning projects. As a result, corruption is a far-spread accompaniment in the upper levels of the planning and implementation process while the inclusion of local knowledge and experiences of local people is equally far-spread omitted.

Additionally to these observations and based on reports from governmental employees as well as on those of local farmers and fishers in the flooding areas of Can Tho city, the author has tried to substantiate these controversial statements by personal interviews among representatives of the top-down bureaucracy and among the farming communities. Not surprising, perceptions of one and the same phenomenon are very different, in some aspects even hardly reconcilable. The first group includes organizations and individuals who support dyke system planning, namely planners, hydrological specialists and the leaders of political and planning organizations at ministry and city levels. People in this group argue that dyke system construction and planning is a necessary need to guarantee safety and reduce flood risks for agricultural production in the floodplains of the city. They insist that dyke systems have brought more advantages than disadvantages to local people in the protected floodplains because the dyke systems protect rice and fruit tree production. Besides, dykes bring more silts and lower inundation in the protected floodplains. People in this group mainly consider and mention economic benefits. For them, flood disaster reduction and the capacity to control flood-flows and flooding level among floodplains within the whole Mekong Delta, especially Can Tho city, is of absolute primacy, although they acknowledge that dyke systems can cause increased water pollution in the floodplains. It is obvious that the viewpoints of this group are dominated by technocratic and engineering aspects rather than by the insights to live harmoniously with floods favored by quite a few local people.

The perspectives and perceptions of the second group totally contradict those of the first group. They are local researchers, farmers, leaders and technicians in agricultural and environmental research sections with various experiences in the fields of ecosystem research, plant protection, aquaculture, animal husbandry research and natural resources management. Almost all opinions in this group point to the negative consequences of the dyke system and stress the long-term effects instead of the short-term benefits. The sustainability aspect of agricultural and flood management should be taken into account in the dyke system planning. Concretely, the local communities' livelihoods as well as the relationship and interaction between local people and floods should be considered more carefully, and more emphasis should be given to the capability of people to cope with potential disasters and to reduce their vulnerability. According to this group, water pollution, erosion, deeper inundation, natural fish and soil fertility reduction and lesser employment of the poor during the flooding time have to be complained. Most of these concerns have, by the way, been expressed in O Mon – Xa No dyke sub-areas and other similarly protected areas in Can Tho city. In addition, inundation in recent years has increased and deeper floods have appeared in the center of the city and in floodplains located along the the Bassac River.

Analyzing and comparing opinions between the two groups, it is obvious that there is a conflict between local people on the one hand and planners as well as leaders of political organizations on the other. Local people and local researchers want to protect floods and ecosystems and live harmoniously with floods rather than fighting them. However, they are pleading for substantive improvements of local people's capabilities to adjust to floods in economic and social respects (see Chapter 5 of this study). As will be discussed in the next two chapters of this study, there are a number of thoughtful suggestions and experiences brought forward against the views of their more technocratically arguing counterparts.

However, there are additional differences between local organizations and planning organizations. They refer to the question whether low dyke systems or high dyke systems to control floods in Can Tho city are the more appropriate tools. The planners have chosen the high dyke system as flood control measure for almost all floodplains in Can Tho while local researchers and the majority of local people have favoured the low dyke system. Almost all opinions of inhabitants and local researchers have expressed that the high dyke system has practically caused nothing but disadvantages for water environment and ecosystems. According to them, the low dyke system still guarantees safety for rice production and causes fewer negative impacts on the ecosystem as compared to those of the high dyke system as it is implemented in An Giang province (Tran Nhu Hoi 2005; Duong Van Nha 2006).

Dyke system planning and its implementation have changed the natural regulations of floods in the whole MD. In this process, local organizations and local individuals were not involved; they had to depend on central planning organizations. Therefore in some cases, organizations at district and commune levels set up their own dyke plans in order to serve the practical needs of local communities. As a result, local dyke system planning is not always coherent with governmental dyke system planning. Independent of these sometimes very conflicting situations, one has to conclude that Can Tho city and its population has been transformed from a rural society in which people lived with the natural rules of floods to a modernized hydraulic society, in which natural flood regulations have been transformed towards a technology-dependent and sophisticated water management under human influence. These changes have created new challenges for the inhabitants in the protected floodplains while it is acknowledged that dyke system planning has created foreseeable benefits in short terms, it may lead to unpredictable negative impacts on sustainable development in the floodplains in the long term. With other words: the natural rules of floods have been transformed into human-controlled regulations, resulting in new problems and new challenges. How rural communities and local adapt to the new regulations and rules and how they will address the obstacles and constraints in the process of the new dyke systems within communities and on an individual household basis will be discussed in Chapters 4 and 5 of this study.

4: DYKE SYSTEM PLANNING IMPLEMENTATION AT DISTRICT AND COMMUNITY LEVELS

4.1 Introduction

The formulation of a coherent and all-embracing hydraulic plan for a large region like the MD is hard, but it is even harder to successfully implement it because the planning implementation is usually a complex process (Joseph et al. 2008) and the biggest challenge in the planning projects (Wu et al. 2008). Successful planning implementation requires active and premeditated actions consisting of the coordination of multiple actors and activities and other actions of a transient and complex kind (Heide et al. 2002). The human needs of land, water and natural functions of ecological systems require a thorough understanding of the complex interactions between land, water and ecological quality, especially the consideration of adverse impacts associated with those human activities that can cause the degradation of ecosystems (Cai 2008). The successful planning implementation usually covers technical and economic aspects (Mirghani and Savenije 1995), strategic thinking (Bell et al. 2010) and the pursuit of organization's goals (Wu et al. 2008). Primary focus, however, is to be laid on the management and solution of the natural environment rather than on social and problems (Mirghani and Savenije 1995). In all cases, policy makers and planners have to ensure the logic and goal-oriented coordination of the large number of activities, the exclusion of competing interests and agencies' involvement in the planning implementation leading to a disparity between plan objectives and implementation outcomes. These factors increase the complexity which in a worst case scenario can lead to implementation failure (Joseph et al. 2008). Therefore, the planning implementation should not only clarify consistent goals, priorities and interests, but also ascertain the facts, realities, and social trends and measure their outcomes to reach implementation success (Kahn 1969). Furthermore, causal linkages between objectives and actions and between adequate resources and authorities' managers' involvement and commitments of managers as well as appropriate supportive policies need to be involved in the planning implementation (Sabatier and Mazmanian 1983).

In Vietnam, the central planning approach in the planning formulation has been an ideology for the unitary state where the resource allocation was and is decided by the central authorities according to administrative plans (Vu Thi Tuyet Mai 2008). In Chapter III, the formulated dyke system planning was identified as a strategic solution to control floods and ensure safety for agricultural development in the floodplains of Can Tho city. The planning approaches were applied in a top-down dyke system planning formulation at national level without the participation of local communities and professional organizations. The negative impacts of the dyke systems have been considered in the flooding context of Can Tho city. However, they can actually not only be blamed on the planning process alone, but they also exist in the dyke system implementation process. Therefore, the implementation of the dykes has challenged local organizations in their pursuit to reach the expected objectives of the central government. For these reasons, Chapter IV continues to investigate the obstacles and constraints of local organizations and farmer communities in their attempts to implement the planning imposed on them. This analysis includes reflections of local people on the flood control dyke system construction at district and commune levels.

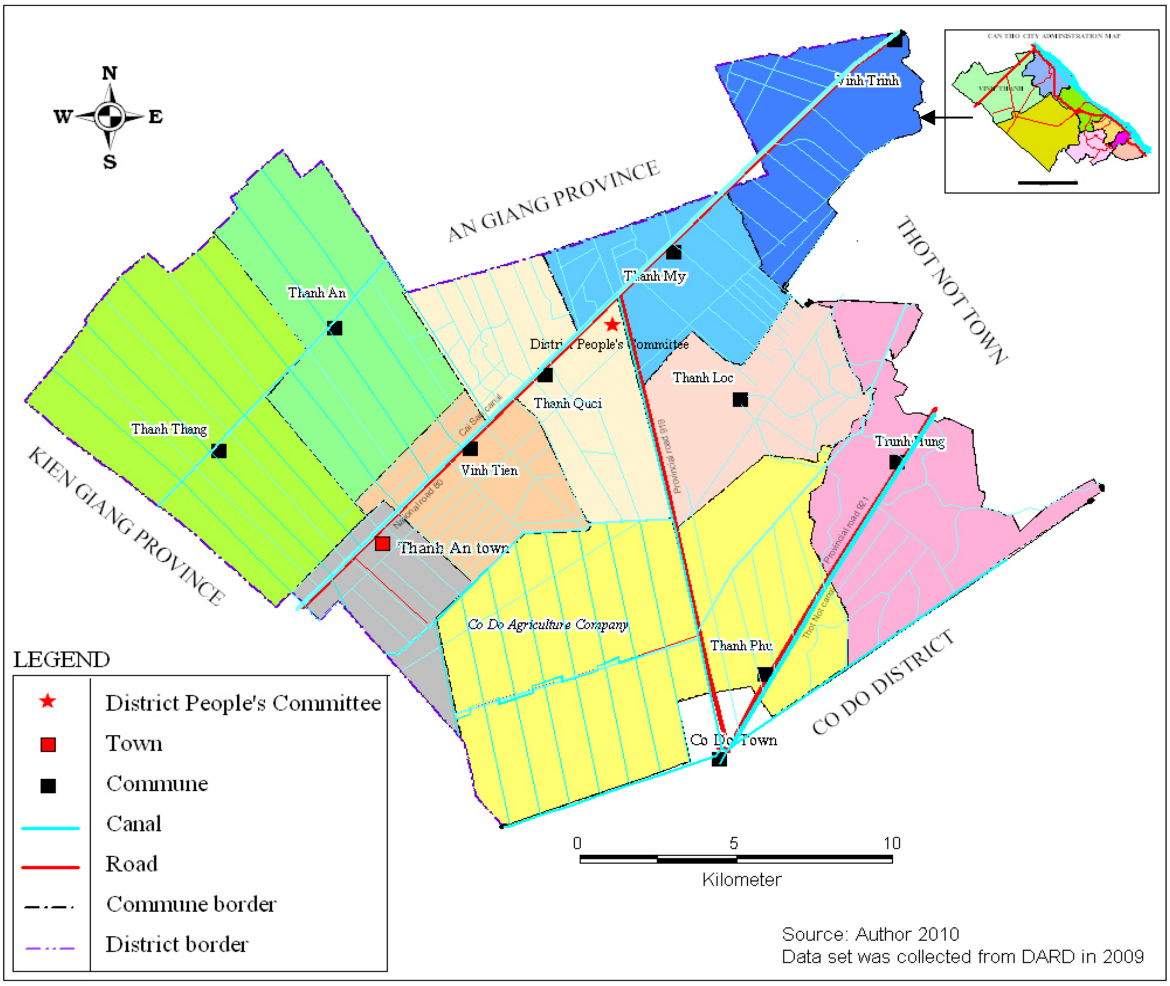
As mentioned in the previous chapters, floods in Can Tho city have created more advantages than disadvantages for the floodplains. The questions to be answered in this chapter are: How was the central dyke system planning implemented in the vulnerable flooding context at district and commune levels in Can Tho city? What were the obstacles and constraints of local organizations at district and commune levels? How vulnerable are nature and society in the floodplains of Vinh Thanh district? How do local people interact with local government? And: To what extent did local communities and authorities accept the design of central dyke system planning?

In order to elucidate the acceptability of local people at district level, the study assumes that central dyke system planning was implemented at local levels without conflicts although local communities rejected the central dyke systems due to their negative impacts. The personal interviews and group discussions with governmental organizations and farmer communities were conducted in Vinh Thanh district and its two communes (Thanh Thang and Thanh Phu) as representative case studies. Knowledge of their socio-economic situation and the natural context of the research sites is crucial for an appropriate evaluation of problems and developments encountered in reality and in daily life experiences of the rural population.

4.2 Dykes in Vinh Thanh

Vinh Thanh is one of four rural districts of Can Tho city with its topography sloping from the North to South and from the East to the West. It is a new district separated from Thot Not district in 2004 by the decree 05/2004/ND-CP dated on January 2nd, 2004. Located in the North and 50 km away from the center of Can Tho city, Vinh Thanh district borders with Kien Giang province in the South, An Giang in the West, Thot Not district in the north and Co Do in the East. In 2008, the administration units of the district included Thanh An and Thanh Thang, Thanh Loc, Thanh Quoi, Thanh My, Vinh Trinh, Trung Hung, Thanh Phu communes and Vinh Thanh and Thanh An towns. In 2009, the administration units of Vinh Thanh were rearranged. Vinh Thanh district today comprises two towns (Thanh An and Vinh Thanh) and five communes (Thanh Thang, Thanh Loi, Thanh An, Thanh Tien and Thanh Quoi). This chapter, however, works with the former administration units of the district because data and information were collected before the district was restructured in 2009 (Map 4.1).

Map 4.1: Administration and irrigation map of Vinh Thanh district



In 2008, the population of the district was 155,345 people of whom 19,206 people lived in towns and market areas while 136,139 people resided at rural areas, accounting for 87.64 percent of the total population. As the fourth crowded district in Can Tho city, Vinh Thanh's population density was 379 person/km^2. The labour force of the district was 46,699 male laborers and 46,890 female ones (the Statistic office of Vinh Thanh district 2008). The main income of local habitants comes from agricultural production and natural fish resources. During flooding time, the majority of the rural labor force is unemployed and has to migrate to other places for earning additional income. The people mainly live on the embankments of canal systems closely to their rice fields or concentrate at the market areas and towns to pursue small business and trade. Poor people and temporary migrants usually build their habitats on boats or on dykes located in the middle of the farming fields.

Irrigation systems of the district are exclusively designed to serve agricultural production and the discharge of floodwater within Vinh Thanh district (Map 4.1). The primary canals such as Don Dong and Cai San and secondary canals such as Thang Loi 1, Thang Loi 2, Ba Chieu, 3 Thang 2, Bon Tong, Thom Rom canals and Thot Not cross Vinh Thanh district and connect with Kien Giang province to serve irrigation and drainage for agricultural production in both the dry and rainy seasons as well as the discharge of floodwater. In addition, a part of National Road 80 and Provincial Road 921 crossing the district together with a large number of smaller roads have been used for flood control and rural transport within Vinh Thanh, Thot Not and Co Do districts and connect it with Kien Giang and An Giang provinces. Thus, canal and road systems of the district serve also infrastructural purposes as waterway and road transport network for commodity transport and rural agricultural development in all villages and communes within Vinh Thanh district and other provinces (Map 4.1).

Vinh Thanh district is a purely agricultural area with approximately 90 percent of its land area used for agriculture. Rice and aquaculture are the primary livelihood activities of local people. The total area of the district is 41,031.84 ha of which 90.40 percent are used for agriculture (37,093.9 ha), 9.55 percent of non-agriculture (3,919.4 ha) and only a small area (18.54 ha) are unused land. In agricultural land use, 470 ha serve for aquacultural uses like fish ponds and 36,623.45 ha for the cultivation of plants. Its overwhelming part (approx. 33,000 ha) is used for rice production, while the rest is covered by perennial plants (ca. 2,600 ha), for weed land for animal husbandry or other agricultural purposes. Non-agriculture land is mainly used for specific public purposes with a total area of

2.270.5 ha, built-up areas (1.042.5 ha) and wasteland (153 ha) (Statistic office of Vinh Thanh district in 2008).

Table 4.1: Land use planning from 2005 to 2020 at Vinh Thanh district

Unit: ha

Land use proposes	Land use orientation			
	2005	2010	2015	2020
1. Agriculture land	37,168.41	35,730.85	34,309.79	32,682.64
1.1. Agricultural production land	36,802.17	35,051.85	33,497.28	31,583.92
1.1.1 Annual plant land	35,818.84	34,001.85	32,347.28	30,333.92
1.1.1.1. Rice land	35,700.57	33,671.85	31,832.28	29,583.92
1.1.1.2. Vegetable land	118.27	330.00	515.00	750.00
1.1.2. Perennial plant land	983.33	1,050.00	1,150.00	1,250.00
1.2. Aquaculture land	366.24	679.00	848.75	1,098.72
2. Non-agriculture land	3,842.17	5,279.73	6,700.79	8,327.94
2.1. Housing land	916.98	1,021.92	1,226.30	1,375.47
- Rural	860.00	905.76	1,086.91	1,090.57
- Urban	56.98	116.16	139.39	284.9
2.2. Special used land	2,409.24	3,727.14	4,925.46	6,381.03
Of which				
- Transport land	489.28	980.00	1,853.18	2,920.40
- Hydrology land	1,851.14	2,486.86	2,595.72	2,728.78
2.3. Religion used land	46.27	55.00	59.50	65.00
2.4. Cemetery land	76.21	76.21	84.67	95.00
2.5. River land	333.54	333.54	333.54	333.54
2.6. Other agriculture land	59.93	65.92	71.32	77.91

Source: Vinh Thanh District Industry and Trade Office in 2008

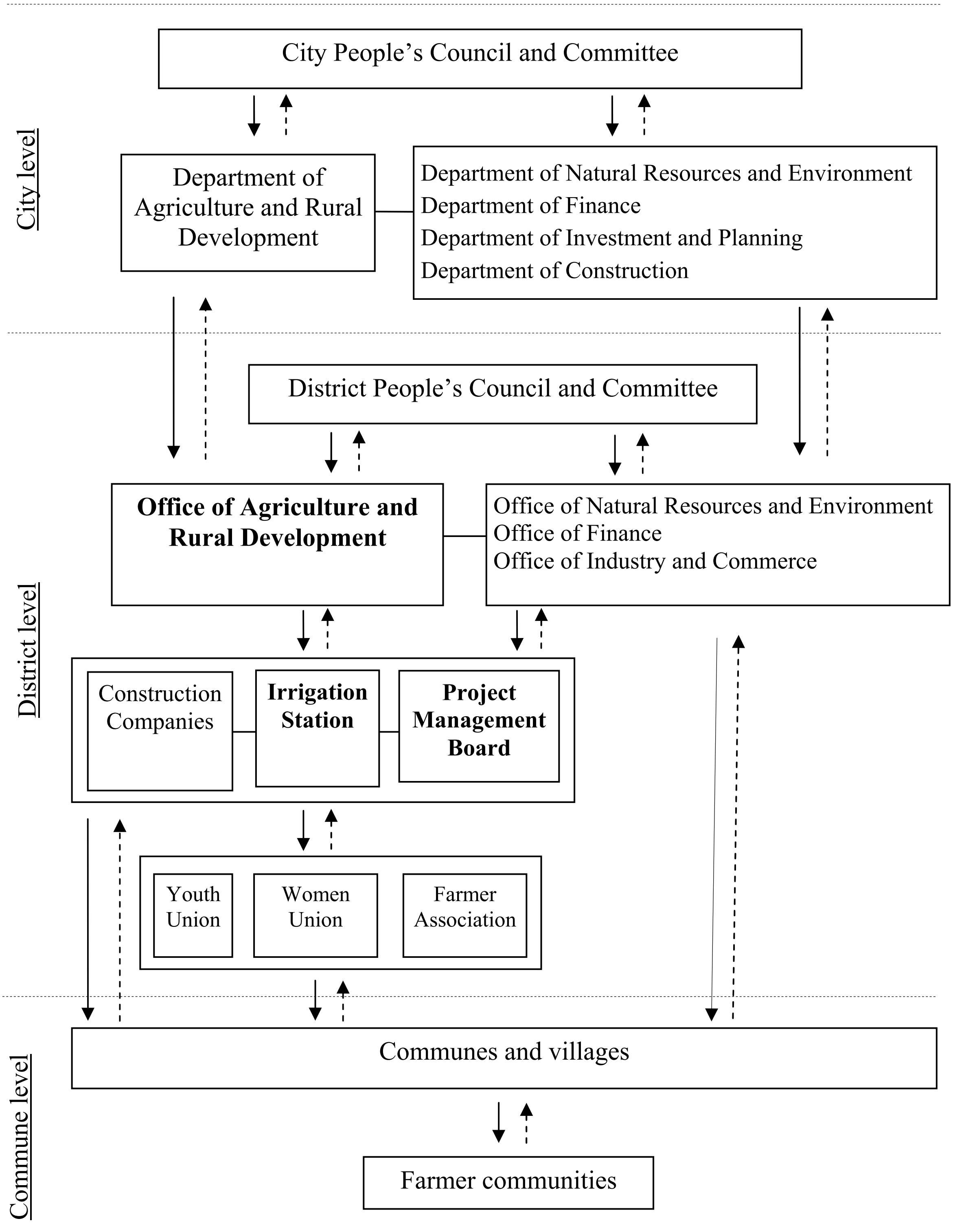
Also the future development of the Vinh Thanh district for the period until 2020 is based on the future development and strengthening of the agricultural sector (Table 4.1). It has nevertheless to be noted that agricultural production land will be reduced dramatically. Especially rice farming land will be reduced and replaced by economically more viable vegetable or fruit production or aquaculture. In contrast, the non-agricultural land area will expand to more than 8,300 ha in 2020, mainly for industrial purposes.

Vinh Thanh is the most vulnerable flooding district of Can Tho city and usually inundated at the deepest level and most seriously affected compared to other districts of the city (Map. 3.6). Like in other parts of the MD, annual floods also in Vinh Thanh bring more advantages than disadvantages for people and ecosystems. In recent years floods have been dangerous and damaging only when they appeared earlier than on the average, e.g. in early July, causing severe damages and even losses to the S-A rice crops. The central question to be answered is therefore: What are the purposes of the dyke system in Vinh Thanh and what problems have arisen in the process of dyke system constructions at district and commune levels?

4.3 The implementation process of dyke construction in Vinh Thanh – the complexities of top-down versus bottom-up approaches

As a result of personal interviews with the Agriculture and Rural Development Office (ARDO) in Vinh Thanh, it was found that ARDO was in charge of carrying out central dyke system planning at district level. ARDO is defined as a professional management office of Vinh Thanh district and a branch of The Department of Agriculture and Rural Development (MARD) of Can Tho city located at district level. Generally, ARDO's main functions and tasks are to implement and manage agricultural and rural developments including the control of hydrology, floods and storms at district level under the direct coordination of the People's Committee of the district and the Department of Agriculture and Rural Development (DARD). In addition, ARDO plays an important role as a consultant for the leaders of district People's Committees and DARD who make important decisions related to agriculture and rural development. Therefore, all ARDO's plans have to be considered and approved by People's Committee of Vinh Thanh district and DARD before they are implemented.

