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# Water Engineering, Agricultural Development and Socio-Economic Trends in the Mekong Delta, Vietnam

Klaus Vormoor

List of Charts, Tables and Figures	ii
Abbreviations	iii
Abstract	iv
1 Introduction: Background and Motivation	1
1.1 The Mekong Delta: A geographical brief	1
1.2 Data sources and methodological approach	3
2 Water engineering and agricultural development in the Mekong Delta	4
2.1 A historical outline	4
2.1.1 Pre-colonial time	4
2.1.2 French colonialism	4
2.1.3 Phase of the divided nation	5
2.1.4 After the re-unification	5
2.2 Recent trends in agriculture	10
2.2.1 Are there Changes in Agricultural Business Size?	10
2.2.2 Paddy Cropping Patterns	10
2.2.3 Diversification in agriculture	11
3 Recent socio-economic trends in the Mekong Delta	14
3.1 Industrialization and Urbanization	14
3.2 Employment, Income, and Education	18
3.3 Poverty	21
3.4 Migration	24
4 Conclusions	27
References	29
Appendix	32

## List of Charts, Tables and Figures

Figure 1: The Mekong Delta Provinces divided into hydrological regions	2
Figure 2: Map on Industrialization in the Mekong Delta Provinces between 2000 and 2007	15
Figure 3: Incidence of Poverty in the Mekong Delta communes in 1999	23
Figure 4: Net-migration rates in Mekong Delta provinces and Ho Chi Minh City in 2006	25
Chart 1: Gross output of paddy in the Mekong Delta between 1975 and 1999 in thousand tons	6
Chart 2: The three-years moving average of agriculture output in the Mekong Delta provinces between 1985 and 2007	8
Chart 3: Regression Analyses between the output in agriculture and the number of pumps and the threshing machines	9
Chart 4: The three-years moving average of aquaculture output in seven provinces having the highest aquaculture output in the Mekong Delta	12
Chart 5: Change of Structure of population by residence form in the Mekong Delta between 1995 and 2008	17
Chart 6: Urban, rural and total population growth rate in the Mekong Delta between 1995 and 2007	18
Chart 7: Employment share by economic sector in the Mekong Delta between 2000 and 2007	19
Chart 8: Poverty rate in the Mekong Delta provinces compared to the delta wide and national average in 2006	22

## Abbreviations

ASS	Acid Sulphate Soils
AusAID	Australian Government's Overseas Aid
GDP	Gross Domestic Product
GoV	Government of Vietnam
GSO	General Statistics Office
HCMC	Ho Chi Minh City
HYVs	High Yield Varieties
MARD	Ministry of Agriculture and Rural Development
m.a.s.l.	meter above sea level
MKD	Mekong Delta
MRC	Mekong River Commission
NCFAW	National Committee for the Advancement of Women
PO	Poverty Incidence
RVN	(former) Democratic Republic of Vietnam
VND	Vietnamese Dong
WB	World Bank

## Abstract

During the last decades, the Mekong Delta in Vietnam was one of the most productive and fastest growing agricultural areas in the world and even today, growth in agriculture still lasts. This paper illustrates the evolution and changes of agriculture closely linked to the development in water engineering in the Mekong Delta. It becomes apparent that the massive growth in agriculture during the last decades is not just the result of economic reforms in Vietnam but also depends significantly on contemporary and historical development in water engineering. Furthermore, this paper sketches recent socio-economic trends as industrialization, urbanization, poverty and migration, which shaped patterns that are partly linkable to water aspects in the Mekong Delta. For example, it could be detected, that the spatial proximity to the Mekong River main channels seems to be an advantageous factor for socio-economic development.

Last but not least, this paper also shows that comprehensive and coherent analysis of secondary statistical data in Vietnam is only possible to a limited degree, since data from various data sources and different administrative levels do not always offer coherence and thus do not often allow comparative statistical analysis.

Keywords:

Water engineering, agricultural development, socio-economic trends, statistical analysis, Mekong Delta, Vietnam

# 1 Introduction: Background and Motivation

The Mekong Delta is one of the most productive agricultural areas in the world. This is especially the result of an extraordinary development in agriculture during the last decades. While in the 1970s a situation close to famine occurred in the Mekong Delta, today the region is crucial for Vietnam's food security and it has become the second biggest rice exporter in the world (Miller 2003: 4). More than 50 % of the national rice production occurs in the Mekong Delta and about 80 % of the total exported rice from Vietnam stem from the Mekong Delta. The agricultural success story in the last decades is primarily the result of economic liberalization reforms in Vietnam, the development in rice farming systems, and the long term development of water management facilities. Irrigation and water control projects were fundamental implementations, which promoted the extension of agriculture production both spatially and with regard to efficiency. However, due to the implementation of these projects, a considerable interruption of the natural hydrologic regime has taken place. Moreover, intensification in agricultural production connected with a massive application of chemical fertilizers and pesticides led and still lead to considerable environmental problems such as water and soil pollution and appear to emerge as a serious threat to human well-being as well.

Most publications about the development of the Mekong Delta are published by economists and agrarian scientists or research groups. Since a couple of years though, the number of publications focusing on the side effects and consequences of the economic growth in the Mekong Delta on the natural environment is increasing (e.g. Hashimoto 2001, Ngyuen et al. 2007). However, there have been only a few efforts dealing with the impact of the recent economic growth in the Mekong Delta on the socio-economic landscape within this region. To some extent, there are publications on selected social topics such as migration or poverty. However, it is rarely the case that these issues are connected with water aspects, although water is a dominant factor and supposed to have great influence on livelihoods in the Mekong Delta. Remarkable exceptions dealing with overall socio-economic issues and addressing the connection to water are publications by Miller (2003), Käkönen (2008) and Käkönen et al. (2006).

This paper aims to illustrate the agro-economic development in connection with water engineering development and its impacts on the socio-economic situation. Thus, a historical outline of the agricultural development in the Mekong Delta will be presented, closely connecting to the development in water engineering over time. By that, it becomes apparent that changing values, perceptions or functions of the resource water influenced both the farming and living system in the Mekong Delta. Finally, the most recent trends in socio-economic development and its inter-correlation will be outlined and set into connection with water aspects. A second objective is to explore the possibilities of a systematic analysis of secondary data, reports and surveys of Vietnam's statistical offices and other agencies at different administrative levels.