Figure 4.1: Organization mapping and relations among organizations in dyke planning implementation at district level



Notes:

Source: Semi-Structured interview in 2008

→ : *Direct leadership in vertical system*

- - ▶ : *Information and feedback from bottom-up*

___ : *Collaboration relationship in horizontal system*

In order to carry out its central task as dyke system planner at district level, ARDO has to collaborate with other administrative and professional offices of the district and the departments of the city. Fig. 4.1 shows interactions and relationships between ARDO and other units in the planning and implementation process of dyke construction on district and communal levels. At city level, ARDO collaborated with the professional departments of Natural Resources and Environment; Finance; Investment and Planning; Construction; and Transportation. At district level, direct collaboration units with ARDO included Project Management Board, Youth Union, Women Union, Farmer Association, communes, villages, the public and private construction companies. Of special importance is the cooperation with the Hydrology Station of ARDO that directly monitored the implementation process of the dyke system at district level (Fig. 4.1). All dyke system construction plans of ARDO had to be approved by the leaders of all these units to get their opinions before the whole process went into action. In view of the high investment costs that exceeded the capacity and budget of district and city, ARDO had to divide the whole dyke building project into smaller dyke sub-projects and to stretch it over several years. In spite of these financial constraints, all activities remained integrated into the general dyke system plan of the district. The fact that all these steps had to be considered and evaluated by the leaders of different offices and organizations of communes, district and city for further contributions and to be coordinated on district level, is another example of the highly complex, not to say clumsy, hydraulic bureaucracy connected with the implementation process of the MD dyke systems. Bearing in mind that the overall planning process was preceded by an equally complicated decision process on national level (Chapter 3) this is testimony to the fact that – although state management may be in transition (Waibel 2010) – bureaucratic impediments are still major obstacles in efficient and goal-oriented planning and implementation processes in the Vietnamese water development sector.

Finally, ARDO organized seminars and workshops at district level to get additional opinions, evaluation and agreement of the leaders of different offices and individuals about the feasibility of dyke system implementation plan of the district before it was approved and implemented in reality.

The process of dyke system planning and its implementation on district level is a complex process including seven steps (personal interviews, 2008).

Step 1: Agenda for implementation plan

ARDO organized a forum to collect the ideas and opinions of leaders, staff and technicians of the district and communes and identify the overall objectives of a dyke system and the practical needs of farmer communities in the floodplains. These initial objectives were evaluated and selected to match the general socio-economic development plan of the district and city. In this step, local people were not invited to contribute their ideas. Therefore, the initial objectives of the dyke plan implementation were mainly characterized by the leaders' perspectives and perception of governmental elites. ARDO summarized the results and compiled a statement letter which was submitted to the district People's Committee. After the district People's Committee had approved this statement, ARDO conducted official investigations to set up a dyke system construction plan in short and long terms.

Step 2: Practical survey and investigation

In this step, ARDO guided the leaders of communes and villages who organized meetings with rural residents and households to identify their practical needs in the floodplains. At the commune level, the leaders of communes and villages had meetings with farmers to reach common agreements between commune authorities and farmer communities. The communal People's Committee summarized ideas and suggestions by the farmer communities and reported to ARDO. Based on the combined information of steps 1 and 2 ARDO built the first draft of a dyke implementation plan and sent it to the professional and administrative offices and the People's Committee of the district for further consideration and evaluation of the investment costs.

Step 3: Investment cost evaluation at district level

The Finance Office of the district considered the investment cost suggested by ARDO. The leaders of the People's Committee made a final decision on the calculated expenditures in close dependence of the annual budget of the district. If the investment costs surpass the district's budget, the People's Committee of the district will suggest the support of the city.

Step 4: Approval of the dyke implementation plan

The draft of the dyke construction plan was sent to the leaders and managers of administrative units, professional offices and mass organizations within the district for their consideration and comments. The People's Council organized a public meeting with the participation of the leaders of administrative offices and organizations from district to village levels in order to discuss and evaluate the feasibility and benefits of this dyke plan and reach the common agreement among the participants. The results of the deliberations within the People's Council were basically the fundament for the leaders of the district People's Committee to make the final decision for a dyke system construction plan. ARDO then had to revise the dyke plan again based on the additional ideas and the common agreement of the district People's Council. Finally, the dyke system construction plan was approved by the president of the district People's Committee.

Step 5: Plan consideration and evaluation at the city level

The approved dyke system implementation plan was sent to DARD and the Departments of Environment and Natural Resources, Investment and Planning, Finance, Construction and Transportation of the city for their consideration and for an evaluation of the overall feasibility of the dyke projects and the investment costs. Finally, the dyke system planning implementation plan was examined and approved by the leaders of the City People's Committee before it was carried out at district level. It must be noted that step 5 was only applicable in case that the investment cost for dyke implementation plan of the district exceeded VND 5 billion.

Step 6: Evaluation and Implementation

The district People's Committee set up a Project Management Board that was officially in charge of carrying out the approved dyke system construction plan at the district level. As from this step, ARDO had to act as supervisor, monitor and evaluator of the further implementation process. In this step, ARDO usually organized bids to select the appropriate implementers. The heads of dyke system construction projects were usually the leaders of ARDO at district level, a certainly problematic combination because of potential conflicts of interests and a source of irregularities in the construction process.

Step 7: Monitoring and evaluation

In this final step, ARDO and the Project Management Board were both monitors and evaluators of the dyke system construction progress and its quality at Vinh Thanh district. In addition, this step was accompanied by the participation of representatives of the

People's Committee and of departments of the city, of professional offices of the district and of the leaders of communes. Their main task was the control and evaluation of the quality of the completed dyke system projects. The Project Management Board synthesized all findings and reported to ARDO and the People's Committees at city and district levels. In order to finally evaluate the quality of the dyke system construction projects at district level meetings were organized to reach final approval, signed between the investors and implementers and sanctioned by the district People's Committee.

The transfer of central authority tasks and obligations to local bodies, supposedly in order to induce faster development at local level with the participation of local people (As-Saber and Rabbi 2009) has in our specific case not contributed to a leaner, more speedy and more effective implementation process. On the contrary: our study shows that the lack of decentralization in the governmental management system has been and still is a major obstacle. The transfer of central government tasks and obligations to institutions outside the governmental apparatus could have accelerated planning and implementation processes. It would mean, however, that such an outsourcing of competence would be connected with a loss of power and influence by governmental institutions at city and district levels as well as by the representatives of the People's Committee and similar organizations. And it is, of course, a political decision whether such decentralization is wanted or not.

Before 2004, the dyke system implementation of the district depended exclusively on the decision-making of the related professional departments and the People's Committee of the city because implementation plans had to be approved by the leaders of departments and the People's Committee of the city. The leaders of Vinh Thanh district had no right to make independent decisions. Under the direction of DARD and the district People's Committee, also ARDO was only allowed to set up the annual dyke construction plan of the district and sent it to the related professional departments and to the People's Committee of the city to be considered and approved before it was carried out. ARDO played a role as consultant rather than direct implementer. In addition, the investment budget for dyke system construction projects was exclusively managed and coordinated by the city's departments. Therefore, the progress of dyke system construction was normally delayed because of the manifold bureaucratic constraints.

After 2004, the cautious decentralization in the planning and implementation processes brought a slight improvement compared to the previous time. Practically, a part of the governmental budget was allocated directly to the district. The District People's Committee got the rights to make independent decisions on the dyke projects with the maximum investment value of VND 5 billion. However, the district still has to inform the professional departments of the city. Thanks to this change, a large amount of dykes could be constructed faster since 2005. In 2009, the high dyke projects, however, were not yet implemented because their investment costs exceeded the financial approval limitation of the People's Committee of the district and the city. The local people and the People's Committee of Vinh Thanh district could not implement it on their own because the investment costs were too high and unaffordable by the district.

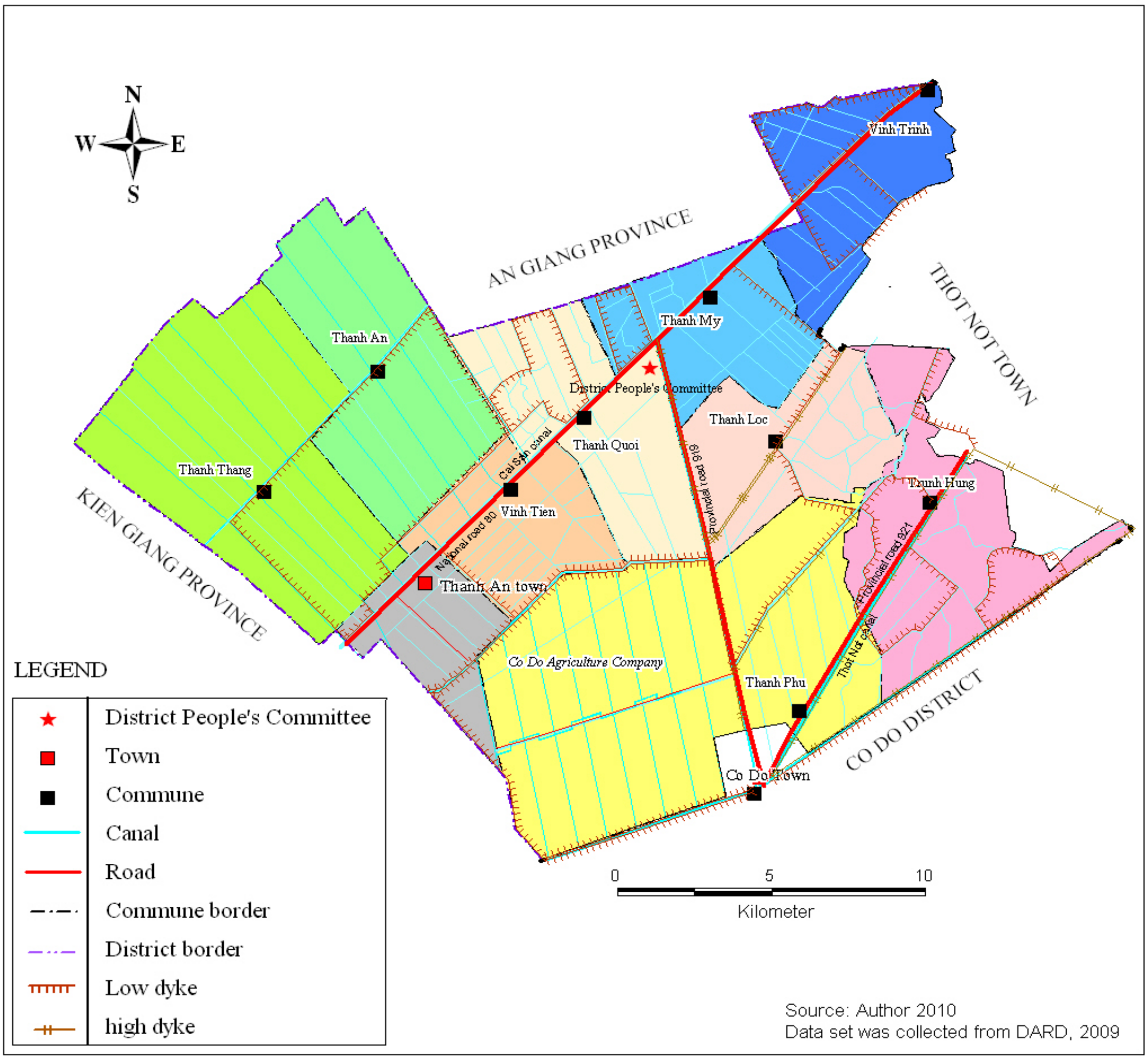
Financial constraints are a major challenge to facilitate the speedy realization of projects from planning to action (Shehu and Akintoye 2010). As indicated, in the Vinh Thanh district – and surely not in this district alone – the capital investment was both insufficient and untimely to implement the approved dyke according to schedule. Most dyke systems were postponed because of lack of money which is provided from central, city and district budgets. The budget of the district is highly dependent on these three sources. Due to the fact that the central budget allocation is channeled to the districts via the organizations of the city, there are almost regularly delays in the transfer of the money to enable the district to continue its dyke systems on time and without interruptions. While corruption – until 2004 a major obstacle to the flow of investive money – may have diminished, in recent years, the annual budget of the Vinh Thanh district was deficient to meet the annual investment costs of the approved dyke implementation plan. On the other hand, the annual income sources of the district are limited because industrial and commercial services are too weak to generate incomes for the district while agricultural production has been exempted of taxes in recent years. For these reasons, the budget sources of Vinh Thanh district usually depend entirely on transfers and remittances of central and city governments.

Altogether, one has to stress that not only the complicated bureaucratic processes but also the lack of information has been a great constraint for all activities at district level. Thus, the responsible organizations of the district were not adequately incorporated into the dyke system planning of MARD and their tasks to be carried out at district level. This lack of information of the Vinh Thanh officers created a number of difficulties also for ARDO and other professional offices of the district who could not comprehend the overall contents and intentions of the dyke system planning of MARD. In addition, the district did not have any direct connection with MARD. Consequently, from a district's perspective the practical needs of the local community and their people attracted more attention and consideration than the design of the dyke system planning of MARD.

This observation is of special importance, because under pressure of a fast growing population in Vinh Thanh district, the agricultural situation has gained increased importance for all farmer households because their income is mainly derived from farming activities. On the other hand, the arable agricultural area of households in the floodplains is usually inadequate to ensure their daily life. Particularly, poor farmers only have modest agricultural production land from 1,000 to 2,000 m^2 supplying basic foods for their daily life. Thus, these poor households considered the flood control systems as a threat for their lives and livelihood. Additionally, the compensation policy for the loss of agricultural land was less than satisfactory for farmers to settle in new places. In practice, the farmers were not compensated at all when their land was expropriated to construct the dyke system. And local authorities only mobilized local people who were willing to offer their land to the dyke system construction. However, some local people refused to offer their land for the dyke system construction. In some cases, the dyke system construction caused conflicts between farmers and local authorities. Thus, also the ground clearance was one of the obstacles in the process of dyke system implementation. Finally, one also has to mention the fact that knowledge and experience of quite a few officers were limited to carry out the dyke system planning at district level. The majority of ARDO's officers were trained in hydrological, economic and agricultural sections, but they had little or no experience in planning and implementation of the processes of flood management. Therefore, the dyke system implementation of the district had to depend on the organizations of the city and construction companies, while the district focused on the solution of specific problems of locals.

As mentioned in chapter III, the floodplains of Vinh Thanh district are divided into two parts by National Road 80. The Northern floodplain includes Thanh Thang and Thanh An communes which are part of the low dyke system. The Southern floodplain with Trung Hung, Thanh Loc and Thanh Phu communes became protected by the high dyke system. Especially, Vinh Trinh, Thanh My, Thanh Tien, Thanh Quoi, Vinh Tien communes and Thanh An and Vinh Thanh towns are located in both Northern and Southern flooding areas of National Road 80 at Vinh Thanh district (Map 4.2) – all of these communes were integrated into the high dyke systems to fully control floods all year round.

Map 4.2: Central dyke system planning at Vinh Thanh district



These examples show that the original dyke system planning of MARD was adjusted later in line with the necessities at local levels. The dyke system implementation plan of the district is another example for the imperfect coordination of the different levels of organizations and institutions and their failure to act in a coherent way. This observation holds also true for the investment budget which was shared between local government and local communities in the floodplains. The majority of the investment capital for the local dyke system construction of the district had to be generated by the local people. According to the plan of the district, local people had to contribute 75 percent of the total investment cost while 25 percent came from the Vietnamese State's budget in Vinh Thanh district (Table 4.2).

Table 4.2: Dyke system construction plan to produce three rice crops of Vinh Thanh District from 2006 to 2010

Communes	Area (ha)	The length of dyke system (m) is invested by		Total (m)
		State's budget	Local people's capital	
Thanh Thang	683	1,300	6,000	7,600
Thanh An	970	8,900	17,000	25,900
Thanh An (town)	1,085	5,300	18,500	23,800
Thanh Quoi	1,250	9,800	28,600	38,400
Thanh My	710	6,800	6,200	13,000
Thanh Loc	865	8,200	7,750	15,950
Thanh Phu	2,537	6,700	53,100	58,800
Trung Hung	1,079	8,500	28,400	34,900
Vinh Trinh	920	6,500	16,900	23,400
Total	10,090	62,000 (25%)	182,450 (75%)	244,450

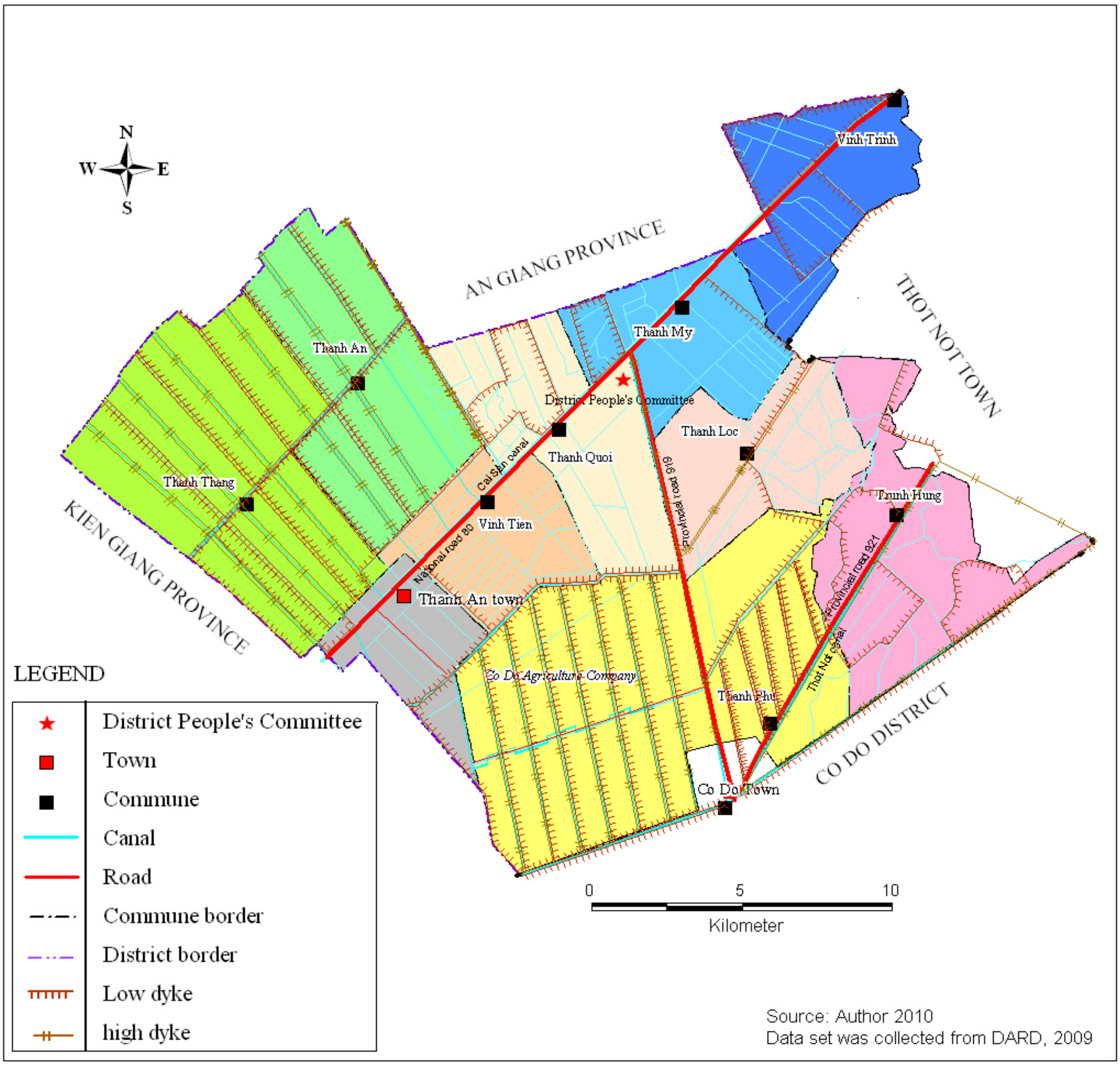
Source: ARDO (2008)

Even the dyke construction plan of the district was also changed later in order to meet the practical needs of local communities in the floodplains. At Vinh Thanh district, the local farmer communities had constructed their own dyke systems to control flood and protect fruit trees, fishponds and rice production since 1996 before central dyke system planning was approved in 1998. Particularly, Co Do State Farm (or Co Do Agriculture Company), a large government-owned enterprise, built its own dykes to protect their rice production as well as to develop rural roads for people's daily life. The dyke implementation plan of Vinh Thanh district was finalized and implemented between 2000 and 2005 with objectives similar to the central dyke system planning. This one, however, was part of the five-year plan for the 2006 to 2010 period and approved only in 2005 by the district's People's Committee.

According to the dyke system construction plan report of Vinh Thanh district, the majority of the dykes were constructed from 1996 to 2005. The total area of the protected floodplains was 30,964 ha with 163 zones. 58 zones with a total area of 16,153 ha were enclosed by the dykes with a height above 1.8 m to fully withstand floods all year round of which only 10 zones with a total area of 1,260 ha were completely constructed to control floods certainly. 95 zones of 13,464 ha were constructed the dykes that have the height varies from 1.2 to 1.8 m to control a part of annual floods for the rice crops. The last 10 zones were not built to control floods.

After 2005, the plan of district was mainly excavated hydrological systems to irrigate and drain off water while the dyke systems were not constructed more from 2006 to 2008. In 2008, the total area of protected floodplain was reduced 20 ha compared to the situation before 2005 (30,644 ha in 2008 compared to 30,664 ha 2005). This reduction could be a part of floodplains that were used to construct resident clusters and other farming

Map 4.3: Vinh Thanh district dyke system implementation situation in 2009



objectives of farmers. In 2008, the total floodplain area of 30,944 ha was protected by both low and high dyke systems, of which 22,977 ha were covered by the low dyke system and only 8,280 ha by high dykes (Table 4.3 and Map 4.3). Thus, the dyke systems were mainly constructed in 1995 to 2005 to control floods for the majority of floodplains in Vinh Thanh district. The high dykes of the district were smaller and lower than the design of the central dyke planners.

Table 4.3: Situation of dyke system implementation from 1996 to 2008

Communes	**Low dyke systems**		**High dyke systems**		**Total flooding area as the designed plan (ha)**
	Enclose-protected area (ha)	Unprotected area (ha)	Enclose-protected area (ha)	Unprotected area (ha)	
Thanh An	3,707	80	2,100	250	6,137
Thanh An town	1,299	25	0	270	1,594
Thanh Loc	1,902	0	310	438	2,650
Thanh My	1,832	55	0	280	2,167
Thanh Phu	2,577	0	534	0	3,111
Thanh Quoi	2,909	0	15	138	3,062
Thanh Thang	3,970	683	1,030	500	6,183
Trung Hung	2,234	100	790	420	3,544
Vinh Trinh	1,386	40	250	820	2,496
Total	21,816	983	5,029	3,116	30,944

Source: The Office of Agriculture and Rural Development in 2008

Today, the whole Vinh Thanh district and its floodplain are divided into a larger number of smaller protected floodplains than originally designed by MARD. Both low and high dyke systems were constructed in the Northern floodplains instead of only a low dyke system as suggested by MARD. In contrast, low dyke systems were largely constructed in the Southern floodplain where MARD had proposed higher dykes. These differences and conflicts between the dyke system planning of MARD and the planning implementation at the district level show again discrepancies between the different planning levels, but also reservations against each other by institutions which should cooperate for the benefit of the people. While MARD pursued its top-down planning and implementation strategies, local authorities prioritized the practical needs of farmer communities. In addition, the local people and leaders were not informed about the dyke system design of MARD because governmental plans and decisions have not been disseminated properly or not at all at local levels.

All practical evidences above illustrate that the dyke system planning of MARD and the dyke system planning implementation of the district are badly coordinated. The practical needs and expectations of the locals differ from governmental visions. In summarizing all these experiences and observations of the planning and implementation processes of the dyke system in Vinh Thanh district, one must stress that the overall process is obviously not only a very bureaucratic one, but also one that leaves questions. Considering the working hypothesis of this study, one has to state that – in spite of the participation of local communities and their elected or appointed representatives – the overall design and definition of the dyke system is based on top-down decisions. While it remains to be seen, how the final perceptions of local people and "beneficiaries" are (Chapter and 5), one has to conclude that ARDO played the key role in coordination and connectivity with other units and offices within district and city. The basic decision-making processes of the dyke system construction, however, depended on the leaders of MARD and the district's People's Committee, while professional organizations and resident communities had only consultative functions. ARDO thus served as a kind of mediator between the different levels. Problematic, however, is its role as supervisor, monitor and evaluator (step 6), because potential overlaps and conflicts of interest are possible. Especially the fact that People's Committees, ARDO and the project management are obviously closely interconnected, gives reason for concern.

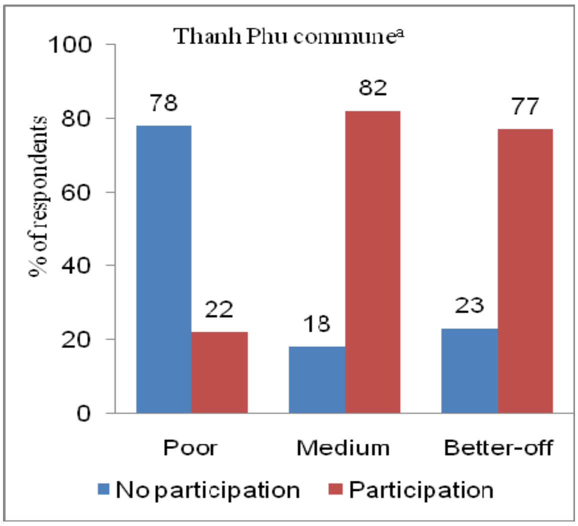
4.4 Local people's participation and perceptions

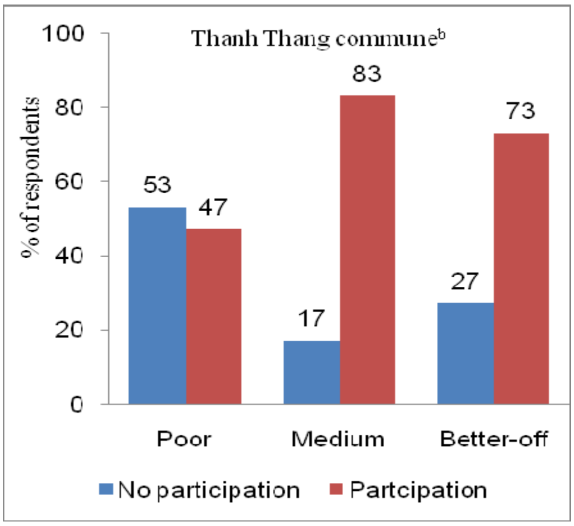
The participation of individuals and organizations can be divided into direct and indirect groups. The direct participation groups included ARDO, the Project Management Board and mass organizations such as Youth Union, Women's Union and Farmer Association who were direct implementers (Fig. 4.1). ARDO was the major coordinator of the implementation process. The Project Management Board was responsible for the realization of the approved sub-dyke projects. The Youth Union, Women's Union and Farmer Association were collaborative partners of ARDO to implement parts of the central dyke system, based on specific assignments and requirements of ARDO. In addition, they cooperated with the leaders of communes to organize the meetings with farmer communities for house clearance and loss compensation for those who were affected by the construction measures. Public and private construction companies were direct participants based on contracts with ARDO or related investors at district level. The indirect participation group included those who belong to offices and departments of finance, industry and trade, together with environmental and natural resources offices of district and city. They principally took part in the meetings organized at district level to share and to contribute their opinions in improving the dyke system construction plans of ARDO and in the quality evaluation meetings of the completed dyke system projects.

In order to understand and evaluate properly the local people's participation at commune and village levels, semi-structured interviews with leaders of ARDO, Thanh Thang and Thanh Phu communes and group discussions with farmers were conducted. The study found that the meetings with farmers were organized to collect farmers' opinions. The purpose of these meetings was to reach agreement between farmer communities and local authorities before constructing the dyke systems at villages. The leaders of communes and villages were the organizers and facilitators together with the representative attendance of ARDO. In these meetings, farmers mostly discussed contents relating to land clearance, compensation for them and investment costs for the dyke system implementation, but they were not informed about the purpose of the dyke system planning and how the dyke systems were to be designed. Actually, the participation of farmer communities in the public meetings was more to appease their mood and to give them the feeling that their voices have been heard.

In order to cover the opinions of socially and economically differentiated farmer groups, individual household interviews were conducted at Thanh Phu and Thang Thang communes (Household interview in Chapter I). The results of household interviews found that the greater number of medium and better-off farmers were involved and participated actively in these meetings in contrast to the poor farmers in these communes. In Thanh Thang commune they accounted for 83 percent of the medium and 73 percent of the better-off group as compared to 47 percent of the poor farmers group. In Thanh Phu commune 82 percent of the medium and 77 percent of the better-off group as compared to only 22 percent of the poor farmers group participated in the public meetings organized at commune and village levels (Fig. 4.2).

Figure 4.2: The participation of farmers in the dyke system construction at Thanh Phu and Thanh Thang communes





Source: Household interview between 2008 and 2009

[a] Chi-Square tests = 55.417; df = 2; Exact sig. (2-sided): 0.00 at sig: 95%

[b] Chi-Square tests = 9.466; df = 2; Exact sig. (2-sided): 0.09 at sig: 95%

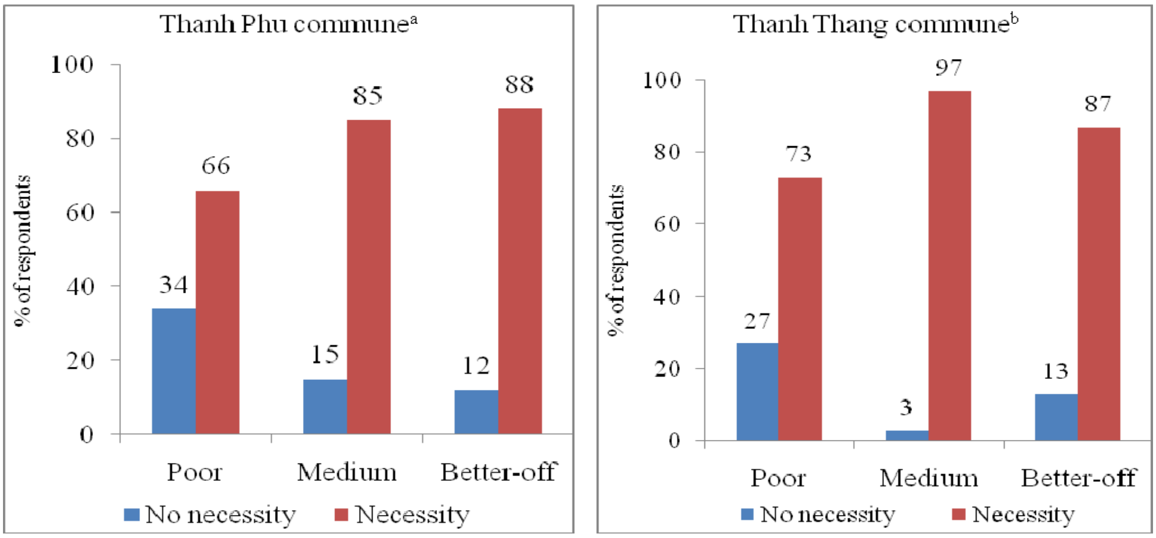
In Thanh Thang commune a larger group of poor farmers was involved in the public meetings than in Thanh Phu commune. While 47 percent of the poor people in Thanh Thang participated, it was only 22 percent of poor in Thanh Phu commune. Reason is that the poor people in Thanh Phu commune possess limited agricultural land so that they are neither affected nor interested in the meetings. Conversely, the larger number of poor farmers in Thanh Thang commune had agricultural land, so they found that it was useful for them to attend the meetings. The major reasons for inactive participation of the poor groups in both communes are the following ones: (i) the poor farmers usually have little or no time at all because they have to work for daily wages, sometimes outside their own community; (ii) the majority of poor farmers are landless and not invited to the meetings at all. Quite a few stated that they were absent at the public meetings because they did not benefit from the dyke systems; (iii) poor farmers, incapable of financial contribution to the dyke construction, were partly discriminated by social prejudice and because of their anticipated poorer knowledge as compared to the medium and better-off groups; and (iv) quite a few of the poor farmers believed that dyke system construction was mainly for the benefit of the medium and better-off farmers or people who have larger areas of agricultural land. The Chi-Square analysis found that the participation within farmer groups (poor, medium and better-off) had highly significant differences in the public meetings in both Thanh Thang (Exact sig. 2-sided: 0.00) and Thanh Phu commune (Exact sig. 2-sided: 0.09).

In summary, the political elements and power of governmental organizations were one of constraints influencing to the famer communities' participation and other organizations in the process of dyke system planning implementation. Farmer communities were actually invited to the meetings to reach their agreement on the compiled dyke system construction plan rather than to receive their contributive opinions to improve this plan. Obviously, the farmer's participation was limited or not actually participated in the public meetings to contribute their own experiences and opinions for the dyke system construction plan at district and commune. Farmers' opinions and experiences were ignored in the dyke system planning implementation and dominated by political organizations, under the bureaucracy and umbrella of district's and communes' authorities, whose power strongly influenced in the decision-making related the implemented plan at community level. Consequently, the inadequate participation of farmer communities could be one of causes leading to the negative impacts of dyke systems on the floodplains of the district and communes.

The main focus of the 270 interviews was, however, directed towards the perception of the farming communities and their socially and economically differentiated groups. While the participation in the household survey was somewhat ambivalent, depending on the social background of the households (Fig. 4.2), the values and results concerning their perceptions on the necessity of the dyke systems in Thanh Phu and Thanh Thang communes (Fig. 4.3) and their acceptance (Fig. 4.4) are somewhat different.

Figure 4.3 shows that most respondents in the three groups (poor, medium and better-off) in both Thanh Phu and Thanh Thang communes perceived the necessity of the dyke system in a similar way: the dyke system was necessary to be constructed to guarantee safety for the life and agricultural livelihoods of local people in the floodplains, especially for rice cropping patterns. There were at least 66 percent of respondents in all groups who reacted positively to the necessity of the dyke system construction in Thanh Phu and Thanh Thang communes. However, medium and better-off farmer groups supported dyke system

Figure 4.3: Farmers' perception on the necessity of the dyke systems in Thanh Phu and Thanh Thang communes



Source: Household survey between 2008 and 2009

[a] Chi-Square tests = 8.924; df = 2; Exact sig. (2-sided): 0.011. Sig.95%

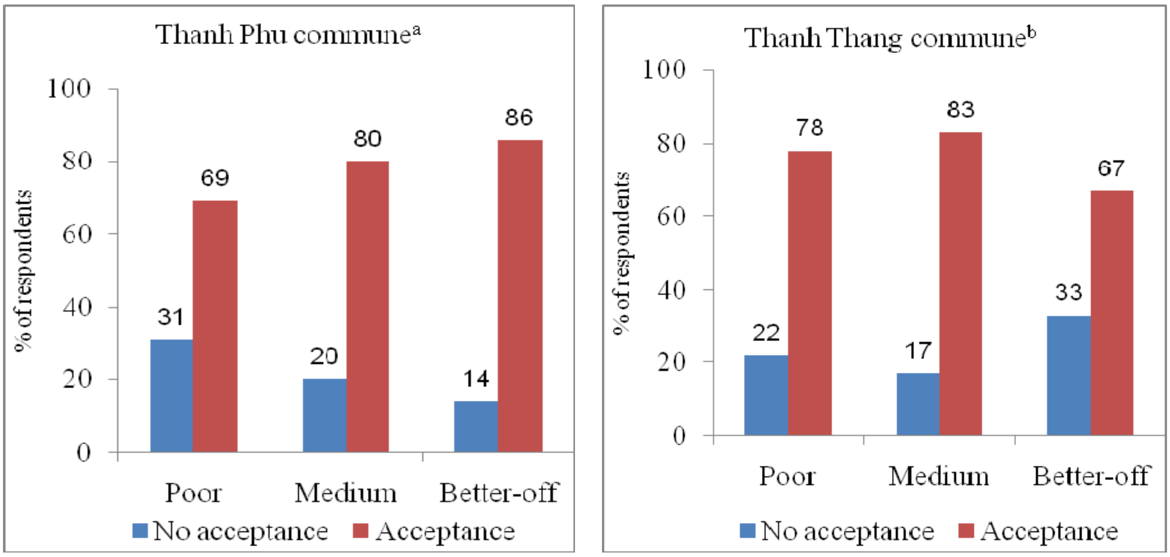
[b] Chi-Square tests = 6.470; df = 2; Exact sig. (2-sided): 0.045.. Sig.95%

construction stronger than the poor farmers' group. Actually, there were at least 85 percent of medium and better-off farmer groups compared to the maximum of 73 percent of the poor farmers' group in both communes. The results of the Chi-Square analysis found that there was a significant difference within farmer groups about the perception of farmers on the necessity of dyke systems in both Thanh Phu (Exact sig. 2-sided of Chi-Square tests is 0.011) and Thanh Thang communes (Exact sig. 2-sided of Chi-Square tests is 0.045). In addition, there were non-significant influences of education, gender and working experience within farmer groups in both communes. However, there was a significant difference in three age groups (lower than 30, from 31-40 and above 40) in Thanh Phu commune (Exact sig. 2-sided of Chi-Square tests is 0.011): Older people perceived the necessity of the dyke construction more positively than younger ones in Thanh Thu commune.

In regard to the acceptance of the dyke systems one has to consider that flood control dykes of Thanh Thang and Thanh Phu communes were mainly constructed between 2004 and 2006. Farmers in these communes have experienced to live with floods before and after dyke construction. Therefore, they could understand the advantages and disadvantages of flood control dyke systems.

The results of the 270 interviews in regard to the acceptance of the dyke systems in both case studies are represented in Fig. 4.4. The investigation shows that the majority of farmers in the three groups (Poor, Medium and Better-off) agreed that the dyke system was a relevant flood control measure to protect agricultural production activities. According to the overwhelming number of interviewees, dykes have contributed to floodwater management and flood risk reduction in both communes and ensure better conditions for agricultural production. In addition, a part of the high dyke system has been used to develop rural roads in the flooding areas, thus improving also communication within the district and to neighbouring districts.

Figure 4.4: Farmers' acceptance of the dyke systems in Thanh Phu and Thanh Thang



Source: Household interview between 2008 and 2009

[a]Chi-Square tests = 4.897; df = 2; Exact sig. (2-sided): 0.083. Sig.95%

[b]Chi-Square tests = 2.375; df = 2; Exact sig. (2-sided): 0.305. Sig.95%

As a result, there was at least 69 percent of acceptance in both Thanh Thang and Thanh Phu communes. Again, however, medium and better-off farmer groups were more positive for obvious reasons of farm size etc. Yet, considering the Chi-Square tests, there was no significant difference within farmer groups found in both Thanh Phu and Thanh Thang communes. This implies that the majority of all farmers perceived that the current dyke systems are useful to reduce flood risks and improve agricultural production.

Altogether one may conclude that, in spite of many organizational problems and bureaucratic handicaps as well as quite a few obscurities in the planning and implementation processes, the planners met the expectations of farmer communities in these communes. The flood control dyke system construction is currently supported by the majority of the farmer communities and by local authorities. However, the medium and better-off farmer groups accept and support dykes more strongly and actively than the poor farmer group because they are the main beneficiaries and profiteers of these protective measures.

4.5 Summary

The flood control policy has been reflected partly through the dyke system planning implementation at local levels. The dyke system construction aims at protecting rice crops, reducing flood risks, controlling, modifying the flooding level, allocating floodwater and developing agricultural production models within and between the floodplains of Can Tho city, especially Vinh Thanh district. The flooding planners of MARD correctly identified emerging problems for the practical livelihood of local people as well as their practical needs to set up the control of flood dyke planning for the floodplains in Vinh Thanh district. Based on the analyzed information and data, the study concludes that the dyke system construction is actually in need to ensure safety for the life and livelihood activities of local people in the floodplains. However, the design of dyke system planning is difficult to carry out at local level because local people were interested in the low dyke system construction rather than the high dyke system as designed in the planning of MARD. This was a significant difference between dyke system planning of MARD and the implementation at district and commune levels. In the case study of Thanh Phu commune, the low dyke system was constructed in the floodplains while the design of MARD is high dyke system. In the case study of Thanh Thang commune, there was no difference between the dyke system planning and implementation. The low dyke system was constructed according to the design of MARD. Thus, the high dyke system construction has caused controversial reactions between locals and planners in the floodplains of Vinh Thanh district. This conflict was due to the lack of decentralization and democracy in the dyke system planning and implementation and lack of collaboration between governmental and local communities. The local communities were isolated in the process of planning formulation and planning implementation. In addition, it is acknowledged that local organizations were incapable of capital and profession. The administrative procedures in planning and implementation have caused the great obstacles for dyke system implementation at district and commune level. In addition, lack of investment capital, decentralization and participation of local communities in the dyke system planning implementation are constraints which need special consideration in the upcoming years. However, the investment cost for the high dyke system construction is the greatest constraint for local people because it exceeds the investment capacity of city, district and local communities. Thus, the high dyke system construction should be considered and reevaluated before it will be constructed in the near future.

5: ADAPTATION AND REFLECTIONS OF LOCAL COMMUNITIES IN THE PROTECTED FLOODPLAINS: TWO CASE STUDIES AT TWO COMMUNES IN VINH THANH DISTRICT

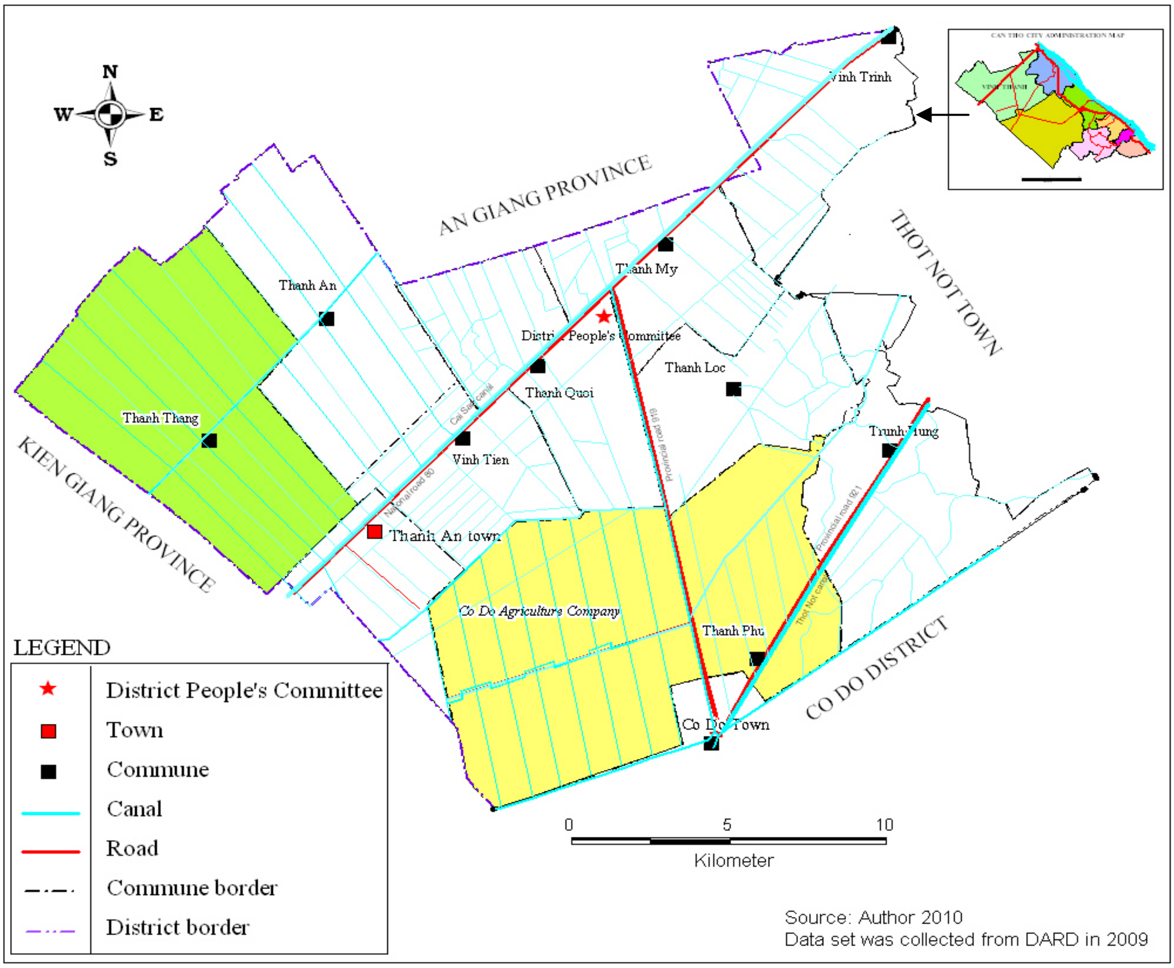
5.1 Introduction

Climate change, conflicts and the squeeze on natural resources due to population growth and environmental degradation lead to poverty and vulnerability of many people and have challenged individuals, households, businesses, governments, and civil society (Christoplos et al. 2009). Adaptation is part of the processes of human development and risk management that have been under way for centuries. Development has always been about how people manage a number of risks. Adaptation needs to reflect a disaggregated perspective on the diverse ways how climate for instance affects the livelihoods, food security, natural resource management opportunities, health, energy security of individuals and local societies, as well as how these impacts are mediated by institutional realities within and beyond their localities. Therefore, adaptation strategies should be built on efforts to effectively support individuals, households, and businesses to adapt to climate change. This should be done with a deeper awareness of the social, economic, cultural, and political factors that frame their actions, incentives, opportunities, and limitations for action (Christoplos et al. 2009).