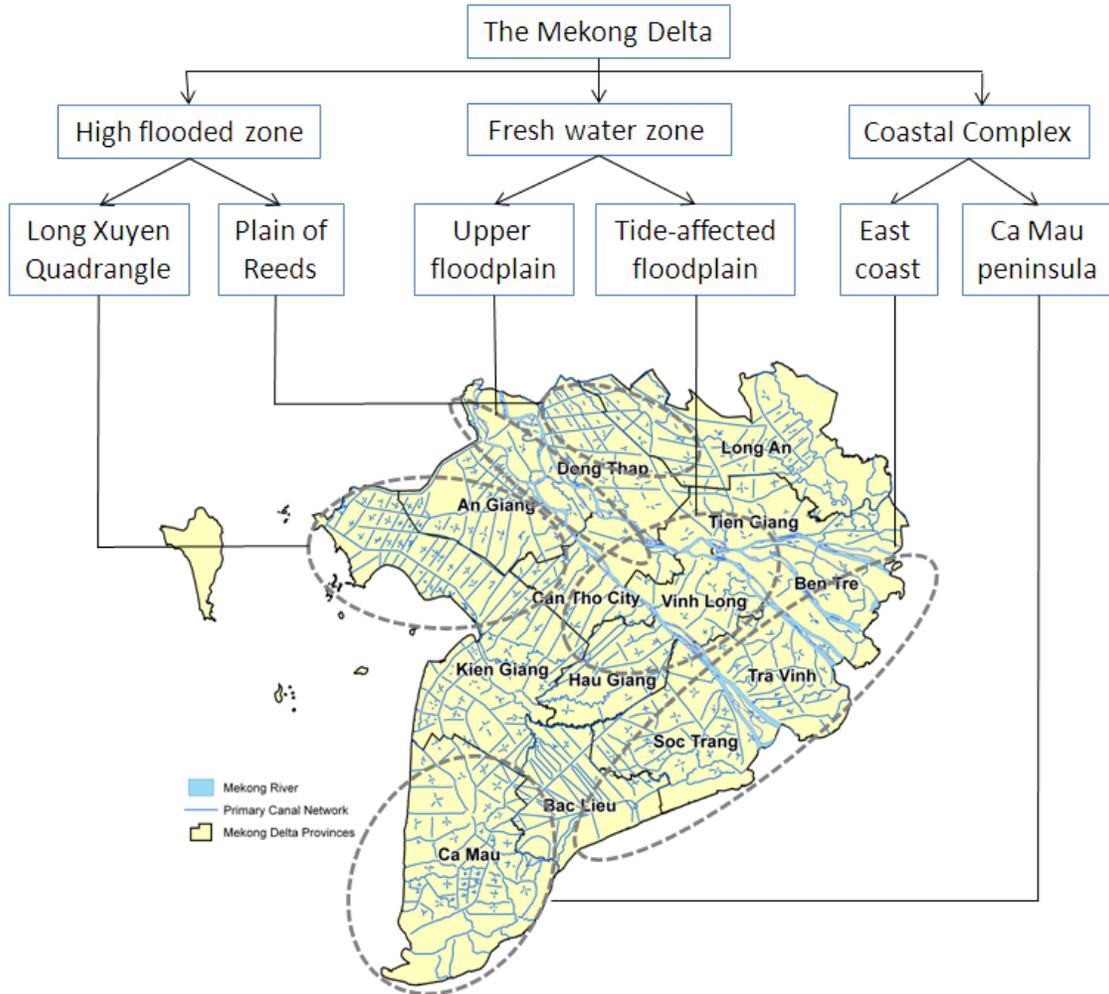
## 1.1 The Mekong Delta: A geographical brief

The delta of the Mekong River covers approximately 55,000 km<sup>2</sup> and is one of the largest river deltas in the world. The uppermost boundary of the delta is defined by the confluence of Mekong and Tonle Sap Rivers in Cambodia. The Vietnamese part of the Mekong delta (termed in the following as 'Mekong Delta') is defined as the lower part of the Mekong River delta, covers the larger part of the delta (about 39,000 km<sup>2</sup>) and is one of the largest coherent agricultural regions in South East Asia.

In the course of Holocene landscape evolution, marine transgressions and regressions as well as alluvial sedimentation under terrestrial conditions have created a vast depositional flood plain (0-4 m.a.s.l.) with rich and fertile alluvial soils (Hashimoto 2001). In combination with humid tropical climate conditions and the omnipresence of water due to the Mekong River branches, the Mekong Delta provides favorable natural

conditions for agriculture, especially along the alluvial floodplain. Following Le et al. (2007: 26) and Kono (2001: 71 ff), the Mekong Delta can be divided into three major hydrological regions which provide both favorable and also limiting factors for agricultural production [Fig.1].

Figure 1: The Mekong Delta Provinces divided into hydrological regions



Source: own drawing modified from Le et al. 2007, completed with information from Kono 2001.

The Long Xuyen Quadrangle and the Plain of Reeds are flat low lands building the 'high flooded zone', which is inundated during the rainy season (June-November) and complements freshwater shortage in the dry season (December-May). They are also characterized by acid sulfate soils (ASS), which are toxic soils with high iron sulfate content. The 'freshwater zone' is defined by the upper floodplain and the tide-affected floodplain between both main branches of the Mekong River (the Tien and Hau Rivers). Both regions are governed by the hydrological regime of the Tien and Hau Rivers. In the tide affected floodplain, the river water level fluctuates according to tidal fluctuations except for the high flood period of the Mekong River during the rainy season. Therefore, in the 'freshwater zone', a year-around supply of freshwater is given (Kono 2001: 72). The coastal complex is occupied by the east coast of the delta and large parts of the Ca Mau peninsula. Their hydrological system is governed by the sea through saline water intrusion especially during the dry season. About 50% of the Mekong Delta coastal complexes are significantly affected by salinity intrusion (Le Anh Tuan et al. 2007: 26).