The dyke construction aims at offering more favourable conditions for agricultural development and flood management of local people in the floodplains. However, the dyke systems can also cause negative impacts as found in the flooded regions in An Giang and Dong Thap provinces. However, the adaptation of farmer communities and the negative impacts of the dyke systems have not been addressed in any of the studies so far. This chapter aims at identifying and analyzing the adaptations of farmer communities to floods and the dyke systems in protected average floodplains. In order to reach these objectives, group discussions and personal interviews with 270 households were conducted to collect data and information. As case studies two communes, Thanh Thang and Thanh Phu, in Vinh Thanh district of Can Tho city were selected, both of which located in the average flooded regions of the Mekong Delta (Map 5.1).

Before, however, going into details of our case studies, the term "adaptation" needs clarification and explanation of how to be used in the context of the following

Map 5.1: Positions of study sites



deliberations. Adaptation is the adjustment of a system to moderate the impacts of climate change and to take advantages of new opportunities or to cope with the consequences (Adger et al. 2003). It is also the present adaptive capacity of governments, civil society and markets to deal for instance with climate perturbations by political interventions, by social science research and related actions by governments, economic enterprises and/or by civil society. Adger argues that intervention is necessary to enhance adaptive capacity or the ability to adapt to new or changing conditions without becoming more vulnerable or shifting towards incapable adaptation. A key issue is the identification of successful adaptations in the developing world under the influence of the greatest risk and persistent physical vulnerability, the identification of indigenous strategies for resource management in physically vulnerable environments as well as the analyses of winners and losers and their strategies towards successful failure. It is also necessary to identify and to distinguish between the diverse stakeholders in the fragile contexts of appropriate adaptation processes. In regard to the effects of climate change individuals, society and government should be clearly identified in these processes of adaptation. In the course of human history, climate has always been a decisive part of the wider environmental landscape of human habitation. Therefore, this section attempts to examine efforts of local people in adapting to the changing risks of floods under the influences of a flood control interventional policy. Adaptability of locals to the changes and risks of floods is one of basic indicators for success or failure of governmental dyke system construction in the protected floodplains.

5.2 Thanh Thang and Than Phu communes: Rice and Floods

Thanh Thang and Thanh Phu are two rural communes of Vinh Thanh district. Thanh Thang commune is divided into 6 villages while Thanh Phu commune is separated into 13 villages of which 8 villages are located in Co Do Agriculture Company (formerly named Codo State Farm), a state company belonging to MARD under the management of the city authority. The population of Thanh Thang commune counts 17,754 people of which 85 percent rely on agriculture, and the rest of 15 percent on non-agricultural activities. Similarly, Thanh Phu: the commune has 20,560 inhabitants of which 87 percent live on rural activities while 13 percent are wage-laborers in non-agricultural fields (Statistic data of ARDO in Vinh Thanh district in 2008). In 2009, the majority of the land was, not surprisingly, mainly used for agriculture in both communes. In Thanh Phu commune, the total land area was 9,570.53 ha of which 92 percent was agriculture while in Thanh Thang the corresponding figures were 6,652 ha of total land area and approximately 91 per cent for agriculture. In both communes rice production is the main activity. In both Thanh Phu and Thanh Thang rice fields cover over 98% of the total agricultural area while the rest is being used for aquaculture respectively for perennial plants (Statistic data by ARDO in 2008).

Rice being the main production goal is annually cultivated from two to three rice crops. The first rice crop, named Winter-Spring rice crop (WS), is normally produced from November/December to February/March. The second one, namely Summer-Autumn rice crop (SA), is usually cultivated from March/April to June/July. The third one is the so called Autumn-Winter rice crop (AW), which, however, can only be cultivated in the full-protected floodplains between July and October. Therefore, in Thanh Thang commune only two rice crops can be produced while there are two to three rice crops possible in Thanh Phu commune. Additionally, integrated agriculture farming models such as rice-fish, rice-vegetables and fish-fruit trees have been implemented in both Thanh Thang and Thanh Phu communes. Mono-rice farming practices have been transformed into integrated farming models in order to utilize the combined advantages of land and water in the rice farming fields of the protected floodplains. Practically, only few farmers in both these communes have so far used the irrigation period to raise fish during the flooding time for additional income. Other forms of animal husbandry include pigs, ducks and chickens; these are also raised for the own consumption of the rural households.

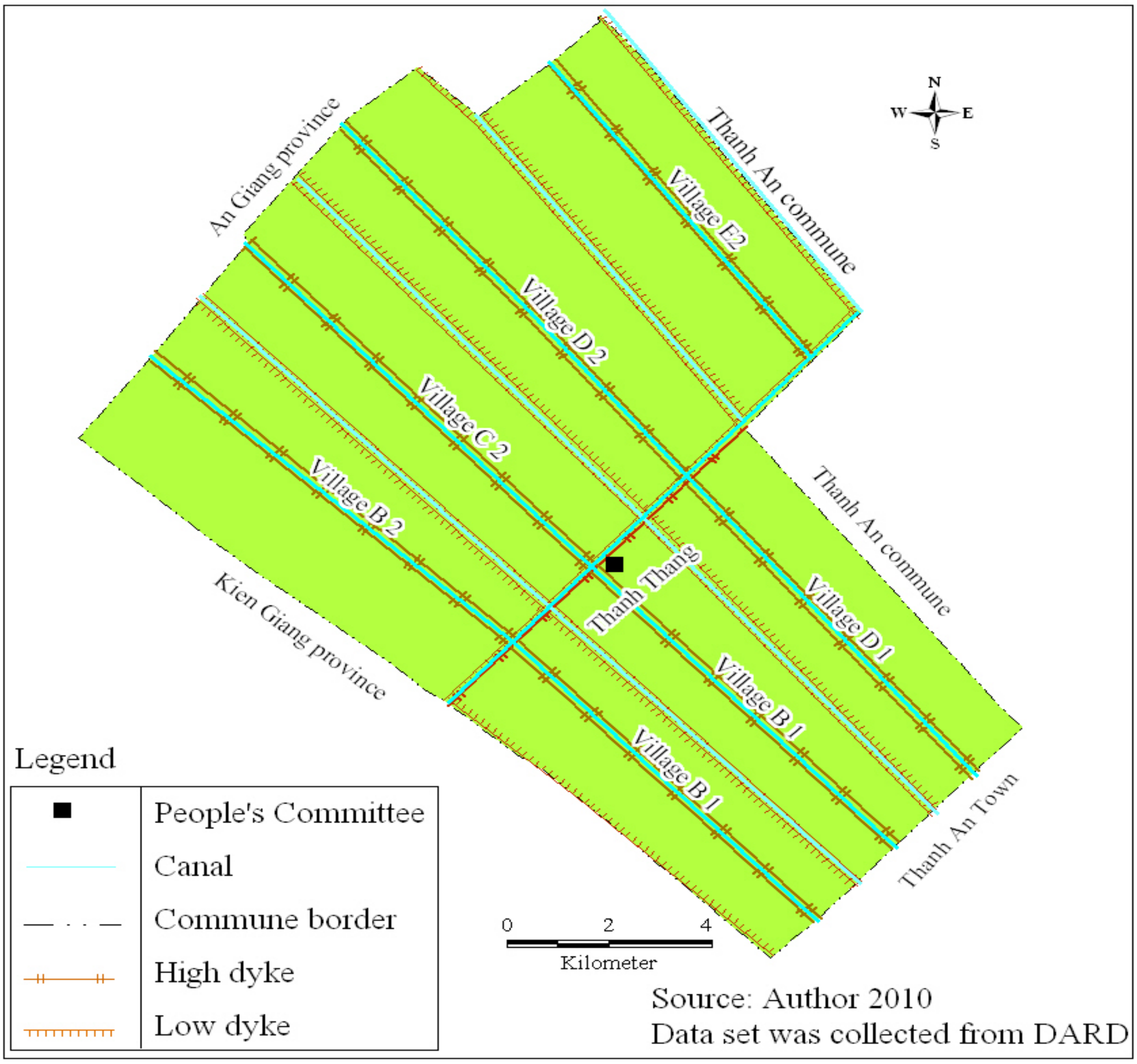
Besides agriculture, non-farm and off-farm activities have been developed in both communes such as non-farm trade agencies for agricultural products, small business and trade services, transport activities and similar employments. Off-farm activities are to be found such as natural fishing or wage labor in agriculture and aquaculture sections in both communes. The non-farm and off-farm employments are opportunities, especially for the rural poor people. According to the leaders of communes, non-farm activities were only slowly developed in Thanh Phu and Thanh Thang communes because there are no industrial enterprises whatsoever. The few small businesses and trade services are coffee shops, family groceries and agricultural material agencies.

Economic activities in both communes as well as in other parts of Vinh Thanh district and the MD as a whole are dominated by the annual flooding calendar. Normally floods occur in summer and inundate the rice fields from August to December with a flood depth varying from 1 to 2.5 m in Thanh Thang commune and from 0.8 to 1.5 m in Thanh Phu commune. In normal flood years, floods bring more advantages than disadvantages to improve locals' livelihood. They provide plentiful silts to increase soil fertility and abundant water sources to clean out the existing toxicity and agrochemicals on the farming fields and provide natural fish resources. Therefore, the normal floods are of benefit for the agricultural production and ecosystem balance, but also for the economic well-being of the local population. In extreme flood years, however, floods cause deeper inundations and therefore potentially serious damage for agriculture, houses as well as other property of inhabitants and infrastructure in the flooding areas. The historic floods in 1978 and 2000 were extreme events and damaged seriously also low-lying rice-fields, fishponds, fruit trees and rural roads. Additionally, farmers suffered from poor rice harvests in August. Fruit tree areas, fishponds, buildings and rural roads were similarly destroyed from September to October because the crest of floods normally reached its highest point in these months. Thus, the over-flooding is always a great challenge and a disaster for agricultural farming sections as well as locals' livelihoods. On the one hand, floods have obviously been recognized as advantageous opportunities to improve agricultural production; on the other hand, they threaten agricultural production and the livelihoods of local people relying on agricultural section and floods' natural resources. Thus, the construction of dykes is being perceived by the majority of the inhabitants of Thanh Thang and Thanh Phu as a blessing and as an overdue protective measure for their livelihood.

Before 1990, no interventional measures were available to control floods in the floodplains of both Thanh Thang and Thanh Phu communes. Dyke systems were simple and not able to prevent floods. Lives and livelihoods of local people depended entirely on the natural regulations of floods. As from 1990 onward, there was a shift from one rice crop to two rice crops per year to meet the increasing demand of growing population. New and fast growing rice varieties replaced the flooding rice varieties. The first crop (WS) was cultivated from January to April, and the second crop (SA) was farmed from May to August, however, not seldom damaged at harvesting time between July to August by floods. In order to avoid flood risks, a few better-off farmers built the first dykes in Thanh Phu commune to control floods and protect their SA. Yet, the big floods of 1978 and 2000 caused serious damages for rice production and rural infrastructure of both Thanh Thang and Thanh Phu communes. Farmer communities and local authorities in Thanh Phu commune immediately recognized the necessity to improve and increase existing dykes. Therefore, many low dykes were officially built in cooperation between local communities and governmental organizations. In fact, individual households could not build dykes by themselves and without the support of the government because the dyke system was a large-scale endeavour of communal dimensions and needed cooperation among farmers living the same floodplains. In Thanh Phu commune, the dyke system was mainly fostered by the government-owned Co Do State Farm because they received strong support from MARD and the city. At that time dyke systems were not considered to be built in Thanh Thang commune.

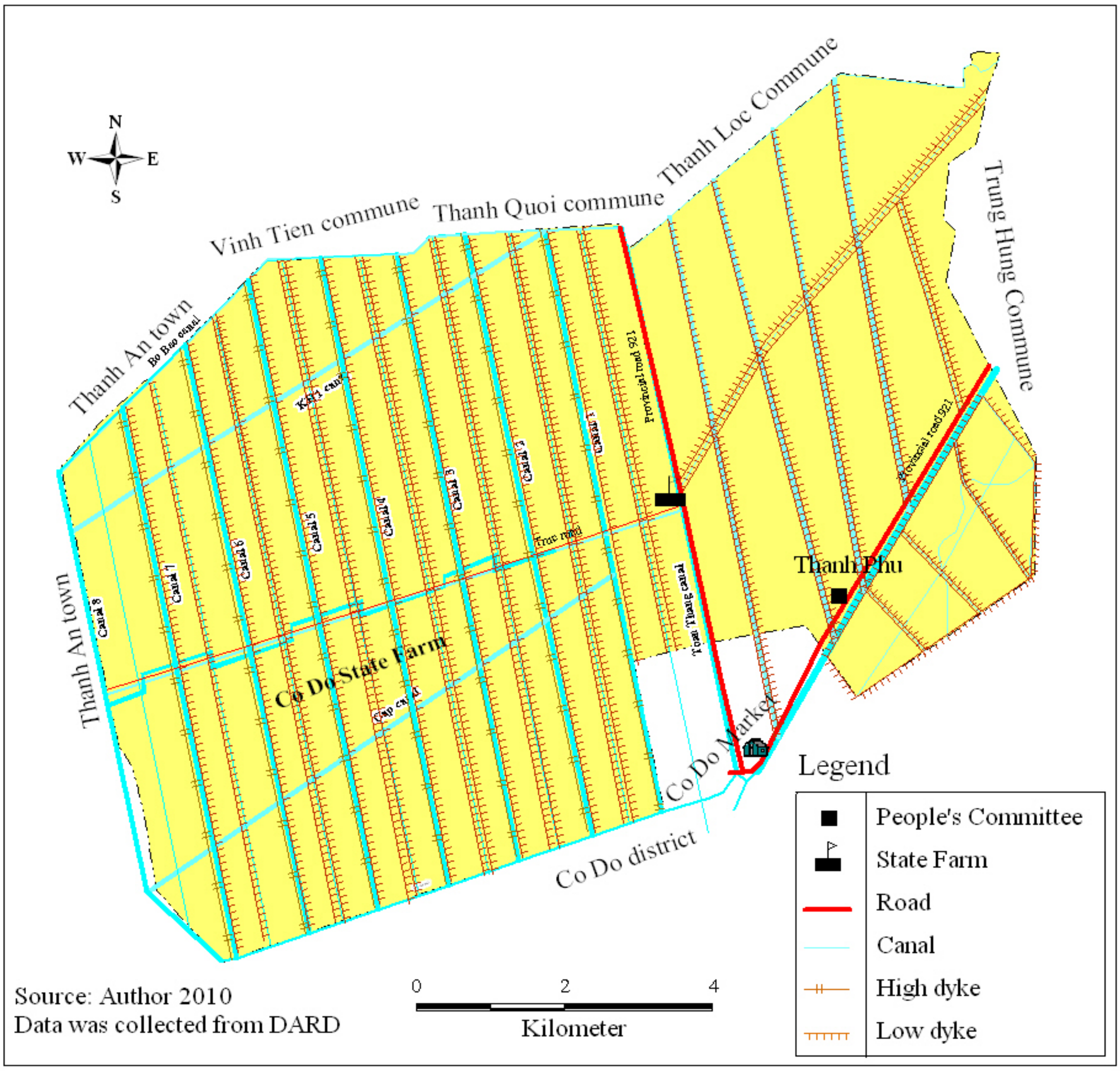
It took some more time, this is until 2003 and from then onwards until 2010, until dyke systems in Thanh Phu and Thanh Thang communes came into existence. Reasons for these belated actions are (i) bureaucratic delays because the leaders of the People's Committee of Vinh Thanh district and ARDO had to develop and approve the overall planning for Vinh Thanh district; (ii) because local communities wanted positive experiences of the neighbouring An Giang and Dong Thap provinces to be included in their own dyke concept; (iii) the financial support of city and district to implement the dyke construction at communes of Vinh Thanh district started only in 2006. Up to 2009, the dyke systems were completed and now protect approximately 90 percent of the agricultural farming area of Thanh Thang and Thanh Phu communes (Map 5.2 and 5.3).

Map 5.2: Dyke system situation in Thanh Phu commune



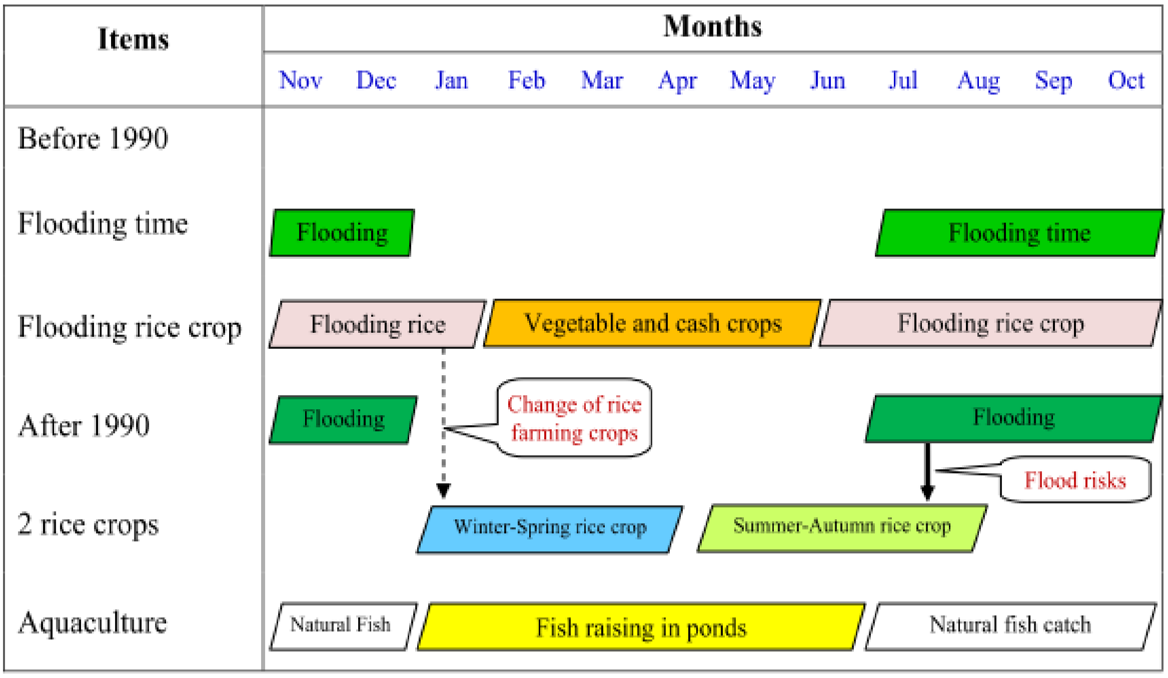
It is before the background of the structural data presented in the previous sections that perceptions and adaptation strategies of the local communities shall be discussed. As mentioned several times before, most people of Vinh Thanh and the MD at large were accustomed to live in a kind of a sometimes harsh "harmony" with nature and its annual rhythms of rainy and dry seasons, of floods and irrigation on the one hand, and occasional droughts on the other. Thus, pros and cons were part of daily life until population pressure, economic necessities and governmental decisions changed these traditions.

Map 5.3: Dyke system situation in Thanh Phu commune



Historically, flood rice as the predominant traditional rice variety has been cultivated in the floodplains. This variety was grown once a year from May to January. It could withstand the severe conditions of weather and floods during the flooding time (Fig. 5.1). On the other hand, rice crops were always at risk because of heavy rains and rapidly increasing floods leading again and again to low rice yields or even lost harvests, causing famines among the rural population. Besides, the flooding varieties usually had low yields from 1 to 2 ton/ha that were not enough to ensure sufficient annual food supply for the locals. In order to produce more food and broaden the dietary basis, local communities cultivated vegetables, fruit and fish in ponds from January to July. People who relied exclusively on rice production in the floodplains were extremely vulnerable in both Thanh Thang and Thanh Phu communes and beyond.