## 1.2 Data sources and methodological approach

This paper is built upon a literature review and a comprehensive statistical analysis of secondary data from various sources. Most of the statistical data was collected within the field work of the ZEF / WISDOM researchers.<sup>1</sup> The statistical studies basically contain time series analyses to detect trends and correlation analyses to detect and quantify interdependencies between water engineering facilities, agricultural development and socio-economic conditions. The most important data sources are:

- Provincial Statistical Yearbooks of the 12 Provinces in the Mekong Delta from 2007 (Provincial Statistical Offices 2007)
- Socio-economic statistical data of 63 provinces and cities from 2009 (GSO 2009)
- Statistics of Agriculture and Rural Development 1996-2000 (MARD 2001)
- Statistical Data of Vietnam – Agriculture, Forestry and Fishery 1975-2000 (GSO 2001a)
- The 2001 Rural, Agricultural and Fishery Census (GSO 2001b)
- The 2006 Living Standard Survey (GSO 2007a)
- The 2006 Population Change, Labour Force and Family Planning Survey (GSO 2007b)
- The Gender Statistics Book (NCFAW 2004)

The information from these different sources were combined to assess recent trends in agricultural development, water engineering efforts, the socio-economic situation and their inter-correlation in a quantitative manner. The findings also indicate general development trends in the Mekong Delta. However, some biases and problems limited the analyses and the level of detail of this paper. These limitations are as follows:

- (1) Availability and accessibility of data: The General Statistical Office (GSO) provides large extent of print data as well as digital data on the internet. Print data, in particular provincial or district reports, are only accessible locally at the corresponding statistical offices. Furthermore, GSO publications of statistical data or surveys are released only in very limited quantities, which means that some editions may not exceed 500 copies. These copies are available as long as the supply lasts and can be purchased at the publishing house in Hanoi. Bookshops generally don't provide GSO publications, nor do other GSO offices in the country. The latter sometimes offer services to make photocopies, if the desired statistics are available. Another limitation is that some publications, especially on smaller scale like on district level, are only available in Vietnamese language; these have to be translated laboriously, if the researcher does not have a good command of the Vietnamese language.
- (2) Reliability of the data: Different data sources provide different information related to the same topic. This is particularly the case if the data stems from different administrative levels, e.g. GSO data from the national scale on the same topic and area sometimes differs from data of the Provincial Statistical Offices.
- (3) Integrity of the data: Often the data lacks details that would be desirable for more intensive analyses. Sometimes there was a missing of detail in either the spatial resolution of the data (i.e. for

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<sup>1</sup> The paper is written in the framework of the WISDOM Project (Water Related Information System for the Sustainable Development of the Mekong Delta, Vietnam) and contributes to a set of research activities on the organizational and institutional set-up of the water sector in Vietnam. Important support and feedback to the draft version of the paper came from Simon Benedikter, Sven Genschick and Gabi Waibel. Information on the project design, its objectives, partner organizations and results can be accessed at: <http://www.wisdom.caf.dlr.de>

different administrative units), the temporal resolution (too small time series to detect real trends), or in the informative resolution (too little information to detect regularities).

- (4) Changing administrative units: Due to administrative reforms in Vietnam, the domain and the spatial extent of administrative units are changing. In the Mekong Delta, e.g., there was a reform of re-organizing administrative domains on the province scale in 2003. In the course of this, the former Can Tho Province was split into Hau Giang Province and Can Tho City. On the district level, the Mekong Delta was divided into 145 districts in 2007, while in 2009 the number rose to 147. This leads to problems regarding the comparability and trend detection since data trends are suddenly interrupted and not comparable any longer.

## 2 Water engineering and agricultural development in the Mekong Delta

### 2.1 A historical outline

#### 2.1.1 Pre-colonial time

The settlement history of the Mekong Delta (see map in Annex) starts during the Fu Nan civilization, from the second to the sixth century AD (Biggs 2004: 25). The territory of Fu Nan stretched over today's Cambodia and South-Vietnam. In the Mekong Delta the Funanese settled along the fertile alluvial plains of the Tieng and Hau River and came along with extensive, subsistence farming systems and first small-scale canal construction for irrigation and transport. The Fu Nan civilization was followed by the Chenla and Angkor civilization. Both had their political center in the territory of today's Cambodia. Khmer populations dominated the regions in those days. Today, the Khmers represent only a relatively small group of ethnic minority in the delta.

The first Vietnamese settlers came into the delta in the course of the "Great March South" from the northern and central regions of Vietnam in the 17<sup>th</sup> century. An even more intensive settlement occurred during the Nguyen dynasty in the 18<sup>th</sup> century. This caused the displacement of the pre-existing Cham and Khmer population, as well as a settlement further away from the main channels of the Mekong River due to newly dug canals (Miller 2006: 75).

#### 2.1.2 French colonialism

The onset of the Vietnamese settlement during the Nguyen dynasty in the Mekong Delta is often connected with the start of a period usually termed as "opening-up the delta" (e.g. Miller 2003, Biggs, 2004, Käkönen 2008). This term, however, especially describes a phase of intensive water infrastructure development covering particularly the time of French colonialism (1862-1954).

Water engineering played an important role in the French's strategy to exploit the delta. In 1875, the French Governor founded a permanent commission for the constructions of canals. But this commission primarily followed strategic and military concerns of settlement and transport rather than concerns of irrigation, drainage and flood protection for agricultural development (Miller 2006: 175). Nevertheless, due to these newly dug canals, flood water could arrive in parts of the delta even further distanced away from the main channels and allowed an agricultural growth in these regions. Thousands of migrants followed the dredges, working as tenant farmers on plantations along the main channels. Extensive and adaptive farming systems were still prevailing and cultivation patterns were adapted to the natural water flow in the region. The development of water channels and control constructions for agricultural use were carried out by farmers

individually. They developed small-scale on-farm constructions. The French authorities played only a limited role in agricultural water management (Miller 2003: 181). Regarding to this, Fuhrmann (2008: 25) concluded that “the French administration had no intention to interfere with agricultural water use until the 1930s, but (through the construction of transportation canals) they interfered indirectly with it.”

After the Great Depression in the 1930, the French government in Vietnam recognized the necessity of promoting agricultural engineering in the Mekong Delta. Agricultural engineering became a state policy to increase farmers' income. Water engineering aimed at drainage and irrigation with the intention of building a monoculture rice area. In consequence, in the 1930s, South-Vietnam emerged as one of the most important rice-production regions in the world (Käkönen et al. 2006: 23). However, since the French canal planning was not exclusively aligned to agricultural purposes and knowledge on local hydrological circumstances was missing, problems and complications caused by sedimentation and flooding emerged. Moreover, the restricted French landholding and changes in the production system led to social polarization and social conflicts. The French were definitely not considering local needs but rather pursued their own export-oriented interests. This led to riots by the local people and also partly to the disruption of existing canal networks (Biggs 2004: 95f, Käkönen et al. 2006: 28).