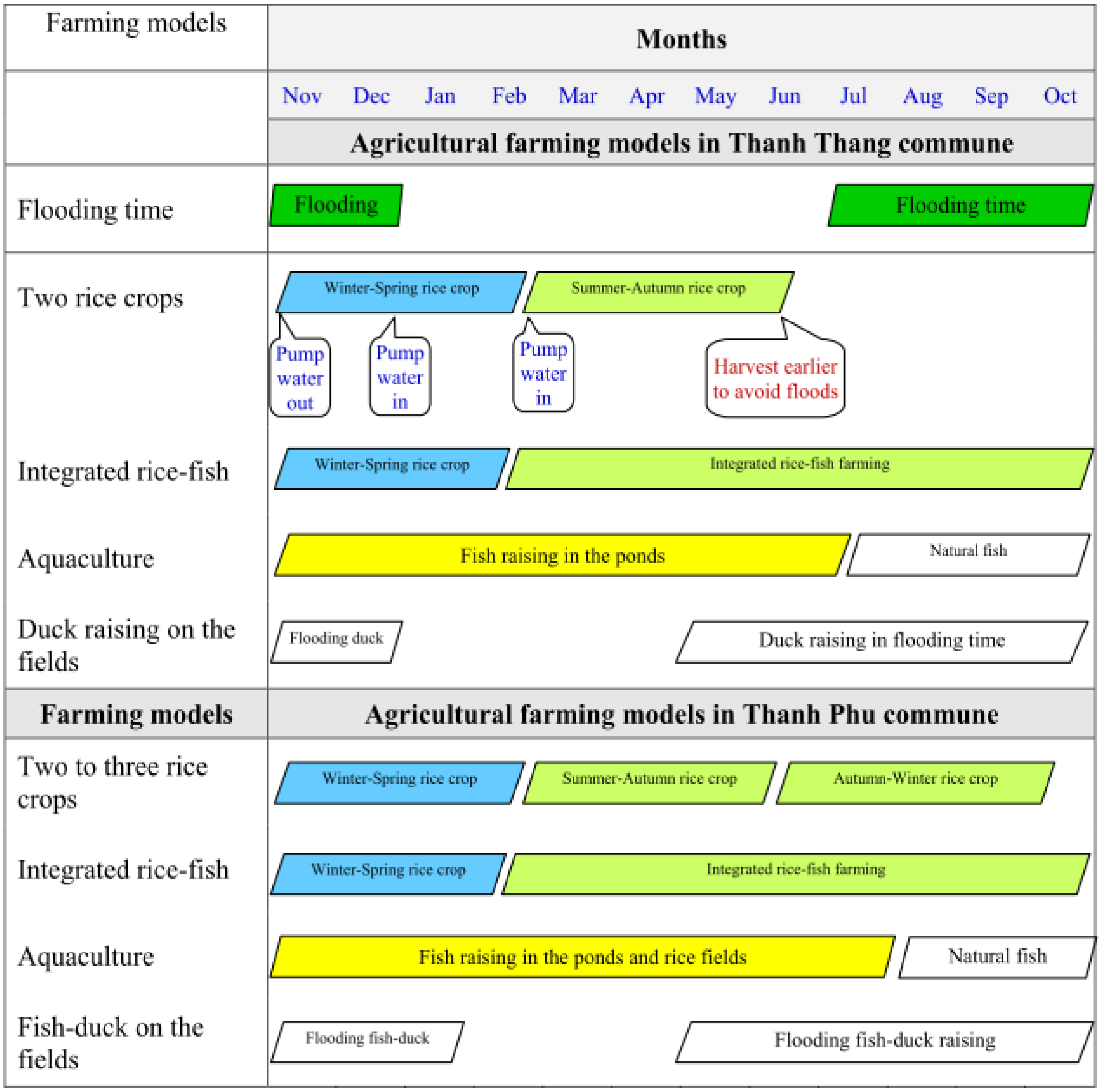
Figure 5.1: Agricultural livelihood plan before the dyke system construction in Thanh Thang and Thanh Phu communes, before and after 1990



Source: Group discussion with farmers in 2008

Annual rice farming was transformed from one flooding crop into two rice crops, which remarkably improved the flood security and life of farmers in the floodplains of these communes. The WS or first crop normally started when floods receded in January and was harvested in March or April; and the SA, the second crop, was cultivated from April to August. The SA, however, was often influenced or damaged at harvesting time by the summer floods in both Thanh Phu and Thanh Thang communes (Fig. 5.1). This was a new challenge for farmers in those first transitional years after the rice farming was transformed from the flooding rice crop into two high-yield rice crops per year. At first, farmers, local authorities and researchers could not find any solutions to help farmers in their adaptation process because new rice varieties had a growing time from 100 to 115 days. Therefore, the farming time of both rice crops could not be shortened in order to avoid flood risks for the second crop from July to August.

Figure 5.2: Agricultural livelihood plans after the dyke system construction in Thanh Thang and Thanh Phu communes in 2008



Source: Group discussion with farmers between 2008 and 2009

After the dyke system construction, what has it contributed to farmer communities adapting to floods and improve their agricultural livelihoods in the floodplains of Thanh Thang and Thanh Phu communes? The dyke system construction aims to assist farmers to adapt to floods as well as to protect their agricultural livelihoods. In practice, however, it is questionable whether farmer communities really adapt better to floods. In order to understand the adaptation processes and their impacts, discussions were held and arguments were exchanged on the basis of personal interviews and group discussions with farmers and leaders of local authorities in Thanh Thang and Thanh Phu communes in 2008. They will be presented under two aspects.

a. Rice farming calendar adjustment and rice variety applications: The first major and innovative step was the revision of the traditional rice production plan. The annual rice crops were planted and cultivated earlier than before. The WS crop was brought out earlier in November instead of January, and similarly also the SA crop was produced earlier between February/March and June/early July. At the same time, new rice varieties with short growth duration from 85 to 90 days such as OM2517, OM2519, OM1940, OMCS2000, IR50404 and JASMINE replaced the traditional rice varieties with growth duration from 100 to 110 days. As a result, the SA was harvested early in early June/July instead of August thus avoiding the dangerous influences of floods. In this way, the new farming calendar shortened the annual rice production process by up to 60 days and ensured two crops per year (WS and SA) and succeeded to overcome the obstacles of early and sometimes disastrous floods (Fig. 5.2). In this process of innovative changes, the construction of the dykes and the use of new rice varieties have played an important role and helped farmers to avoid the flood risks in Thanh Thang and Thanh Phu communes.

b. Agricultural farming and its changes: The second important finding of the interviews is the fact that, while the two rice crops (WS and SA) are the main income of households, the third and additional rice crop, namely Autumn-Winter rice crop (AW), could be cultivated in the protected floodplains in Thanh Phu commune because the high dykes were constructed in the villages to control the floods. In contrast, AW could not be farmed in Thanh Thang commune because the low dykes were usually flooded in the flooding season.

Besides this intensification process in rice production which, by the way, is also confirmed by other authors in other parts of the MD (Käkönen 2008), an equally important outcome of the dyke constructions is the fact that farming and especially the mono-rice farming systems could be transformed into a broader spectrum of land use and of Farmers' economic basis.

Table 5.1: Agricultural farming transformation before and after dyke construction in the floodplains

Agricultural farming models	Thanh Phu commune		Thanh Thang commune	
	Before dykes	After dykes	Before dykes	After dykes
Flooding rice	+++++	-	+++++	-
Double rice crops	+++++	+++++	+++++	+++++
Triple rice crops	-	+	-	-
Double rice crops – one flooding fish and duck	-	++	-	+
Integrated rice – fish	-	+++	-	+
1 rice crop – 1 cash crop	-	++	-	-

Source: Group discussions with farmers between 2008 and 2009

+ Less popular ⟶ ++++ very popular; - Disappear

The improved control over water and land resources in the protected flooding areas in Thanh Phu and Thanh Thang communes enabled the farming population to use the available basins also for the simultaneous raising of ducks, fish and shrimps together with rice and continue keeping them in the fields after harvesting the rice. Thus, the two rice crops system was transformed into an integrated farming model with combinations such as rice-fish, rice-fish-duck, rice-vegetable and special fish-duck during the flooding time. Especially in Thanh Phu this broadening of the production spectrum can be observed, while in Thanh Thang these effects are less pronounced (Table 5.1). In all integrated farming models, rice was and is the main income while fish and duck are welcome additions to the productivity of rural households. Theses additions, by the way, fit very well into the agricultural cycle because fish can be kept in the rice fields during flooding time and after the rice is harvested. Fish can either be released directly into the rice fields or is raised in ponds for few weeks or months before being released into the rice fields. The time for raising fish in the rice fields lasts from SA crop to the next WS crop. Ducks can be raised as part of the rice-fish combination and can be kept continuously during flooding time. It should be noted that the integrated farming models were mainly implemented by the medium and better-off farmers, because the investment into these models is rather costly on account of the prices for fish and fowl. Generally, the risks and damages of floods have been gradually eliminated in these communes. Local people have favorable opportunities in agricultural production and the possibility to offer employment and additional incomes for households and farmer communities in comparison to the earlier situation (Table 5.1). Integrated farming models have gradually replaced the traditional mono-rice farming models in Thanh Phu commune while the agricultural farming situation has changed only slightly in Thanh Thang. The results of household interviews found that 80 percent of farmers in Thanh Phu and 72 percent of farmers in Thanh Thang commune agreed that the dyke system construction has ensured safety and created a much more convenient environment for agricultural farming than the previous flooding situation.

5.3 Water and flood management in Thanh Thang and Thanh Phu

5.3.1 Problems, constraints and conflicts

According to farmers and leaders of villages, the most successful consequence of the dyke construction process was the avoidance of flood risks and, as a result, the shortening of the growth period of rice and the possibility to produce two to three harvests per year. Cooperation of local farmer households in flood control and floodwater management in the protected floodplains was a precondition for these changes. As mentioned in the previous sections, floodwater was pumped out of the protected floodplains to start the WS crop before flood seasons ended, and the SA crop was produced and harvested earlier in June/July (Fig. 5.2). Generally, there were and still are two methods of water management: collective and individual water pumps. The collective water pump requires the participation and cooperation of all farmers whose rice farming land is located in the same protected floodplains. The collective and individual water pumps are normally used for the WS crops while individual water pumps are used for SA crops.

In order to organize and to manage the control mechanisms of floodwater in the WS harvesting period, the leaders of villages annually organize meetings with farmers who have rice fields located in the same protected floodplains. Farmer households discuss to reach an agreement on the pumping plan. The major contents of the meetings is to reach an agreement on appropriate pumping times and costs of the collective water pump in terms of gas, oil, hiring costs for the pump, labor and dyke repair as well as appropriate water pump alternatives to save costs for pumping. According to the researcher's observation in the public meetings, farmer communities discuss and make the final decisions under the leadership of local authorities. They agree on water pump costs and select a responsible committee of two to three farmers who are then in charge of managing and monitoring the whole pumping process. Obligations of this committee are to define and control the floodwater level in the fields, to detect leaks and risks of possibly broken dyke systems, and to control water pump costs during the pumping process. The agreements of farmer communities in the collective water pump meetings include: (i) the costs and time of the collective water pump are divided equally for each farming unit as accounted for 1,000 m^2; (ii) all households are responsible for managing and protecting dykes and sluices during the flooding time in the respective floodplains; and (iii) floodwater is pumped out until the water level is lower than the rice fields' surface of all farmer households located in the same protected floodplains. Hereafter, individual households have to manage water in accordance with their own needs during the rest of the WS crop and the whole SA crop season.

Individual water pumps are used when the floodwater level is reduced lower than the small bunds of rice fields or the surface area of all farmer households' fields in the WS season. In addition, floodwater management is also implemented by smaller farmer groups from three to five farmers who have similar land conditions, water needs and interests in the same protected floodplains, but who may not be part of the village farming community because their fields are too small and they are too poor to participate in the collective pumping endeavour. Most of these groups were found in Thanh Thang commune, but not in Thanh Phu commune. Thanh Thang has electric motors to pump water for their rice fields located in the independent dyke systems. This saves water pump costs as compared to individual and collective water pumping in larger groups.

In view of the fact that different water management alternatives have been implemented in Thanh Phu and Thanh Thang communes and in order to identify which system brings the highest benefits for farmer communities 270 households were asked in both communes to understand farmers' perception and water management experiences. The results of these interviews are presented in Table 5.2. The majority of farmers prefer collective water pumping for the first pumping and after that individual water pumping for the WS crop season. 84 percent of the farmers in Thanh Phu commune and 81 percent of the farmers in Thanh Thang commune voted in favour of this alternative to be applied in the WS crop if the WS is produced early enough before the flood recedes in the protected floodplains (Table 5.2).

Table 5.2: Water management alternatives for rice production in Thanh Phu and Thanh Thang communes

Water management alternatives	Thanh Phu		Thanh Thang	
	WS (%) n=75	SA (%) n=76	WS (%) n=79	SA (%) n=78
Collective water pump during rice crops	4	3	16	15
Collective pumping for the first time and then the individual water pumping for the rest of the time	84	4	81	13
Individual water pump in the rice production	12	79	3	59
Water pumping in small groups from three to five farmers	0	14	0	13

Source: Group discussion and household interview between 2008 and 2009

According to the perception of the farmers, the use of the collective water pump in this scenario has mainly two advantages: the weather conditions are favorable for the WS crop to produce high yield and therefore the appropriate preparation of the fields pays off, and second: the SA will not be influenced negatively at the harvesting time. In contrast, the individual water pump in the SA cropping period is favoured by 79 percent of farmers in Thanh Phu commune and 59 percent of farmers in Thanh Thang commune (Table 5.2). The reason is that this crop needs more individual than collective care and attention; therefore individual decisions are more important and altogether less expensive. The small number of farmers using the collective water pump in small groups from three to five farmers in the SA cropping period argues that the costs for water pumps in small farmer groups are lower than the collective water pump in larger farmer groups because they can manage the water needs for each farmer household individually.

Apart from the advantages of the dyke system, which on the whole is seen as a positive achievement in spite of some problems, and considering also the advantages of collective efforts to manage the flood and water situation in the floodplains, there are nevertheless a number of constraints. Shared by farmer households and community leaders alike, they refer mainly to both ecological and economic aspects of water and flood management (Table 5.3).

Table 5.3: The major difficulties of farmers in water management

Main difficulties in water management	Thanh Phu commune	Thanh Thang commne
Full protected flooding areas is too large (%)	25	75
High cost in collective pump (%)	100	100
Erosion on dykes (%)	100	100
Uncompleted dyke ((%)	75	50

Source: Group discussions with farmers and commune leaders in 2008

Although the figures are rather crude and may not be totally representative, they show that high collective pump costs and erosion on the dyke system are the main difficulties of water management in rice crops in Thanh Thang and Thanh Phu communes. Annually, farmer communities have to pay a high cost for collective water pumps and the broken dykes. As many dykes break regularly after each flood season, farmers have to repair these dykes at their own costs and by the investment of their own labour before the beginning of the WS season. In addition, the area of a protected floodplain is too large to be managed during the pumping by individual solutions. Therefore, all farmers have to cooperate and also to bear the increased costs of the collective water pump in Thanh Phu and Thang Thang communes. However, the farmer communities in Thanh Phu commune have faced more uncompleted dyke systems than those in Thanh Thang commune. Since the area of the protected floodplain in Thanh Phu commune is smaller than that in Thanh Thang commune, flood control, water management and collective water pump in Thanh Phu commune is easier to handle than the situation in Thanh Thang commune.

An important aspect in the evaluation of water and flood management in both communes and in Vinh Thanh district and the MD at large are the facts that difficulties in regard to technicalities, to costs and to ecological as well as social constraints can be very different dependent on the WS or SA cropping patterns.

The difficulties of farmers in water management in the WS (Table 5.4): In the WS season, collective water pump costs for the WS are the main challenge of both farmer communities. The high costs sometimes cause conflicts among farmers in the same protected floodplains and between farmer communities and local authorities over the production plan for WS crop. The difficulties of farmers in water management can, however, be divided into two farmer groups. The first one includes farmers who are primarily interested in individual water pumping. People in this group start their WS cycle only after the flood season ends to save the costs of water pumping and challenge flood risks in the SA season. Conversely, the second group agrees to pump water out of the fields to start the WS crop before the floods recede in the rice fields to avoid the threats of floods to the SA. The different interests between farmer communities cause difficulties in the flood and water management in the WS season. Difficulties arise more often in Thanh Thang than in Thanh Phu commune because the area of the protected floodplain is too large and possibly incurs high costs for the collective water pumps. According to the results of household interviews, 24 percent of farmers in Thanh Thang and 8 percent of farmers in Thanh Phu communes reported that reaching an agreement of farmers in regard to the use of collective water pumps is a great challenge in WS (Table 5.4). In order to solve conflicts between farmer groups, the leaders of villages and communes had to organize additional meetings with farmers to negotiate and to reach agreements.

Water pump cost is the second difficulty in the water management in the WS season. Actually, pumping needs to be done several times in a rice crop; however, the first water pumping usually costs more because it takes longer and has to pump more water than the following ones. This fact is a controversial problem because if farmers produce the WS crop after the floods have receded in the rice fields, they will save this water pump cost. The water pump costs for the first time in the case of collective water pumping for each WS, varied from VND 200,000 to VND 250,000/ha in 2004 and VND 300,000 to VND 350,000/ha in 2009 (1 USD = VND 15,000). According to the survey results of household interviews, 16 percent of farmers in Thanh Phu commune and 20 percent of farmers in Thanh Thang commune felt that the total cost of collective water pumping was much higher than at other pumping times.

Table 5.4: The major difficulties of farmers in water management for the WS crop

Difficulties	Thanh Phu commune		Thanh Thang commune	
	Collective water pump (%) n=75	Individual water pump (%) n=54	Collective water pump (%) n=89	Individual water pump (%) n=45
- No water or not enough water	13	9	0	0
- Broken and uncompleted dykes or repaired dykes	21	20	18	9
- No water pump machines	4	11	10	18
- High oil and fuel costs	16	20	20	24
- Fields cannot keep water	3	13	1	11
- Water pump hour fraudulence in collective water pumps	21	0	13	0
- Unclear financial report for the collective pumps	13	0	13	0
- Agreement of farmer community in water pumps	8	26	24	38

Source: Household interview between 2008 and 2009

Another considerable difficulty is that the uncompleted dyke systems pose severe problems and threats to farmer communities in Thanh Thang and Thanh Phu communes because their repair and maintenance increase rice production costs in the WS cropping season. Almost annually, the dykes are broken or eroded by floods causing more or less regularly high costs for their repair before the beginning of WS season. The results of household interviews found that there were from more or less 20 percent in collective and individual pumping in Thanh Phu and similar 18 percent in collective pumping and 8 percent in individial pumping of farmers who agreed that the broken and uncompleted dykes are a difficulty (Table 5.4). In addition, other difficulties in term of the mismanagement of time and operation schedules during the water pump usages led to controversies among farmers and need to be considered in the WS. Generally, the agreement processes of farmer communities and the high costs in collective water pumping are the main difficulties in the WS period.

The difficulties of farmers in water management in the SA cropping season (Table 5.5): As mentioned before, water management and flood control mechanisms are different in connection with the SA crop season. Especially the preference of individual pumping activities is a characteristic of rice production in this period. Water is being pumped into all rice fields to irrigate rice production because water levels in canals are normally lower than those of the rice fields. The main difficulty of water management in the SA season depends mainly on the adaptability of each farmer household to reduce water pump cost.

Table 5.5: The difficulties of farmers in water management in SA

Difficulties	**Thanh Phu commune (%) n=66**	**Thanh Thang commune (%) n=85**
- No water or not enough water	15	18
- Uncompleted dykes	2	6
- No water pump machines	6	9
- High fuel costs for water pump	26	24
- Fields cannot keep water / leakages	15	12
- Lack of agreement among farmers	36	32

Source: Household interview between 2008 and 2009

In the SA season, the first pumping is costly compared to other following ones because water has been lost from one field to another in case of individual water pumping. Farmers negotiate among themselves but they can hardly get the approval of neighboring farmers in the first pumping to save water during the pumping process. According to farmers' explanation, the main reasons include that collective water pump costs are higher than those for individual water pumps, as has been discussed before. Besides, however, water needs and production plans are usually different from farmer to farmer to obtain optimal benefits. Therefore, most farmers decide on water-pumping time spontaneously and according to their own specific needs. However, farmers sometimes negotiate with one another to join forces and to pump water at the same time in neighboring fields in order to reduce water pump costs. According to the results of household interviews, 36 percent of farmers in Thanh Phu commune and 32 percent of farmers in Thanh Thang commune stated that it was difficult to reach an agreement among farmers in the same areas to pump water in the fields during the SA season. Individual farmer households therefore had to accept the significant losses of water in the water pumping times of this period (Table 5.5).

Results of the household interviews show that 26 percent of farmers in Thanh Phu commune and 24 percent of farmers in Thanh Thang commune perceived high water pump costs for the SA season as one of farmers' main difficulties compared to other handicaps. The main reason is that the small dykes (bunds) between fields are not strong enough to keep water within the irrigated rice farming fields. For this reason, the water is easily leaking from one field to another. 15 percent of farmers in Thanh Phu commune and 12 percent of farmers in Thanh Thang commune encountered this difficulty. In addition, the water level in the canals was not seldom far too low to pump water into the fields. 15 percent of farmers in Thanh Phu commune and 18 percent of farmers in Thanh Thang commune had to face this difficulty.

If we summarize our findings in regard to the flood management of farmer communities we have to conclude that farmers afforded more money and work to avoid flood risks than to control floods in the protected floodplains. In practice, floods are only controlled at the beginning of flood seasons to start the WS activities. After the SA crops are completely harvested, the floodwater can accumulate enough alluvial soil and return to its natural status. After dyke construction, the annual flooding time has been shortened by 1 to 2 months reducing also the practical flooding time to only from 2 to 3 months in the protected floodplains. Nevertheless, farmers actually want to maintain floods in the fields during the flooding time to utilize the described advantages of the floods. The results of this survey found that 96 percent of individual farmer households in Thanh Phu commune and 97 percent in Thanh Thang commune actually expected to keep floodwater in the fields after the SA crop was harvested in order to take the advantage of the fertile alluvium soils, to ensure "field hygiene" by the cleansing effects of natural waters and to ensure natural fish exploitation and protection. In addition, flood water could be utilized to raise fish as well as ducks. According to the surveyed results, 4 percent of the farmers in Thanh Phu and 3 percent of the farmers in Thanh Thang commune suggested that fish should be raised during the flooding time. Those expectations and demands are, however, in contradictory contrast to the planners' objectives in the dyke system planning. While farmer communities try to adapt to floods and draw additional advantages out of the dyke construction flood planners only want to control them in the protected floodplains.