By the end of the French colonial era, a web of 2,400 km of canals were dug with an amount of 180 million m<sup>3</sup> (for comparison: the Panama Canal 210 million m<sup>3</sup>) for the flow of water, goods, and people (Biggs 2004: 108, Miller 2003: 180).

### 2.1.3 Phase of the divided nation

After the decade of the first Indochina War (1946-1954), and the division of the nation into Northern and Southern Vietnam, a shift in agricultural development in the Mekong Delta resulted from the onset of the Green Revolution. This phase is characterized by modernization and the introduction of new technologies including high yield varieties (HYVs) of paddy, chemical fertilizers and pesticides, mechanized land preparation and the first low-lift diesel pumps. In addition, a further extension of the irrigation and drainage canal system was arranged on the local or village scale. The government of the former Democratic Republic of Vietnam (RVN) followed the policy of an extension and intensification of agriculture in the Mekong Delta (Miller 2006: 179). In that course, production surpluses were reached which were intended for exportation. Hence, the time after the Green Revolution marks the beginning of the 'rice-bowl' phenomenon.

The introduction of HYVs offered the opportunity to have yields 1.5 to 2 times larger than with traditional varieties (Kono 2001: 74). However, the upcoming of HYVs also resulted in a decrease of the number of rice varieties from about 1,000 to the present number of less than 150 (Kono 2001: 74). With fast-growing HYVs, the onset of double-cropping became possible, firstly in those areas where the natural water conditions allowed double-cropping (in the tide-affected floodplain). In other areas, however, the spread of HYVs were limited to only about 10-20 % due to inadequate soils and – in those days – missing water control systems (Kono 2001: 74).

The onset of the Green Revolution in the Mekong Delta led to a sudden out-fading of traditional farming systems, replaced by more engineered and mechanized agricultural enterprises.

### 2.1.4 After the re-unification

After the end of the Vietnamese War (or American War respectively), which slowed the agricultural modernization, the communist regime of re-unified Vietnam introduced a central state water regulation management; land was collectivized and private trade was prohibited.

Between 1975 and 1980 steady effort was made in water control and irrigation works. This led to fragmented flood and salinity intrusion control systems on the one hand, and further canal and irrigation works on the other hand. A special focus for irrigation and drainage canal constructions lay in the Plain of

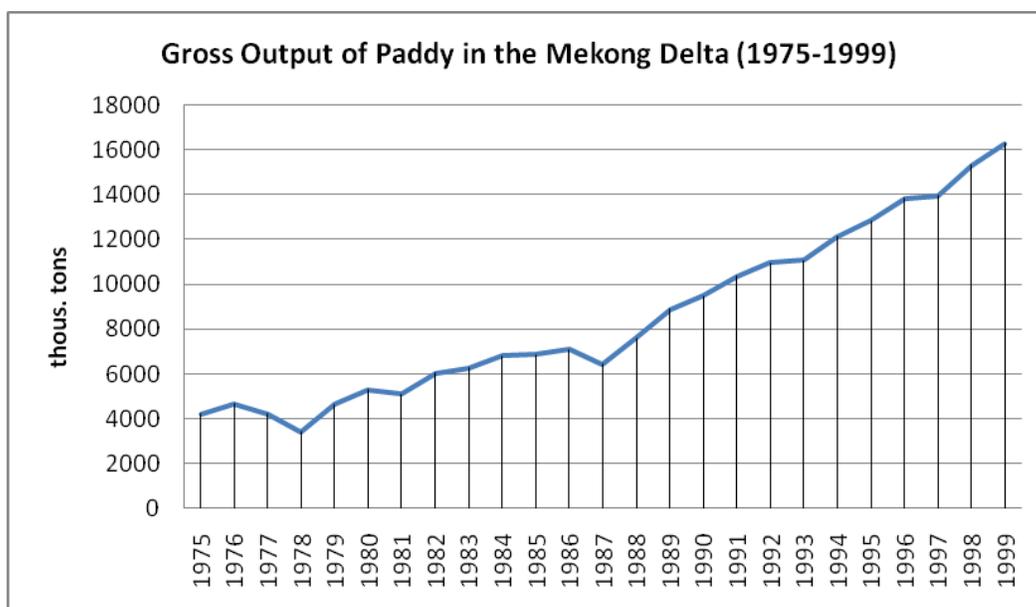
reeds, the Long Xuyen Quadrangle and Ca Mau peninsula. Here, large acid sulphate soils (ASS) should become arable for rice production. So far, these areas have been excluded from regular agricultural use. A government program coming along with this development aimed to encourage people from more densely populated areas to settle in these marginal regions (Hashimoto 2001: 24, Miller 2006:178). In the Plain of Reeds (An Giang province) and in the Long Xuyen Quadrangle (Kien Giang province) a significant extension of paddy land was obtained (Kono 2001: 74). Moreover, a further intensification of agriculture due to new HYVs in combination with new irrigation systems allowed double-cropping in many regions (Kono 2001: 78).

Nevertheless, the record level of national food deficit was reached in 1978 due to the consequences of the war and the political shift. Yields decreased as farmers faced problems in getting agricultural inputs. Furthermore, collectivization of land diminished farmer's engagement for higher production (Käkönen 2008: 206). A situation of famine loomed in the course of this development in the Mekong Delta. Rice has had to be imported into Vietnam's 'rice-bowl' to ensure food security (Kono 2001: 73).

Recognizing the inefficiency of collectivized land holding, land re-allocation began to occur in the 1980s. This was followed by a political and economic renovation policy (Doi Moi) starting in 1986 as a reaction of the economic deficits in the 1970s. Doi Moi is associated with political and economic decentralization, democratization and liberalization. Moreover, property rights were re-organized which meant in concrete that land use rights were granted to individual farmers for 20 years (Kono 2001: 80). This in addition to further canal improvements and a massive increase in trading and using of chemical fertilizers launched a rapid growth in agricultural production. Benjamin & Brandt (2002) reported that especially rural households in the south benefited from the positive impact of Doi Moi. In 1989, Vietnam suddenly resumed rice exportation, and until 1997 it had become the second biggest rice exporter in the world (e.g. Kono 2001: 74, Käkönen 2008: 27). In 1997, 51 % of the national rice production originated from the Mekong Delta, and about 80 % of the exported rice was produced in the Mekong Delta (estimated from data by GSO 2008).