5.3.2 Factors influencing the water management decisions of farmers

The decision-making of farmers on the annual water management for rice farming crops depends on a number of internal and external factors. As discussed with farmers and local authorities and indicated in earlier sections of this study, farmers actively decided the time for rice farming and water pumping without the intervention of governmental organizations and communities before the construction of the dyke system. They have learned to live with floods in several years so that they can judge adequately the advantages and risks of floods for their lives and livelihoods. In the past, the factors influencing their decisions were more depending on their own experiences than on the suggestions and on the interventional plans of communities and authorities. Therefore, the knowledge and common sense of the individual farmers were the most important internal factors that influenced farmers' decisions on rice crops, their planting and harvesting times. This changed dramatically after dykes were constructed. Rice farming no longer depended on the farmers themselves, but decision-making and production plans were defined and implemented by communities and local authorities. Farmers, whose rice-farming fields were located in the same protected floodplains, had to agree on collective actions to organize rice-farming. Instead of individual decision-making processes, the farmers had to enter into group discussions with local authorities that set the frame for farmers' water management decisions including annual production plans on district and commune levels. Discussions and joint decisions also referred to flooding levels in the fields, disease and pest control, market price of paddy materials, weather conditions, water pump machines and so on.

The majority of farmers reported (Table 5.6) that the flooding level in the fields was one of the factors strongly influenced by farmers' decision on water management in the WS planting and cropping season in both Thanh Thang and Thanh Phu communes. However, farmer communities could not control the floods because the dyke systems were submerged from September to October. For this reason, it was mainly the flooding level issue that principally influenced farmer communities' water pump and production plans. 31

percent of farmers in Thanh Phu commune compared to 38 percent of farmers in Thanh Thang commune agreed that the flooding level discussions directly affected the farmer communities' decision on water pumping and production plans. For this reason, farmer communities had to organize public meetings to reach an agreement on a reasonable flooding level and appropriate water pump time with the ultimate goal to save pumping costs.

Table 5.6: Factors influencing the water management and rice production decisions of farmers in the protected floodplains

Influent factors	Thanh Phu		Thanh Thang	
	WS (%) n=135	SA (%) n=178	WS (%) n= 130	SA (%) n=122
Rice production plan of commune People's Committee	36	18	21	7
Floodwater level on the field (inundation)	31	0	38	0
Diseases and pests situations	21	23	18	18
Market price of agricultural input materials and rice	4	14	8	3
Plans for the third rice crop or upland crops	1	2	2	0
Weather (rains, storms and floods)	0	24	0	43
Facilities (Water pump)	0	10	0	3
Agreement of farmer communities	6	10	14	25

Source: Household interview between 2008 and 2009

Furthermore, the rice production plan of the commune and district heavily affected farmers' decisions over water pumping. Production plans prescribed stable periods for pumping water and the beginning of the rice farming crops. In line with these plans, local authorities informed farmer communities about the contents of the plan and organized meetings with farmers to schedule time for water pumping and planting periods. The farmer communities had to subordinate their own schedules under the production plans of district and commune. As addressed in Table 5.6, 36 percent of farmers in Thanh Phu compared to 21 percent of farmers in Thanh Thang commune in the WS season, and 18 percent of farmers in Thanh Phu compared to 8 percent of farmers in Thanh Thang commune in the SA season confirmed that the rice production plan of the commune and district influenced their own decisions on water pump and rice crop. Altogether and not surprisingly for a top-down organized society and economy, local authorities have a strong influence on rice production and water management plans of farmers.

Another considerable constraint was the appearance of pests and diseases in the last few years. Pests and diseases usually cause serious damage to rice production in the protected floodplains. Therefore, local authorities and farmer communities set up rice production plans to avoid pests and diseases. This meant that rice production was usually implemented in the protected floodplains at the same time in large areas to save costs and reduce damage. According to the results of household interviews, 21 percent of farmers in the WS season and 23 percent of farmers in the SA season in Thanh Phu commune considered this factor while 18 percent of farmers in both seasons in Thanh Thang commune agreed that the avoidance of pests and diseases influenced their decisions in water pumping and management (Table 5.6).

In addition, also weather conditions and market price of rice were of influence. Annually, the irregular regimes of the rain and storm at the beginning and at the end of floods affected water pumping costs and caused risks for rice production. Most farmers follow the data and information broadcast and announced on public media such as television and radio to predict the weather influences and to adjust to them when- and wherever possible. In practice, however, many farmer communities do not have adequate broadcast information to avoid rain and storm regimes. As our survey shows, 24 percent of farmers in Thanh Phu commune and 43 percent of farmers in Thanh Thang commune consider meteorological impacts seriously and acknowledge that weather is a vulnerable factor increasing the cost for water pumping and reducing rice yields.

Concerning the factors that are of decisive influence for reasonable decision-making processes in water management the use of collective water pumps is obviously most critical. As indicated before, to reach agreement among farmers is a challenge for both farmers and leaders of villages. This observation holds true also for Thanh Thang and Thang Phu communes. Reasons are that farmers have different water management experience and needs for water pumping. Besides, some farmers do not want to pump water out of the flood basins to save costs and to augment their incomes by fish or duck production. A third reason is that the field elevations are sometimes different among farmers causing different priorities and necessities. Thus, it is difficult to get consensus within the farmer community. In the household interviews, 6 percent of farmers in the WS crop season and 10 percent of farmers in the SA season in Thanh Phu commune considered this factor a serious obstacle while 14 percent of farmers and 25 percent of farmers in the WS respectively SA seasons in Thanh Thang commune agreed that reaching the agreement of farmer communities was and is a permanent problem and the cause of lengthy discussions.

Finally, also market prices and facilities influence farmers' decisions on water pumping and production plans, but they are of minor importance compared to the aspects discussed above. Practically, most farmers have to sell their products at low price during the harvesting season. This is another reason why farmer communities in Thanh Phu commune have decided to pump water to start rice crops earlier than others to achieve better selling prices before the main crops are harvested in the protected floodplains.

In summary, empirical water management practices of farmers are influenced by many factors of which the agreement of farmer communities and flooding levels in the fields are the two main ones. With these findings, our two case studies verify the observations made on district level. In line with our hypothetical assumptions as formulated in chapter 1, we have to conclude that the top-down approaches of a highly bureaucratic "hydraulic" administration from central government via city and district administrations trickle down to the community and household levels, leaving only very limited freedom of choice to the experienced farmers in the MD. On the other hand, perceptions and reflections of these knowledgeable people indicate that there may be large spaces for improvements.

5.4 Dyke system impact assessment: Perceptions and reflections by local communities

The analysis of the dyke planning projects and their implementation on regional and local levels, as outlined in the preceding chapters of this study, demonstrates that on almost all levels there are juxtaposing strategies, intentions and expectations. Top-down and bottom-up are sometimes seemingly incompatible aspects of one and the same issue – however, due to the political hierarchies of all decision-making processes, the unequal distribution of power structures and an encrusted bureaucratic administration, even reasonable arguments and long-term experiences from the local knowledgeable and experienced bottom-up perspective thus hardly have a chance to be heard, not to speak of potential acceptance of these views. It is before this basic situation that the following reflections of the farmer communities should be seen. The division of their views and experiences in regard to the economic, the ecological and the social impacts of the dyke system should also be seen as an acknowledgement of the expertise of the local farmers.

5.4.1 Economic impacts

The first impact of the dyke system concerns the rice crops in the protected floodplains. Observations according to which the rice yields were reduced in the protected floodplains of the neighboring An Giang province (Tran Nhu Hoi 2005) caused concern among the farmers of Vinh Thanh district and our two communities.

Table 5.7: Farmers' perception on rice yields in the protected floodplains of Thanh Phu and Thanh Thang communes in 2008

Rice yield	Thanh Phu commune		Thanh Thang commune	
	WS (%) n=65	SA (%) n=77	WS (%) n=65	SA (%) n=78
Increased	75	88	89	77
Reduced	22	1	7	1
Unchanged	3	10	4	22

Source: Household interview between 2008 and 2009

However, the rice yield of crops increased in the protected floodplains of Thanh Thang and Thanh Phu communes. The majority of farmers reported that the practical rice yields had increased from 2004 to 2008 in the protected floodplains of Thanh Phu and Thanh Thang communes (Table 5.7). There were at least 75 percent of farmers in both Thanh Phu and Thanh Thang communes reporting that the rice yield of both the WS and SA crops was higher than the situation before the dyke system construction. According to farmers' explanations, the rice crops were cultivated under convenient weather conditions for the growth and development of rice. Besides favourable climatic conditions, also the benefits of new farming technologies have helped to improve the harvests in recent years. However, also the amount of fertilizers and agrochemicals has been increased compared to previous years in Thanh Phu and Thanh Thang communes (Table 5.8), contributing to higher problems in the ecological and environmental sector (see Chapter 5.4.2).

Table 5.8: The perception of farmers on using fertilizers and pesticides in comparison with the situation before the dyke system construction

Perception on change	Thanh Phu commune				Thanh Thang commune			
	WS		SA		WS		SA	
	Fertilizers (%) n=72	Agro-chemicals (%) n=97	Fertilizers (%) n=53	Agro-chemicals (%) n=53	Fertilizers (%) n=84	Agro-chemicals (%) n=85	Fertilizers (%) n=83	Agro-chemicals (%) n=79
Increase	51	86	70	79	49	71	47	65
Reduction	29	9	9	15	7	9	7	10
Balance	19	5	21	6	44	20	46	25

Source: Household interview between 2008 and 2009

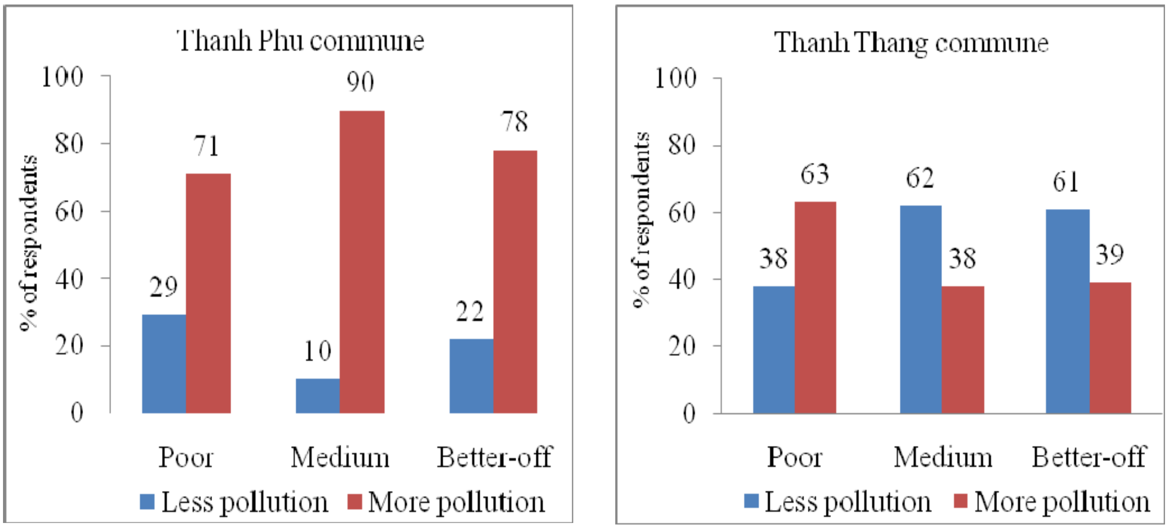
In the WS season, a large number of farmers used additional fertilizers for rice farming that is 51 percent of farmers in Thanh Phu commune and 49 percent of farmers in Thanh Thang commune. The causes of these increases were mainly due to a decline of natural land fertility because of fewer floods after dyke construction. But not only fertilizers increased but also the use of agrochemicals. At least 86 percent of farmers in Thanh Phu and 71 percent of farmers in Thanh Thang commune applied additional agrochemicals, especially for WS crops after the dyke system construction. But also for the SA cropping period, the farmers confirmed the application of more fertilizers and agrochemicals. At least 47 percent of farmers used fertilizer and 65 percent agrochemicals. A few farmers switched to three rice crops in Thanh Phu while there were and are only two rice crops farmed in Thanh Thang commune. The intensive rice farming in Thanh Phu has surely contributed to higher applications of fertilizers and agrochemicals for rice farming there.

Another objective advantage of the dyke system is its positive impact on aquaculture, thus improving the economic basis of many rural households. The transformation from double rice crops into integrated rice-fish farming and special fish cultures has created additional incomes in the protected floodplains. The fish is raised together with rice in WS and SA seasons and also during flooding time. The first integrated rice-fish farming models were mainly implemented after the official dyke systems were constructed in Thanh Phu in 1993-1995 and in Thanh Thang communes in 2005. These models have become increasingly popular since 1996 in Thanh Phu commune, while they were carried out in Thanh Thang commune only from 2005 onwards. However, in recent years these models have not really been beneficial for farmers because the fish yield was low, and even the selling price of fish was below the production costs. Therefore, fish production has gone down and is today pursued by only a few farmers in Thanh Phu commune. Fish is mainly raised during the flooding time after the SA crop is harvested. Farmers use nylon nets to enclose their rice fields to culture fish. The results of the household interviews found that 42 percent of farmers in Thanh Phu and 32 percent of farmers in Thanh Thang commune pursued rice-fish farming. Main reasons for the increasing abandonment of additional fish cultivation were too low prices for fish, too high investment costs and unstable market prices. Finally, the height of the dyke systems was too low to guarantee safe conditions for fish raising. As shown in the results of the survey, 70 percent of farmers in Thanh Phu and 67 percent of farmers in Thanh Thang commune agreed that the dykes were too low and unstable to raise fish in the fields. Although the dyke system construction has created favourable pre-conditions for farmers to transform from mono-rice farming into integrated rice-fish strategies, these models were always connected with high risks and uncertain results for most farmers who have applied them.

5.4.2 Ecological and environmental impacts

As a result of increased use of fertilizers, agrochemicals and plant protectors such as pesticides and fungicides, the impacts of the dyke system on the surface water became quickly apparent. Water sources have been polluted in both Thanh Phu and Thanh Thang communes. However, the consequences in Thanh Phu commune were obviously much higher than in Thanh Thang commune (Fig. 5.3).

Figure 5.3: The water pollution in the protected floodplains



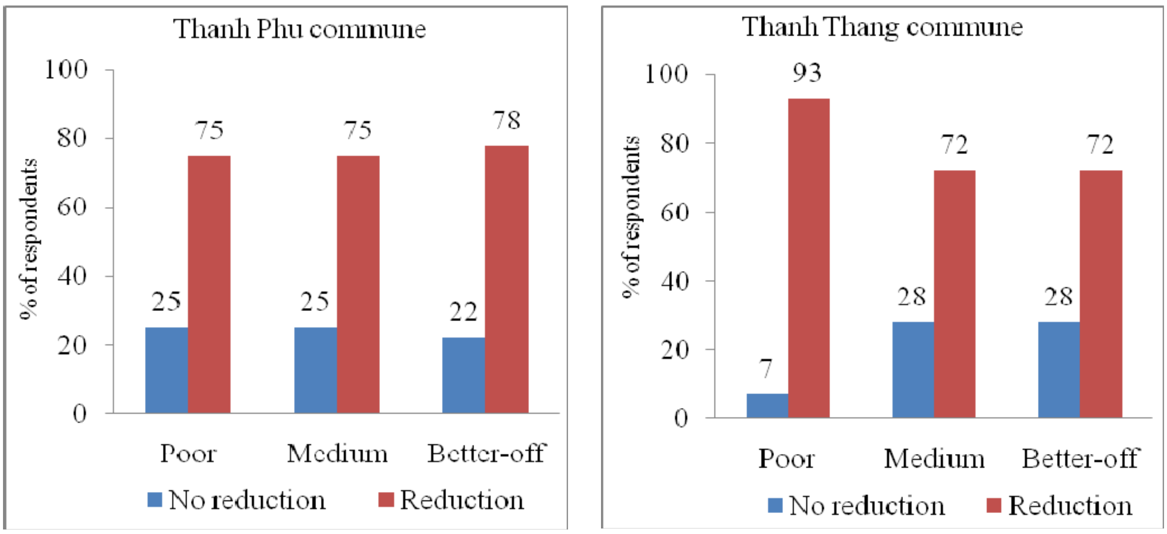
Source: Household interview between 2008 and 2009

In Thanh Phu commune, the great majority of farmers confirmed that water pollution was so serious that the water in canals and fields could not be used for the daily lives of local people. As the surveyed results show, there were at least 71 percent of farmers in all three farmer groups confirming that water has been seriously contaminated, especially so in the dry season. The main causes of this pollution are the intensifications of rice farming, animal husbandry and intensive fish culture in ponds within Thanh Phu commune. Chemicals of all kinds have been overused and were uncontrolled in agricultural production activities, especially in rice production. Also the waste and by-products from pigs and fish have not been treated properly but were directly disposed of in canals and the rice fields within Thanh Phu commune. In addition, wastewater from other communes located along Bassac River contributed to the additional surface water pollution in the floodplains of Thanh Phu commune, which is the shallowest and deepest flooded area of Can Tho city, thus receiving surface water also from other communes of Vinh Thanh and Thot Not districts. The hydrological connection of Thanh Phu with the Bassac River also leads wastewater from agricultural processing companies, fishponds and industrial zones into the rice fields of this commune. These problems are aggravated by the fact that the new dyke systems prevent water flowing between canal systems and fields so that toxicities and agrochemicals cannot be cleaned and washed out during the flooding time.

Problems in Thanh Thang commune are similar, although farmers' perceptions are not quite as pronounced as in Thanh Phu. In the surveyed results, 38 percent of medium farmers and 39 percent of better-off farmers reported that the floodwater was polluted in the protected floodplain; nevertheless, it could be used for daily living activities in the deep flooded months (Fig. 5.3). Farmers explained that floodwater was not polluted so seriously because the actual dyke systems were still low and were submerged during flooding time. Therefore, the floodwater could cleanse part of toxicity and agrochemicals out of the fields. The floodwater in canals and rivers in Thanh Thang commune today flows with higher velocity than before building the dyke system because National Road 80 is used to prevent floodwater flowing in the Southern area of the commune, as mentioned in Chapter 3. Nowadays, floodwater flows very slowly as compared to the previous situation.

The ecological and environmental impacts of the dyke system on natural fish resources and erosion processes are a deplorable side effect of the implementation of the dyke system. The natural fish resources have been reduced fast since dyke contruction in Thanh Phu and Thang Thang communes. The main reasons for the reduction of natural fish resources are due to the fact that rice crops are being cultivated earlier than in the times without flood control dyke systems. Practically, the WS crop which is cultivated early in November, shortened the flooding time from 1 to 2 months and resulted in the loss of habitats for

Figure 5.4: Impacts of dykes on natural fish resources



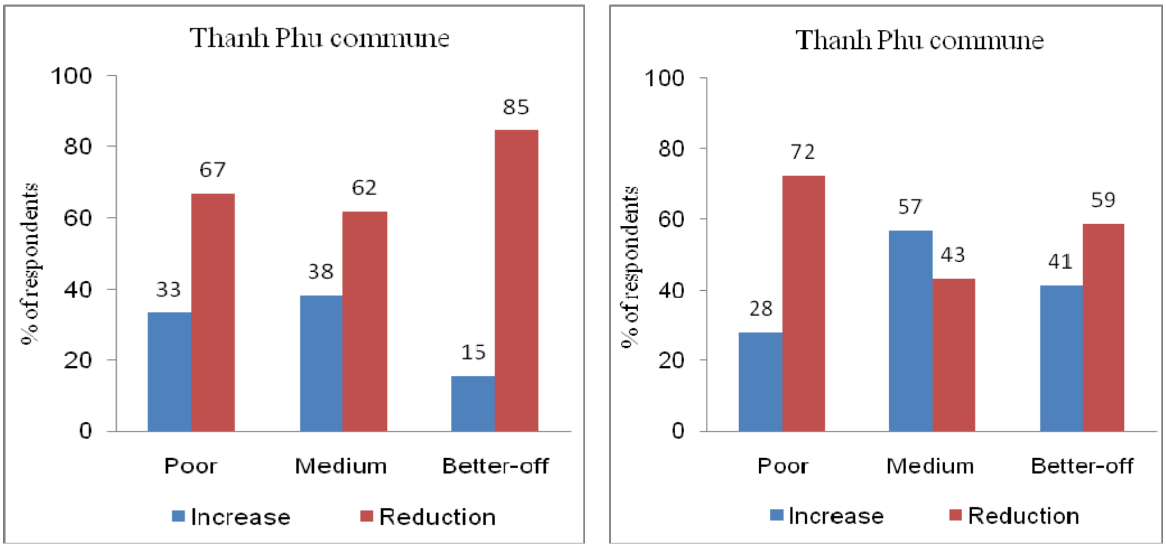
Source: Household interview between 2008 and 2009

natural fish. Besides, dyke systems prevented the movement of wild fish species from canals and rivers into the fields during flooding time connected with losses of their spawning and breeding grounds. Another reason for the rapid decrease of wild fish species was and is the custom of rural people to use electric equipment to catch fish, which served as additional income for many of the poor and unemployed people of both communes.

It is therefore not surprising that the household interviews confirmed these facts. There were at least 72 percent of all farmer groups in Thanh Phu and Thanh Thang communes realizing that the natural fish resources have been reduced rapidly in comparison with the situation before building the dyke systems. Particularly, the poor farmers group in Thanh Thang commune reacted strongly in comparison with others because they usually caught natural fish as part of their daily diet and income during the flooding time (Fig 5.4). In the last few years, a number of natural fish species practically disappeared in the cultural landscape of the MD.

Another alarming consequence of the dyke construction is the negative impact on the quality and fertility of the soils. In Thanh Phu as well as in Thanh Thang commune, as in many other parts of the MD, the natural soil fertility has been reduced considerably (Fig 5.5), causing decreasing harvests and/or increased application of fertilizers and other

Figure 5.5: Land fertility reduction in the protected floodplains

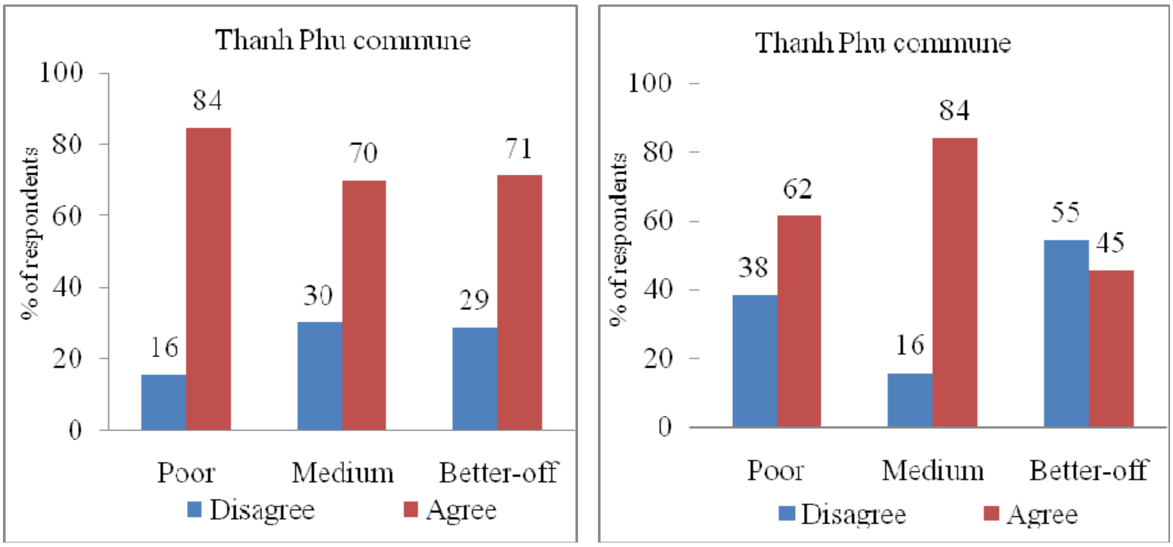


Source: Household interview between 2008 and 2009

agrochemicals. There were at least 62 percent of farmer groups in Thanh Phu commune and 43 percent of all groups in Thanh Thang commune reporting an increasing decline of soil fertility (Fig 5.5). The annual re-fertilization of the fields with high silt loads was and is prevented by the dykes. Besides, there is an unequal sedimentation of the remaining floodwaters that are reaching the fields. Those areas that are located around sluices, canals and rivers usually have more soil nutrients than those located further away.

In addition, increased erosion and annually broken dyke systems cause additional concerns for the rural households. Farmers reported that the dyke systems are eroded and broken mainly because of heavy rain and the waves of floodwater during the flooding time (Fig. 5.6). Additionally, local people also destroyed or changed the dyke systems in order to use

Figure 5.6: The impacts of the dyke systems on erosion in the protected floodplains



Source: Household interview between 2008 and 2009

them for transportation purposes or as pathways for pedestrians and scooters, thus causing additional damage. Therefore, farmers have to spend annually additional money and time to repair the broken dykes before the beginning of the WS season in Thanh Phu and Thang Thang communes. All farmers have to contribute to the dyke repair funds in amounts equivalent to their farming size, which may cause financial troubles, especially for the poor farmers group. As the survey shows, there were at least 70 percent of all farmer groups in Thanh Phu commune and at least 45 percent of all farmer groups in Thanh Thang commune indicating that the dyke systems had to be repaired annually.

A final aspect of the ecological and environmental impacts of the new dyke systems is to be seen in their consequences for the annual inundation of the rice fields. In recent years, inundation has changed irregularly in the protected floodplains of Thanh Thang and Thanh Phu communes. A large number of people suspect that the dyke systems have caused annual inundation changes in the protected floodplains. According to farmers, the annual flooding level has increased between 2004 and 2009. A fair assessment, however, is difficult to give because the annual depth of inundations is influenced not only by the dyke systems but also by heavy rains, tides and flood-flows from higher located flooded areas. According to the results of our household interviews, 53 percent and 69 percent of respondents in Thanh Phu and Thanh Thang communes argued that the dyke systems were the main cause of deeper annual inundations (Table 5.9). However, a large number of other respondents could not understand the impacts of the dyke systems on the change of annual inundations in these communes. Besides an assumed deepening of the flooding level, also the increasing length of the flooding period is of ecological importance. As observed by Le Thi Viet Hoa et al (2007), due to the engineering structures in the MD, water levels tend to be deeper in rivers and canals, thus contributing to earlier inundations and longer time spans for the recession of flood waters.

Table 5.9: The influence of dyke systems on inundation and flood control in the protected floodplains

Dyke impacts	Thanh Phu commune		Thanh Thang commune	
	No (%) n=81	Yes (%) n=72	No (%) n=89	Yes (%) n=44
Inundation level reduction in the floodplains	53	47	69	31
Flood measures sastified farmers' expectated needs	59	41	60	40

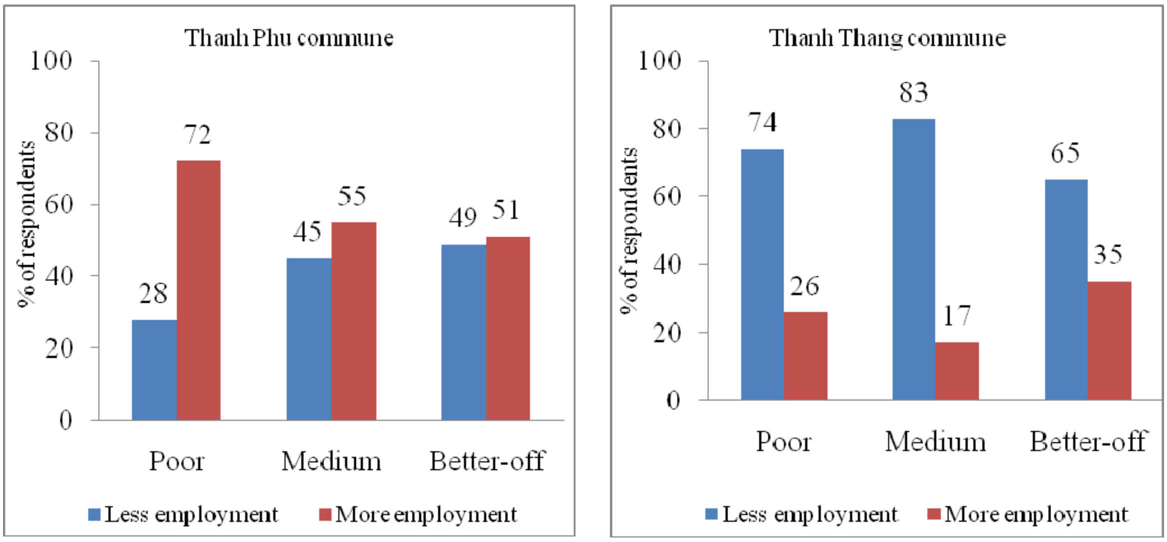
Source: Household interview between 2008 and 2009

In regard to the flood control role of the dyke systems in rice production, dykes could not always fully control floods because they were inundated from September to November. The rice crops still were dependent on the flooding level and time, as reported by 59 percent of respondents in Thanh Phu commune and 60 percent in Thanh Thang. The flooding level was only controlled at the beginning and ending of each flood season to ensure safety for rice farming. In contrast, 41 percent of respondents in Thanh Phu commune and 40 percent of respondents in Thanh Thang commune reported that the dyke systems have satisfied the flood control needs of farmers (Table 5.9).

5.4.3 Social impacts

As indicated in earlier parts of this study, the dyke system construction created a number of employment opportunities for rural people, especially the poor working as wage laborers. The transformation from rice cultivation to integrated farming models and special fish raising activities provided additional incomes to quite a few of the rural households. In Thanh Thang commune, the majority of farmer groups reported that the employment situation had not changed in comparison with the time before the dyke system construction. On the contrary: almost all local people lost additional income sources from natural fish exploitation during the flooding time. Therefore, there were at least 65 percent of respondents within all social groups in Thanh Thang commune who stated that practical employments were fewer than in the past (Fig 5.7).

Figure 5.7: Dyke impacts on employments in the protected floodplains



Source: Household interview between 2008 and 2009

In Thanh Phu commune, however, the majority of farmers reported that there were more employment opportunities than before. Opposite to Thanh Thang commune, mono-rice farming was transformed into integrated farming models, especially raising fish to procure additional income. In addition, rural service institutions such as Co Do market and processing companies have developed and attracted local labor in non-farm and off-farm sections. Thus, the dyke systems have contributed positively to the labor market situation in Thanh Phu commune while in Thang Thang commune the opposite tendency was and is observable.

Especially, poor people have to face a number of additional difficulties during flooding time because in connection with dyke construction and re-arrangement of fields also a mechanization process took place. Increasingly, agricultural equipment and machines are replacing manual labor resulting in rapidly increasing unemployment, especially of the rural poor labor forces. However, while the poor people in Thanh Phu commune were comparatively successful to find employments from non-farm activities, their counterparts in Thanh Thang commune were less successful. The household interview results show that 72 percent of the poor group stated that there were more employments in the protected floodplains compared to only 26 percent of the respondents in Thanh Thanh commune (Fig. 5.7). Overall, the dyke systems have created additional employment opportunities for those who have agricultural land rather than the poor living in the same protected floodplains.

Table 5.10: The impacts of the dyke systems on rural society

Dyke impacts	Thanh Phu commune		Thanh Thang commune	
	Disagree % (n)	Agree % (n)	Disagree % (n)	Agree % (n)
Develop local roads	26 (47)	74 (133)	54 (44)	46 (38)
Create linkage among rural areas and between local and city	66 (103)	34 (53)	65 (37)	35 (20)
Develop rural processing enterprises	93 (101)	7 (8)	76 (32)	24 (10)
Develop agricultural services to provide employment directly for farmers	45 (60)	55 (74)	68 (34)	32 (16)
Exchange products among rural areas and between rural areas and city	49 (69)	51 (74)	56 (32)	44 (25)

Source: Household interview between 2008 and 2009

A positive side effect of the dyke construction measures is that the rural roads have been improved. Most of the high dykes along the primary and secondary canals were built to serve also as roads replacing the traditional waterways and connections between villages and communes in Vinh Thanh district. There were 74 percent of farmers in Thanh Phu commune compared to 46 percent of farmers in Thanh Thang commune who agreed that new dykes have improved the rural road system (Table 5.10). Also agricultural services have been developed in rural flooding areas after the dyke system construction. Shops for fodder or agricultural material have come into existence and rural transport services have been developed to provide for the needs of local people and exchange commodities. Again, rural services in Thanh Phu were developed better than in Thang Thang commune, as confirmed by 55 percent of respondents in Thanh Phu compared to 32 percent in Thanh Phu commune (Table 5.10). Road construction has also greatly enhanced school children's access to schools. Thus, the dyke systems have in an overall perspective contributed positively to the development of the rural society. Rural people have experienced favourable opportunities to develop rural services and to generate rural employments in the rural floodplains. One has to note, however, that not all households have been participating in these developments. Therefore, social gaps between winners and losers of these innovations have been widening.

5.5 Summary: Observations and perceptions of the beneficiary groups of the dyke construction

In summarizing the economic, ecological and social impacts of the dyke construction measures in Vinh Thanh district and the two communes of Thanh Phu and Thanh Thang, we have to conclude that not all households have benefited. On the contrary: the perceptions and realities of the three groups of poor, medium and/or better-off beneficiaries are far from uniform. Table 5.11 reflects the different observations and experiences by the local groups.

Table 5.11 shows that a large number of farmers have benefited similarly from the dyke systems. 50 percent of all respondents in Thanh Thang commune and 30 percent of the respondents in Thanh Phu commune have the impression that dyke construction has been beneficial to all members of the communes. Main advantages are the improvement of rural roads and the creation of employment opportunities. Also the intensification of rice production from two to three rice crops and the increased hatching of fish are considered to be major improvements. Finally, also the improved employment opportunities are seen as an additional positive result of the construction measures.

Table 5.11: Beneficiary analysis in the protected dyke areas

Beneficiary groups	Thanh Phu commune		Thanh Thang commune	
	N	%	n	%
Poor	26	10	13	10
Medium	75	29	23	18
Better-off	81	31	27	21
Benefits for all farmer groups	79	30	64	50
Total	261	100	127	100

Source: Household interview between 2008 and 2009

A somewhat closer look at the results of the household interviews reveals, however, that perceptions of these pros and cons have to be seen very critically and in a differentiated way. As mentioned before, there are winners and losers. Consequently, the just mentioned reactions are by no means representative for the total population of the two communes. The correlation of the answers with the interviewees and their social attachment to one of three social groups shows remarkable differences in perceptions and evaluations. The majority of respondents argued that benefits are unequal between social groups. The medium and better-off farmer groups have got more benefits out of the construction measures due to the afore-mentioned improvements, while the poor group with only small pieces of land or even landlessness did not get any long-term benefits. The dyke construction has protected farmers who have rice farming land while the poor farmers group had to face difficulties due to the reduction of natural fish resources in the protected flooding areas. Thus, the gap between the three groups has widened.

In generalizing the results of our in-depth analysis of the economic, ecological and also social improvements respectively changes in the communes of Thanh Phu and Thanh Thang, we have to recall that the primary objective of the governmental dyke planning only aimed at protecting and improving rice production. In practice, however, it was also possible to reach remarkable progress in flood management and rural development in all flooding areas of Can Tho city. The dyke system has not only contributed remarkably to mitigate the damages of floods but it has also contributed to the development of rural infrastructure and – in a very discriminating way – to the improvement of social and economic well-being of parts of the rural population. It is to be supposed that these findings are transferable also to other communes of the MD, wherever dyke construction has taken place.

On the other hand, one should not neglect the problematic consequences of the engineering interventions into the natural ecosystems. Loss of natural fertilization by silt-loaden floodwaters cannot be counterbalanced by agrochemicals of all kinds. Their negative effects on land and water have been mentioned. Also the negative impacts of newly created and deepened (irrigation) channels have to be considered. Increased erosion is only one of those side effects. So one may conclude in a very general way that the dyke construction is a combination of reasonable benefits and losses of natural resources. The dyke system has created favorable conditions for agricultural development and employment opportunities for rural people in the short term. Conversely, it is threatening the sustainable resources development in the protected floodplains in the long term. The beneficiaries of the dyke system are medium and better-off farmer groups while it is a challenge for the poor farmers to earn a living during the flooding time. Nevertheless and altogether, farmers perceive that the dyke system had to be built to protect and develop agricultural production and rural infrastructure in Thanh Phu and Thanh Thang communes.

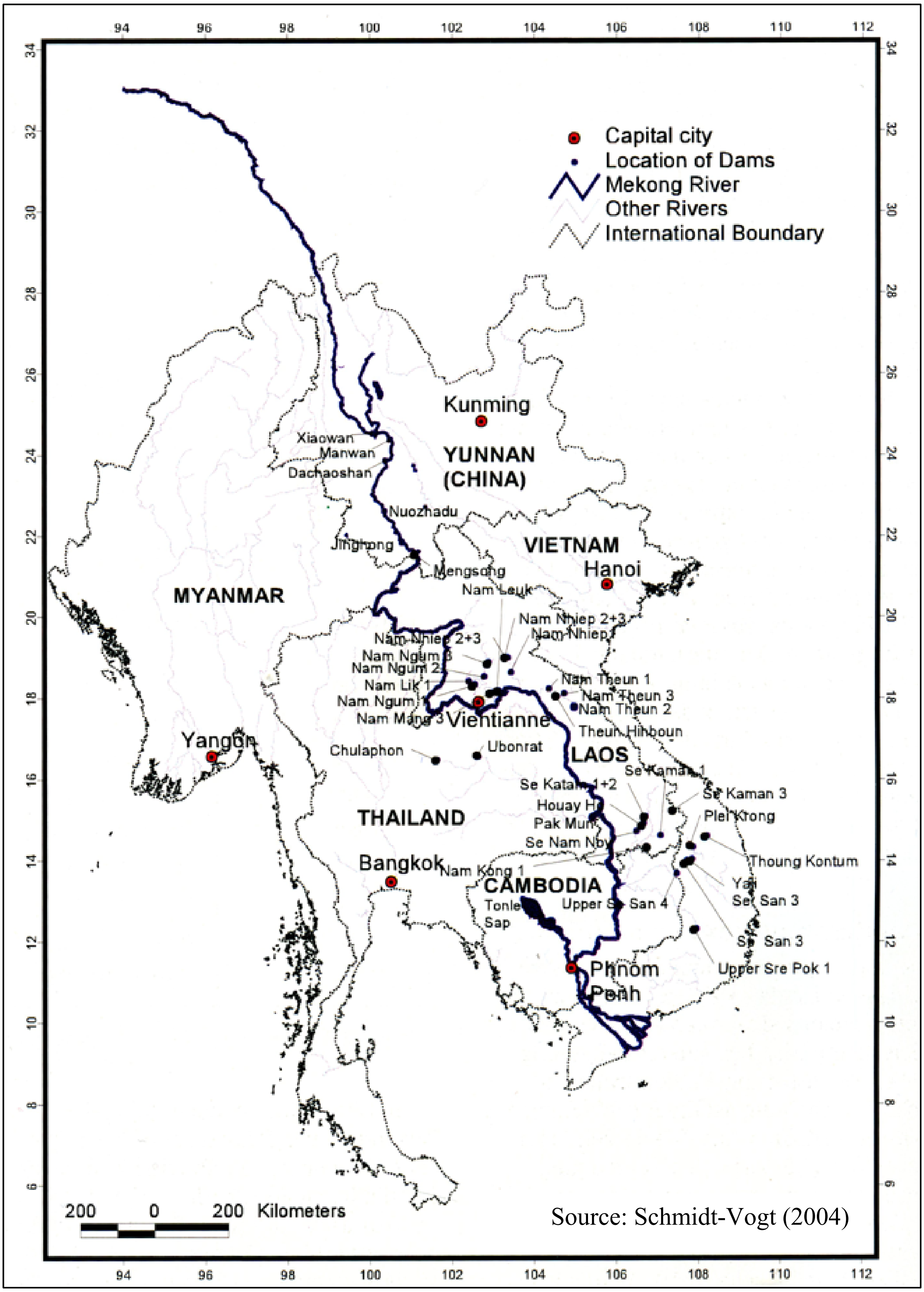
6: GENERAL DISCUSSIONS AND CONCLUSIONS

6.1 Can Tho city, Mekong River and Mekong Delta - The framework of the study

The analysis and evaluation of the planning procedures of the dyke system in the Vietnamese MD regions and the problems of their implementation may be considered as a first attempt for a scientific evaluation of this process. It is at the same time probably the first serious attempt to give voice also to the recipients and potential "beneficiaries" of this huge national endeavour, i.e. the local population and the rural farmers. As has been demonstrated in the previous chapters of this study, the dyke system planning in the MD and the manifold and not always frictionless aspects of its implementation can be considered as an almost ideal example of a modern hydraulic bureaucracy and its questionable overrating of its competences vis-à-vis the demands and experiences of the local people. With other words: dyke system planning and its implementation in the MD of Vietnam is a showcase of top-down bureaucracy versus bottom-up lethargy.

Before going into a closer analysis of our research findings and conclusions to be drawn for the future improvement of dyke system planning and its implementation, it may be appropriate to put our case study into the broader perspective of the whole MR system again. As mentioned in the introductory chapters, this river system is not only one of the biggest on earth, but also a multi-national problem. With a total length of more than 4300 km, a drainage area of almost 800,000 km^2 and an annual discharge of approximately 470 billion m^3, the biggest river system of SE-Asia flows through five countries (China - Thailand - Laos - Cambodia - Vietnam), but also affects marginally and via its tributaries Myanmar. Thus, there are many claims to this river. These are necessarily different, depending on national priorities, but also on topography and water availability. In a generalizing way, interests may be summarized under four predominant options for the use of the MR and its waters: irrigation - flood control - river traffic - energy production. While some of these options do not exclude each other, national governments very obviously have their own priorities. These priorities cause conflicts between governments. The list of dam projects along the MR - finished, under construction or in preparation - shows intensity and purpose of MR water uses. While China and the upper reaches of the MR focus their activities - due to topography and national priorities - mainly on energy production, the altogether 18 projects in Laos and three finished dam sites in Thailand follow combinations of irrigation and comparatively modest energy production (for further details see Schmidt-Vogt 2004, Map 6.1 and Table 6.1).

Map 6.1: Dams in the Mekong River



Source: Schmidt-Vogt (2004)

The fact that out of a total of approximately 60 million people living in the catchment area of the Mekong more than 90% concentrate on the lower MR basin (Thailand, Laos, Cambodia, Vietnam) is reason for different development strategies in these countries compared to China. In Vietnam, due to its location in the lower part of the MR and a corresponding topography, dams have to be lower and the production of hydro-electricity is comparatively low. The more important, however, are the functions of Vietnam's reservoirs for flood control and irrigation - with effects and consequences indicated in Chapters 3, 4 and 5 of this study.

Table 6.1: Dam projects along the Mekong River

Country	Project	Capacity (in MW)	Status
Yünnan, China	Xiaowan	4,000	*Feasibility study*
Yünnan, China	Manwan	1,500	Finished 1993
Yünnan, China	Dachaoshan	1,500	Finished 2001
Yünnan, China	Nuozhadu	5,000	*Pre-feasibility study*
			Operational by 2014
Yünnan, China	Jinghong	1,500	Operational by 2013
Yünnan, China	Mengson	No data	No data
Laos	Nam Nhiep 2+3	565	*Feasibility study*
Laos	Nam Nhiep 1	440	*Pre-feasibility study*
Laos	Nam Ngum 3	460	*Pre-feasibility study*
			Operational by 2008
Laos	Nam Ngum 2	615	*Pre-feasibility study*
			Operational by 2008
Laos	Nam Lik 1	100	*Feasibility study*
Laos	Nam Ngum 1	150	Finished 1971
Laos	Nam Mang 3	60	*Pre-feasibility study*
Laos	Nam Leuk	60	Finished 2000
Laos	Nam Theun 1	800	*Feasibility study*

			Operational by 2012
Laos	Theun Hinboun	210	Finished 1998
Laos	Nam Theun 3	237	*Feasibility study* Operational by 2016
Laos	Nam Theun 2	1088	Operational by 2008
Laos	Se Katam 1+2	130	*Pre-feasibilty study*
Laos	Houay Ho	150	Finished 1999
Laos	Se Nam Noiy	372	Under construction
Laos	Nam Kong 1	240	*Pre-feasibility study* Operational by 2012
Laos	Se Kaman 1	363	*Feasibility study* Operational by 2010
Laos	Se Kaman 3	308	*Pre-feasibility study* Operational by 2012
Thailand	Chulaphon	40	Finished 1965
Thailand	Ubonrat	25	Finished 1968
Thailand	Pak Mun	136	Finished 1994
Vietnam	Upper Se San 4	No data	*Pre-feasibility study*
Vietnam	Plei Krong	170	*Feasibility study*
Vietnam	Thoung Kontum	No data	*Pre-feasibility study*
Vietnam	Yali	900	Finished 1996
Vietnam	Se San 3	220	*Feasibility study*
Vietnam	Upper Sre Pok 1	No data	*Pre-feasibility study*

Source: Schmidt-Vogt (2004)

As a result of this short overview, we have to state that our research area, the MD and Can Tho city, is only a very small section of the total MR system. In agricultural terms, however, the MD is its most important part. It is Vietnam's food basket. As such, its development and functioning is of central importance for the country - and the new dyke system is considered to be an essential improvement by the Vietnamese government to maintain and strengthen this function.