Chart 1 illustrates the development of the gross output of paddy in the Mekong Delta between 1975 and 1999. It is obtained from the chart that the average increase in rice production after Doi Moi (1987-1999) is significantly larger than for the time between 1975 and 1987.

Chart 1: Gross output of paddy in the Mekong Delta between 1975 and 1999 in thousand tons



Source: Figure by author; data source GSO 2001b

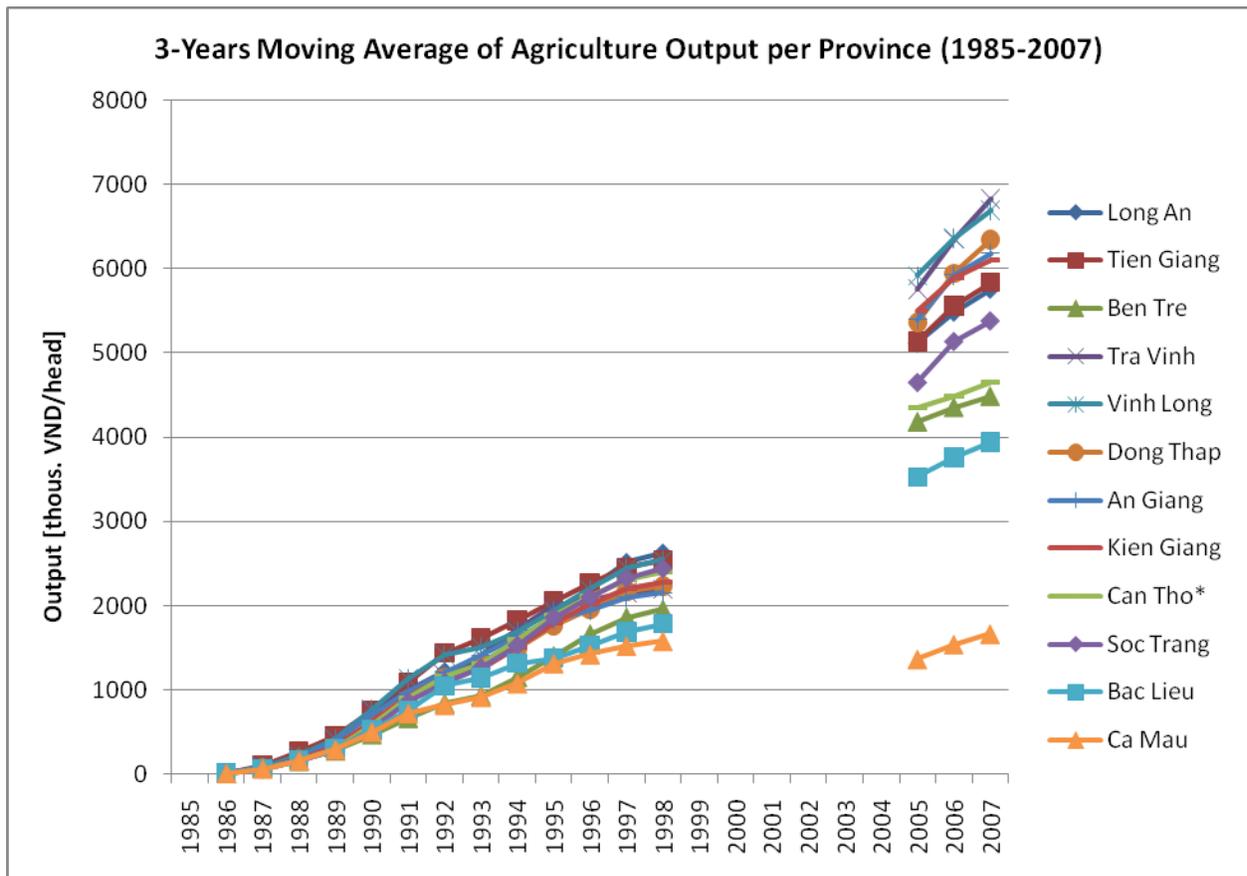
Further irrigation and water control efforts were done to back up intensive farming and to extend double-cropping patterns. By 1990, nearly 5,000 km canals were constructed in the Mekong Delta (Käkönen et al. 2006: 27).

Until 1990, however, water engineering efforts basically took place on the secondary level. In 1991, a Dutch consulting company commissioned by the World Bank and the Mekong River Commission (MRC) developed the "Mekong Delta Master Plan". This plan picked up major ideas from plans compiled during the 1960s by Dutch and Americans engineers that aimed at total water control in the entire delta in order to make agricultural production independent from the seasonal hydrological regime. Hence, in the course of the 1990s, several large-scale water control projects were realized for integrated flood and salinity intrusion protection and water control at the delta-scale (Miller 2006: 178). This phase of hydraulic constructions was associated with the term "closing off the delta" replacing the phase of "opening up the delta" characterized by canal building. Barriers as dykes, sluices, gates, dams, and weirs were then the most conspicuous new constructions. The last major irrigation works were constructed until 2000 (Käkönen et al. 2006: 27). Following Le et al. (2007: 19), in 2003, the delta was occupied by 11,000 km of primary and secondary canals. This is in line with the magnitude of canal lengths in 1990 (5,000 km), however, this data differs significantly from those data provided by GSO (2001b) saying that canal lengths in 2000 was about 43,000 km. The total dyke length in 2000 was about 20,000 km (Le et al. 2007: 19). Newly saline intrusion and flood protection measures constructed in the course of the 'Mekong Delta Master Plan' were implemented in areas of 10,000 to 100,000 ha (Hashimoto 2001: 24).

The increase in large scale water control led to the opportunity of triple-cropping in many parts of the delta. In the second half of the 1980s, double cropping of HYVs replaced single cropping of local varieties in most parts of the delta. Since 1999, the 'Mekong Delta Water Resources Project' (funded by the World Bank with US\$ 148 million) has aimed to extend multiple cropping by irrigation, drainage and (sea) water control in order to maximize land usage and agricultural production.

Since the late 1980s and the early 1990s there has been an enormous increase in agricultural production and turnover. The dominating crop was still rice due to the rice-monoculture philosophy that is held until the early 21<sup>st</sup> century. Chart 2 shows the 3-years moving average of the gross output of agriculture from 1985 to 2007 at current prices for the Mekong Delta Provinces. Here, the impressive growth in agriculture since Doi Moi is well expressed. The data stems from two different sources, though for the time between 2000 and 2004, no data set was available. Assuming that the data sources used are correct and comparable, Fig. 3 illustrates strong disparities in agricultural growth from province to province. All provinces experienced a first large increase in their agricultural output in 1989. But since the early 1990s, the values for agricultural output begin to vary significantly between the provinces. Until 1999, Fig. 3 suggests that in An Giang, Tien Giang and Vinh Long the growth in agricultural output was the highest, while this was the lowest in Bac Lieu and Ca Mau. The latter are interestingly those provinces that were the last areas discovered for agriculture as these are the areas with the largest salinity problem and the areas that are most distant from the main channels of the Mekong River. The order of provinces with the highest agricultural output after 2005 is a little but not significantly different from that in 1999. The order of provinces with the smallest agricultural outputs, however, remains the same. The most significant here is that the output in Ca Mau does not seem to be steadily increasing comparing to the output of the other provinces. It is rather true that Ca Mau's output of agriculture was interrupted or even broken off at the end of the 1990s. In 2007, the mean agricultural output in Ca Mau is not significantly larger than in 1999.

Chart 2: The three-years moving average of agriculture output in the Mekong Delta provinces between 1985 and 2007



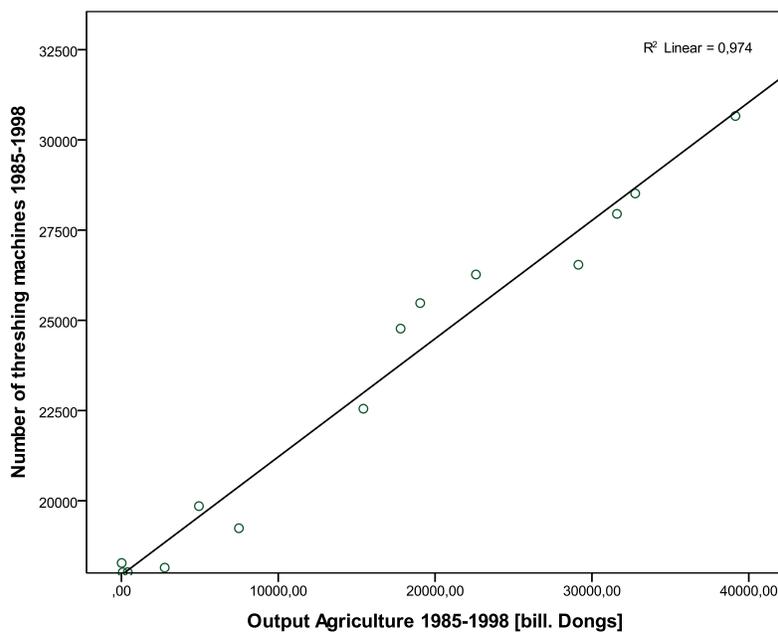
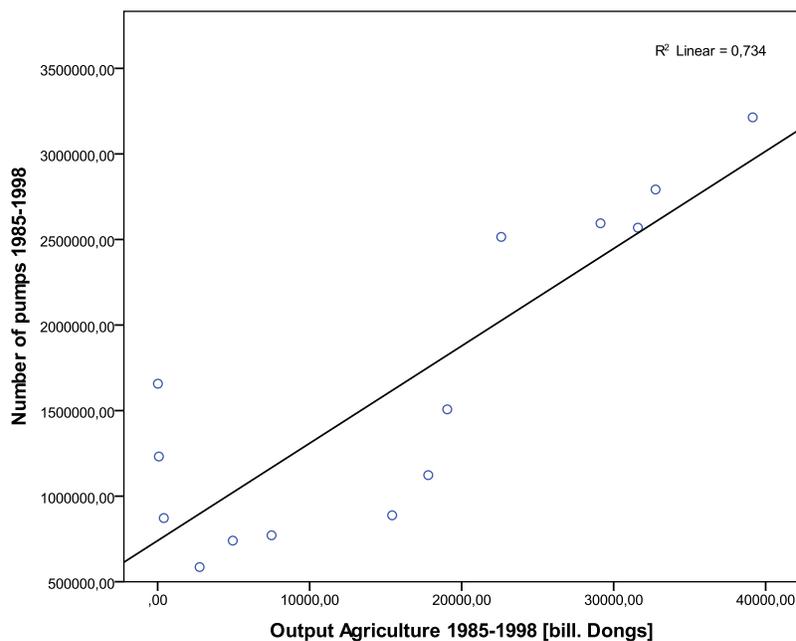
Source: Figure by author; data source: GSO 2001a & Provincial Statistical Offices 2007

The mean delta wide growth in agricultural production does not seem to have reached an end yet. And indeed, agricultural output and crop production are still increasing. A correlation analysis between the most recent agricultural output data and the irrigation network development on the delta scale shows that there is no significant correlation between recent agricultural growth and the irrigation density (lengths of the canal network per area). The same is true at the province scale. For the year 2000, correlation analysis between agricultural output and irrigation density per province were performed. Significant correlations meaning that provinces with higher irrigation density also produce more agricultural output were not obtained.

Both results have to be seen behind the fact that after 2000 no further significant irrigation works were carried out (Käkönen et al. 2006: 27). Unfortunately, it is impossible to analyze this correlation for periods before 2000 due to imprecise or unavailable data.

However, correlation analyses between the agricultural growth (from 1985 to 1998) and the number of pumps as well as the number of threshing machines offer significant correlations [Chart 3]. There, it is observed that the linear regression between the agricultural output and the number of threshing machines is even larger ( $R^2=0.97$ ) than between the agricultural output and the number of pumps ( $R^2=0.73$ ). This means that the factor of mechanization in agriculture played a significant role for the agriculture development in the Mekong Delta. This, however, is often neglected in corresponding reports or only mentioned as a marginal note.