6.2 Dyke systems in the Mekong Delta: Lessons learned and lessons to be learned

It is before these backgrounds that the following discussions and conclusions of our study should be seen. In the introductory Chapter 1, a central research question as well as a hypothesis have been formulated. Before giving answers to the central question and before discussing the validity of our hypothesis, however, special attention should be given to those three sub-questions that have been, more or less, a guiding principle of our research.

(iv) Sub-question I: How was the decision-making of the governmental dyke system planning made within the given institutional structures? - Who was involved in this decision-making?

Before going into somewhat detailed answers to these questions, it should be noted that there are a number of flood control theories and measures. The theories are mainly concerned with sustainable flood management and flood risk reduction in the floodplains. These theories have as their predominant goal to transform flood control measures into integrated flood management approaches in order to ensure sustainable development in economic, social and environmental aspects. In practice, the majority of developed and developing countries have applied structured flood measures to manage water and reduce flood risks to the flood affected communities. Developed countries such as Japan, America, Germany and Netherlands have, of course, much better capacities and technological knowledge to control and to manage floods as well as water quality in the protected floodplains than developing countries like Vietnam, Lao, Thailand, Bangladesh or China. However and nevertheless, many countries in the world have decided to live with and adapt to floods rather than to struggle against them (see Chapter 2). Our research area is a good example of how one tries to control the advantages and disadvantages of floods in such a way that the benefits of the floods are still maintained.

Therefore and in contrast to many flooded regions in the world, floods in Can Tho and in other floodplains of the MD offer a great number of advantages to the life and livelihoods of inhabitants in the floodplains, although they can also cause disasters to agricultural production, infrastructure and life of inhabitants (see Chapters 2 and 3). Hence, the

Vietnamese government decided to build dyke systems that reduce flood risks with disastrous consequences for land and people, but which - at the same time - ensure agricultural development and human safety in the floodplains. Therefore, the dyke system was prioritized in comparison with other flood control measures in Can Tho city.

Governmental organizations were instructed to develop concepts and designs of a dyke system to be implemented, in which the expectations and experiences of the local people of the flood-affected communities, however, were not involved. While on a global scale, strategic goal setting is the policy management process to determine a desirable state of the water system based on a broad consensus of a great number of parties involved and affected (Pahl-Wostl et al. 2010) this process is different in Vietnam. The planning policy is entrusted to the National Assembly and the final decision and approval rights are carried out by the government and its relevant ministries. Afterwards, details of planning and implementation are transferred to the central planning organizations. Local organizations from city to commune levels have no rights whatsoever in the dyke system planning. The central planning organizations were and are fully in charge of designing and developing the dyke system submitting the final report back to the National Assembly before it gets the decisive approval of the governmental ministers. Thus, it is obvious that the central political institutions have the full decision right, that none of these steps has been decentralized to lower levels and that local communities have never been involved in any of the top-down decisions.

With regard to planning in Can Tho city, the dyke planners did not consider any of the vulnerable groups, experience and expectations of the flood-affected communities. Their main purpose was to control floods and flooding levels and prevent flood risks within the city rather than to listen to the ideas of local non-planning organizations. Only the contributions of a few important political institutions of the city such as DARD and the People's Committee were heard. Another considerable problem was and is that there are overlapping tasks and functions of governmental organizations in the dyke system planning. Planners never had full planning authority to decide independently, but they had to depend on the agreement of many other political organizations from central to local levels. Practically, MARD was commissioned to set up the dyke system planning in Can Tho city, however, MARD had to ask for the approval of its plans by MoNRE, the organization in charge of managing natural land and water resources and controlling land

and water use plans of the city (see Chapter 3). Thus, the overlap of task and function caused complex procedures and bureaucratic obstacles to the dyke planners.

In summarizing our observations and experiences, we have to state that the organizational process of the whole dyke construction in the MD is not only a highly bureaucratic one, but also a procedure that is characterized by almost one-way top-down decisions. Even if we have to acknowledge that "state management is in transition" (Waibel 2010) and that the hydraulic bureaucracy is undergoing careful adaptations to the needs and necessities of the presence (Evers and Benedikter 2009), we nevertheless have to accept the persistence of traditional structures as they were identified long ago (Wittfogel 1957). Even the establishment of new "strategic groups" cannot prevent the persistence of the typical top-down structures that are so closely connected with hydraulic societies.

With regard to our own experiences in Can Tho city and as a response to our self-imposed question we have to conclude that a considerable constraint in the dyke system planning is the lack of democracy at local levels. Participation of civil society in planning, decentralization and devolution of many areas of natural resource policy and decreases of state responsibility are an international trend, because democratic decentralization is more efficient and equitable than state-centered control (Lane 2003). However, in Can Tho city and the MD, the political influence and decision-making of central governmental organizations are strongly dominating in all social and public aspects. Rights and benefits of the flood-affected communities rely entirely on the decisions of governmental planning and political organizations, while local people and organizations of local character are not considered. This monopoly in the centrally organized system of dyke planning and implementation offers, of course, favorable opportunities for the planning organizations, which are hardly controlled by bodies outside the system and which benefit from the central investment budget for the national dyke system planning and practice. Thus, corruption can easily develop and become part of the bureaucracy mechanisms during dyke system planning formulation. The answer to our question is that the governmental organizations have played the central role in the dyke system planning in Can Tho city. The decision and planning rights mainly concentrated on the central planning organizations and lacked democratic participation at local levels. Governmental organizations created, dominated and controlled the political monopoly, thus causing gaps or implicit conflicts between local people representing the bottom stratum of the whole process, and governmental planning organizations as the top-down bureaucracy.

(v) Sub-question II: How was the dyke system planning implemented in the flooding areas? - What were the barriers and constraints in the process of the governmental dyke planning implementation in the flooding areas?

As a result of our in-depth analysis of the implementation process in Can Tho city and in our two case study communes, we have to conclude that conflicts between central institutions and local communities exist. However, they have never really come to the surface due to the given distribution of power structures. The fact, however, that there are contradictory perspectives and perceptions between central dyke planners and local people in the flooding context of Can Tho city is beyond doubt. As discussed above and presented in previous chapters, the central planners were mainly concerned with flood risk reduction for agricultural production and life safety of the flood-affected communities but did hardly consider social and economic aspects of the vulnerable groups and the consequences of sustainable agriculture development in the floodplains for the members of these groups.

In summarizing our experiences in Can Tho city and Thanh Thang resp. Thanh Phu, we have to come to the conclusion that it is difficult to evaluate the pros and cons of the final results. Fact is that the government experts predicted that the dyke system would change flooding levels after its completion in the floodplains. However, the negative impacts of the dyke system to ecosystem, water quality and natural resources exhaustion were not considered carefully enough causing new and additional constraints for the representatives of the most vulnerable groups. Contrary to the perspectives of the central planners, local farming communities and researchers wanted to maintain the advantages of annual floods, that is to improve soil fertility, field hygiene and natural fish sources protection. This plea for the conservation of traditional structures in combination with new and innovative improvements of the whole hydraulic situation was fundamental to many local farmers who have lived with floods in the past and who were fully aware of the important role and benefits of floods for their agricultural livelihoods and ecosystem in the floodplains. Therefore, they were interested in living with floods and finding ways to avoid flood risks, but not floods as such. local researchers did not see any contradictions in combining sustainable agricultural development with maintaining the advantages of floods, the effective usage of land and water as well as the employment of local people. Generally, local farming communities and researchers in Can Tho city argued that central dyke system design was not actually in accordance with the practical needs of local people and their livelihood strategies. According to the central dyke system planning, both low and high dykes were designed to the specific needs in the floodplains of Can Tho city. The high dykes were designed to protect the shallow floodplains, while the low dykes were designed for the deep floodplains. High dykes were planned to be built in large areas whereas low dykes were planned for smaller areas. In reality, however, only low dykes were constructed in the floodplain with the exception of O Mon – Xa No sub-floodplain. So, low dykes were constructed in almost all the floodplains of the city (see Chapters 3, 4 and 5). However, O Mon – Xa No dyke system was a great conflict between local people and the planners because of its negative impacts.

High dyke construction requires high investment costs that exceeded the capacity of district and local communities. It caused losses of large farming areas, increased water pollution, decreased natural fish resources and led to soil fertility reduction together with the adverse changes of inundation compared to low dykes. In contrast, low dyke construction saves investment costs while still ensuring safety for rice production, maintaining the advantages of floods and causing less negative impacts on the ecosystem. Many conflicts and frustrations could probably have been avoided if central planners had carried out public meetings at community level and listened to contributive ideas and experiences of rural inhabitants, local researchers and other professional organizations. It is therefore not surprising that the participatory absence of local organizations and local communities led to conflicts between central and local levels. In practice, local people favoured low dyke systems to control floods in the floodplains as an appropriate measure to ensure the traditional advantages of land and water management. In order to meet the practical needs of local communities, therefore, local organizations of district and communes set up a new dyke plan based on the participation of local communities. Content and design of this dyke system at district and commune levels seemed to meet the practical needs of the flood-affected communities. Thus, some democratic elements have played a certain role in the process at district and commune levels. However, dyke system construction at local levels was not in accordance with the central dyke system planning.

(vi) Sub-question III: How have farmer communities adapted to floods before and after the dyke system was constructed in the floodplains? - What are the assessable perceptions of farmers on the applicability and impacts of the dyke system in the protected floodplains? - Who are beneficiaries from the dyke system?

As indicated especially in our research results on the communal level, farmers have always lived with floods in the MD. In Thanh Thang and Thanh Phu they have experienced catastrophic events as much as the benefits of the traditional flooding regime of the MR. And also after dyke construction they have experienced positive as well as negative results of the new situation. So far, however, the local farming communities have always succeeded to cope with the changing situations and to adapt to them. This observation holds also true for the present time and it includes awareness of the successes and failures of the dyke system in Can Tho city. In regard to the success of the dyke system, it has positively contributed to the rural socio-economic and agricultural development in the floodplains of the city for a number of reasons. Firstly, the dyke system has prevented flood risks and has ensured safety to life and agricultural livelihood of the rural people. Rice crops have been protected successfully since the dyke construction. Evidence has shown a reduction of flood damages from 2000 and 2007, especially in regard to agricultural production and infrastructure. Thus, the basic flood security and income of rural households and families were stable compared to the previous flooding situation without the dyke system. Thus, the dyke system has positively contributed to controlling floods, reducing their risks and ensuring the flood security for at least the population living in the floodplains of Can Tho city. Secondly, the dyke system has created favorable opportunities for the local organizations to develop new land use models for the floodplains of Can Tho city. The agricultural farming land has been planned to meet specifically the socio-economic development demands of the city at present and in the future. This means that the agricultural farming land of the city will be reduced considerably until 2020, while aquaculture and industrial development land will be increased, and the size of the industrial land will actually double by 2020 (for details see Chapter 3). Thus, the land use strategy has been oriented towards transforming rice farming land into aquaculture and industrial development. It remains to be seen to what extent this transformation process will be able to improve the local economy and to create new jobs for the urban and rural poor. Thirdly, the new dyke system has offered favorable opportunities for farmers to transform their agriculture from mono-rice crops into integrated farming models. Besides the introduction of new rice varieties, the integrated farming models have enabled farmers to also raise fish and shrimps in their fields during the flooding time. Thus, farmers can cultivate from two to three rice crops and raise fish together with the rice farming. Fourthly, the new dyke systems have created favorable advantages for the rural infrastructure development in Can Tho city. Traditionally, the rural infrastructure systems were undeveloped in the floodplains. Almost all roads were usually flooded during flooding time. Therefore, rivers and canals served as major transportation routes for local people in the flooding period. The majority of local people had to use boats as daily means of transport in the rural areas. After the construction of the high dyke system, the majority of rural roads were upgraded along primary and secondary canals. In recent years, the rural road system has connected all rural settlements within Can Tho city and with other provinces located in the Western areas of the Bassac River. In addition, a number of the high dykes have been upgraded and they serve as safe residential clusters for those poor people who used to suffer from the annual flood impacts. So far, 25 residential clusters with 2,835 houses have been constructed to provide safe shelter. A final positive result of the dyke construction is the fact that a number of canals and rivers were excavated to discharge floodwater during flooding time as well as to improve the waterway systems.

Our research on the regional level of Can Tho city (Chapter 4) and in the two communes of Thanh Thang and Thanh Phu has shown that, besides the advantages just mentioned, there are also failures of the new dyke systems. And these failures are not only well known to government officials, but even more so to the local farmers and communities. One of the main problems is that the new dyke systems have changed the inundation levels among floodplains in Can Tho city. There are two reasons for this deficiency. First, the sluices in the dyke system have not yet been built properly to control inlet and outlet of waters in the protected floodplains and the exchange of this water with canal and river systems during the flooding time. Secondly, the dyke system along the rivers and canals caused a rise of the water level in these rivers and canals, thus leading to inundation of the protected floodplains. In addition, the considerable floodplains along Bassac River and the center area of Can Tho city were flooded deeper between September to November from 2004 to 2007 compared to the flood situation before 2007 (see Chapter 3). Previous studies (Le Thi Viet Hoa et al 2008) found that the changes of infrastructure from 1996 to 2002 had massive effects on the flood regime. The dyke system along rivers, canals and roads reduced the drainage of floodwater in the paddy fields. Inundations last from 5 to 10 days with varying depths from 0.2 to 0.3 m in some regions near or between high embankment systems. The dyke system in the upstream provinces decreases the inflow and increases the water flow to the canals. Thus, the dyke system is one of causes affecting the flood regime and the inundation levels among floodplains. It has caused unpredictable impacts in the protected floodplains of the city. Besides, the new dykes contribute to a considerable reduction of natural fish resources because the dykes have prevented the migration of natural fish from rivers and canals into the protected flooding plains. Also the intensified rice cultivation between June and September reduced the living environment of natural fish species in the protected floodplains. It were especially the high dykes that have caused these reductions whereas the low dyke systems in Can Tho city were not affected that severely. However, the dyke system was also one of the causes leading to water pollution and soil fertility reduction. If we add the erosion of rivers and canals that has happened in Can Tho city, then we have a negative list of the dyke construction measures that has to be set off against the advantages mentioned before.

Comparing advantages and disadvantages one has to acknowledge that the positive aspects prevail. This judgment is also substantiated by our own observations and research results in the two case studies. On the one hand, the new dyke system offers favourable opportunities for the farming communities to adapt better to floods and to avoid flood risks for rice production. This must be considered as a great success of the dyke system apart from a number of its failures mentioned before. This conclusion refers especially to the economic changes in Can Tho city; the social aspects may be seen somewhat differently. Although the comparative evaluation of the pros and cons of this big national endeavour does not necessarily answer our sub-question III, it gives a clear and positive reply to the overarching question raised on page of this study: Yes, the dyke system must be considered as a relevant flood control measure to mitigate flood risks and to improve rural livelihoods, although additional endeavours are needed in regard to social and environmental improvements.

6.3 Conclusions and suggestions for future improvements and research

Altogether, one may summarize that the Vietnamese government identified correctly the practical needs of local people in the floodplains of Can Tho city. The governmental decision to construct the dyke system is a correct one in order to guarantee safety for agricultural livelihoods of the flood-affected communities in the floodplains. However, there were and are problems in the process of dyke system planning and its implementation. This has caused conflicts between local people and central dyke planners. One may call it with good reason a lack of democracy in the dyke system planning and implementation process. On the other hand: one lesson to be learned is that, because of the overall positive effects of the dyke construction, an opening of discussion and the inclusion of the bottom-up groups would cause additional positive results and diminish conflicts between the central dyke planners and local people. Thus, democracy is a necessary precondition in future planning practices in order to ensure benefits for both sides, that is for governmental organizations and local people.

Grassroots democratization and participation had, to a certain degree, been included in the process of dyke system planning and implementation. In future, inhabitants and local organizations should be much more involved in decision-making processes. Governmental planning has to observe the participatory rights of the flood-affected communities. Local people, villagers and local organizations have the right and also the knowledge to discuss and to take part in the decision-making processes concerning their own interests, responsibilities and benefits in the given floodplains. Thus, the collaboration between the central organizations and local people must become a significant factor to reduce conflicts between central and local levels. This means that, in concrete terms, the dyke system planning needs to be based on a broad participatory foundation in order to increase the transparency of goals, planning contents, budget and expected results and outcomes of government and planning organizations. The implementation guidelines must be disseminated to each level from central to local communities. Besides, additional experiences by local people regarding the dyke planning must be considered and incorporated adequately in order to achieve wide consensus and basic agreement in the dyke system planning and implementation processes. With other words: the role and responsibility of local people should be included in governmental policies in order to reduce conflicts between governmental organizations and local people. The contributions of locals should be perceived by government organizations not as criticism, but as opportunities to control and to improve weaknesses in the process of policy implementation. Furthermore, they could and should serve as a means to control power abuse and corruption in the governmental organizations at each level. Democratization should be considered and applied widely in all governmental activities to ensure equal participation rights, interests and benefits from central to local levels. The inclusion of local expertise is not only a relevant and practical demand, but it can also contribute to control.

With regard to the ecological aspects of hydraulic engineering in the MD, we have to recall that the construction of the dykes has also to be seen as a contribution to the MDG by the Vietnamese government. While economically parts of these goals have been achieved, socially and ecologically new problems have been created and need to be improved. As mentioned before, the dyke system planning was primarily focused on hydraulic technology aspects to control floods and reduce risks for the local people in the floodplains. The technological details of the dyke system were based on the professional knowledge and experiences of hydraulic engineers who were successful in the pursuit of their specific tasks. But were they also successful in ecological terms? Our research in Can Tho city, in Thanh Thang and Thanh Phu has shown that the new dykes have caused a number of new problems which need to be addressed. Besides increasing problems of erosion, which can potentially be solved by additional engineering interferences, there are other setbacks. They include a dramatic increase of land and water pollution as a result of the use of agrochemicals of all kinds. But they also refer to the decrease of natural fish resources and so on. A lesson to be learned from these negative side effects is the necessity of closer cooperation not only between different experts in land and water management. Beyond hydraulic engineers, especially ecologists, biologists, plant and soil scientists as well as agricultural experts with different backgrounds have to cooperate to tackle these newly developing problems. A solution would be to establish an agricultural extension service which consists of both professional experts and local farmers with the purpose to solve problems jointly and to give advice to the local farming communities in order to reconcile economic and ecological aims and goals of the dyke systems and their effects.

A final aspect of our conclusions and suggestions for future improvements of livelihood and well-being of the local households refers to the social impacts of the dyke systems in Can Tho city and the MD. Our interviews and investigations in the two case study communes have revealed two aspects which future planning as well as future research should take up for further consideration. One aspect is the widening gap between the better-off farmers and the poor members of the communes with little land of their own and little access to other resources. The latter group actually is severely affected in a negative sense, because their access to improved farming techniques, new rice varieties or agrochemicals is very limited or impossible; besides, this group has been deprived of its traditional casual emoluments, i.e. the catch of natural fish during flooding seasons. It is a political decision that the government has to take: Is the widening gap between “rich” and “poor” an option under the given political circumstances? And: Is the development of a rural “underclass” without access to basic services and natural resources a desirable development or not? If not, then the responsible political organizations have to take care of these inappropriate side effects of the dyke system policy!

The other and second aspect concerns the envisaged changes of land use until the year 2020. The very fact that large amounts of agricultural land will be transferred to urban and industrial uses (see Chapter 3 and Chapter 6.2) will be connected with the creation of new employment opportunities. A considerate social policy by the central government and by the regional administrations must use these scenarios for the creation of new jobs, which should be available also and especially for the underprivileged inhabitants of the rural communes. The construction of rural infrastructure – roads and highways, bridges, residential and industrial premises etc. – offers a wide variety of possibilities to include the rural poor into the benefits of the future socio-economic development of the MD and its people.

Our research has shown that the MD and its people are undergoing deep changes. In short, one could say that Can Tho city has been transformed from a rural society living with the natural regulations of floods into a society of human-controlled regulations of the MR in the long term. And these developments and trends will continue. Until 2020 the area of agricultural land will be diminished in favour of industries and urban residential areas. Therefore, the new challenges and risks that have appeared as a result of human interventions into the natural regimes and cycles of the MR and the MD, are threatening the sustainable development and life of natural ecosystems and human habitats. The dyke system has solved the practical problems of farmers by controlling the floods and thus has obtained short-term benefits. However, its negative impacts are a threat for sustainable development in the long term, especially whenever floods will rise and inundate all dykes. Therefore, a close observation of the dyke systems in the Mekong Delta will be an indispensable task also for the future. And additional research on questions of how to improve the effects of the dykes for nature and society will remain an equally indispensable challenge.

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Eidesstattliche Erklärung

Hiermit erkläre ich and Eides statt, dass ich für meine Promotion mit dem Titel “Planning and Implemantation of the Dyke Systems in the Mekong Delta, Vietnam” keine anderen als die angegebenen Hilfsmittel benutzt habe, und dass die inhaltlich und wörtlich aus anderen Werken entnommenen Stellen und Zitate als solche gekennzeichnet sind.

PHAM Cong Huu