Chart 3: Regression Analyses between the output in agriculture and the number of pumps and the threshing machines



Source: Figure by author; data source: GSO 2001b & MARD 2001.

The relationship between agricultural output and the number of pumps is so far often ignored in evaluations of the interaction between water management and agriculture in the Mekong Delta. The focus is usually only put on larger scale hydraulic works such as canals, dykes and sluices or canal constructions for irrigation and drainage. Kono (2001: 81), however, emphasizes in his article on canal development and the intensification of rice cultivation that “diesel pumps play a crucial role in the evolution of rice cultivation.” In a case study in Thoi Lai village in Can Tho City, he reports that during the last decade the number of pumps

has increased significantly. While in the late 1980s one out of ten households owned a portable pump, today almost all households own at least one pump. He further argues that “the general popularity of portable pumps indicates that the household is the decision-making body in water management” (Kono 2001: 81). Large scale water management facilities, planned and constructed by superordinated state management institutions just seem to be perceived as given random conditions. Delta wide, between 1985 and 1998 the number of pumps has more than doubled (GSO 2001a) which also underlines their importance.

## 2.2 Recent trends in agriculture

### 2.2.1 Are there Changes in Agricultural Business Size?

As outlined above, the steady growth in agricultural output is closely connected with industrialization and mechanization of agricultural production. Additionally, the number of employees within the agricultural sector is increasing constantly until 2005. In that course, trends towards larger and more productive agricultural enterprises could be assumed. At the same time the absolute number of farms<sup>2</sup> could be expected. However, these trends could not be detected by the given data.

The estimates of the Pearson correlation coefficient between the numbers of farm and their agricultural output from 2000 to 2008 on the province scale were positive in almost all cases. For the entire delta the mean correlation coefficient accounts for +0.76. That means that both the number of farms and the agricultural output are increasing. There are two exceptions having a negative correlation coefficient. These are Long An and An Giang provinces. They offer correlation coefficients of -0.72 and -0.46 respectively. That means a growth in agricultural production is to observe while the numbers of farms are decreasing. Hence, only these two cases indicate signs towards larger productive agricultural businesses. Referring to the larger correlation coefficient in Long An, the trend seems to be more significant in that province than in An Giang.

However, a general anti-proportional pattern regarding increasing agricultural output and decreasing numbers of farms cannot be detected. Thus, on the delta scale the agricultural growth in the Mekong delta also involves an increasing number of farms. The critical issue of landownership is, however, not covered by the available GSO data sets, though landlessness appears to be a major social problem in the Mekong Delta today.

### 2.2.2 Paddy Cropping Patterns

In the 1990s, a triple-cropping policy was launched by the central government and large scale hydraulic works were designed to make land units ready for triple-cropping, if the environmental and hydraulic conditions were favorable for such a shift. However, farmers who actually practiced triple-cropping often face the risks and uncertainties coming along with this cropping pattern. One problem that is connected with triple cropping is the need of a tight schedule within the cropping calendars. That offers the risk of losing the third crop if harvesting is not possible before the onset of the flood season. Moreover, triple-cropping depends on high investments but offers low yields from the third crop. Farmers who realized that their income did not really increase from triple-cropping finally shifted back to double cropping. With regard to the Mekong Delta, Le Meur et al (2005:21ff.) also conclude that mono-cultural rice production is less profitable for farmers than diversification.

Analyzing GSO data on seasonal paddy production, the decrease of triple-cropping is well documented. 1996 was the last year that the Statistical Yearbooks of GSO provided data for all three crops in every province. After 1996 the number of provinces providing data on triple cropping constantly decreased. In 2001, only ten provinces provided data on triple cropping, in 2008 there were only eight provinces. This may indicate

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<sup>2</sup> The GSO reports do not reveal any information on the classification and size of farms of the respective statistics.

that today the triple cropping pattern is not practiced anymore in five provinces, namely Tien Giang, Vinh Long, Dong Thap, Hau Giang and Can Tho City. However, that is in contrast to paddy cropping patterns observed in the field or by remote sensing (e.g. Sakamoto et al. 2006) that triple-cropping patterns are predominantly practiced in the central parts of the delta since their hydrological conditions are supposed to be most suitable. Moreover, data on district level provided by the Provincial Statistical Offices show that in every province triple-cropping is still practiced in at least some districts. This is especially valid for Can Tho City. Whereas the national GSO data indicate that in 2007 triple-cropping is not practiced in Can Tho, the Provincial Statistical Office of Can Tho provides data on triple-cropping in all districts.

However, also in the Provincial Statistical Yearbooks either the number of districts in each province which practice triple-cropping or the yields of the third crop (with the exception of Tra Vinh province) is continuously decreasing. Nevertheless, the assumption that triple-cropping is given up completely in five provinces cannot be kept up completely since data given by different sources of different scale are quite contradictable.

The yields of winter paddy (the third crop in the cropping calendar) are steadily decreasing in seven of the eight provinces GSO provides data on. Only in Tra Vinh the yield of winter paddy is increasing of about 22.5 %. On the average delta scale, however, the yields of winter paddy have decreased from 1995 to 2008 of about 33.5 %. The highest decreasing rate is observed in Soc Trang (about 77 %). In contrast to this, the production of spring and summer paddy is increasing on the Mekong Delta average. Following the numbers from the Statistical Yearbooks by GSO, in spite of the decrease in winter paddy production, the production of paddy in total has increased of about 61 % from 1995 to 2008. On the delta wide average spring paddy with about 84 % increase was slightly stronger than summer paddy with about 75 % increase.

To sum it up, in spite of contradictable data provided by different data sources, there is a clear trend towards a slowing-down of triple-rice cropping in the Mekong Delta. This is in line with the fact that the rice monoculture strategy, which has been pursued since the 1930s and further emphasized lately in the 1980s by the Vietnamese government, has shifted to a strategy aiming at more integrated farming systems (Pham et al. 2009). In fact, farming systems continuously changed in recent years and the fishery, aquaculture, vegetable and fruit production further developed. Crop diversification for income insurance is one of the major goals recent rural development strategies set their target on. However, it must also be noticed that triple-cropping still plays an important role in some recent provinces' master plans, e.g. in An Giang (Käkönen et al. 2006: 52), and some hydraulic constructions continue to aim at the harness of land for triple-cropping by water control. That this may lead to interest conflicts in some cases and regions will be outlined in the following chapter.

### 2.2.3 Diversification in agriculture

The shift from the rice monoculture paradigm to more diversified policies of agrarian development introduced the possibility of crop diversification after Doi Moi (Biggs et al. 2009: 211). A particular policy claiming for rural development with a special focus on the diversification of agriculture was announced by the central state at the end of the 1990s, and further emphasized from 2002 onwards (Evers & Benedikter 2009: 17; Käkönen et al. 2006: 36). Aquaculture especially experienced a significant boom starting in the early 1990s; perennial crops such as fruits also began to rise.

The aquaculture boom correlates with a breakdown of rice prices on the world market. For farmers who had access to necessary credits and know-how, the change to aquaculture was a reasonable alternative since it was also promoted by the government. The aquaculture boom came along with strong growth rates in many provinces of the Mekong Delta. In 2008, about 1.8 million tones of aquatic breeding products were produced in the delta, which is about 75 % of the entire aquaculture production in Vietnam (GSO 2008). Moreover, about 71 % of the entire water area in Vietnam used for aquaculture was located in the Mekong Delta. Next to rice, aquaculture products are the major exported goods from this region (GSO 2008). The main breeding

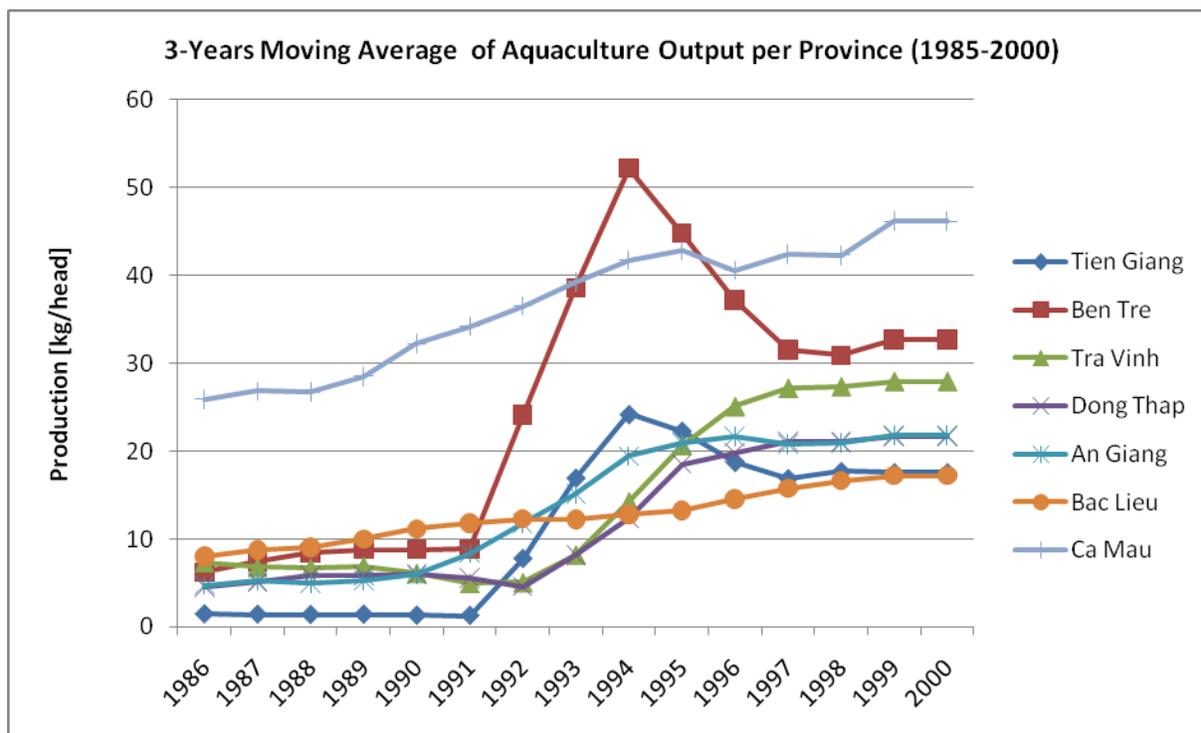
products are shrimps and catfish from geographical production centers determined by the natural water conditions:

Shrimp farming is mainly practiced in the coastal or very downstream areas of the Mekong River. Here, saline or brackish water conditions in addition to the presence of mangrove forests provide favorable conditions for shrimp cultivation. Ca Mau, Soc Trang, Bac Lieu and Tra Vinh are the provinces with presently the highest shrimp output. These provinces provide the largest parts of the shrimp cultivation in the Mekong Delta, which was 79 % of the whole national amount in 2008 (GSO 2008).

Catfish farming is done further upstream in the flood prone areas, where freshwater conditions are present all year round and thus allow intensive fish farming. Consequently, An Giang, Dong Thap and the very northern part of Can Tho are the major production centers for catfish farming. In summary, about 76 % of the entire fish production of Vietnam in 2008 is cultivated in the Mekong delta (GSO 2008).

Chart 4 shows the three-year moving average of the aquaculture output per capita of those seven provinces in the Mekong Delta with the highest rate of aquaculture production per capita. There it becomes apparent that the onset of the aquaculture boom started in the beginning of the 1990s. With the exception of Dong Thap and An Giang, all the other five high producing provinces are coastal provinces with intensive shrimp farming. The most significant increase is obtained for Ben Tre, although after the first peak in 1994, the trend of intensive growth mitigates to some extent in this province. Aquaculture development in Ca Mau contrasts the shape of the development in the other provinces. Here it seems that both provinces focused on aquaculture already before the 1990s since a gradual growth is determined in Chart 4.

Chart 4: The three-years moving average of aquaculture output in seven provinces having the highest aquaculture output in the Mekong Delta



Source: Figure by author; data source: GSO 2001b.

The latter circumstance is interesting to compare with the development of agricultural output of the Mekong Delta provinces as shown in Chart 4. Here, especially in Ca Mau, it seems that agriculture

development stops in the 1990s in favor of focusing on aquaculture development. This result may indicate that the water engineering efforts since 1975, which aimed to make the Ca Mau Peninsula suitable for agriculture production have not been completely fruitful. With the onset of aquaculture development, a reassessment of water as a natural resource occurred. What before was considered as problematic factors for agriculture development (saline water intrusion, saline or acid soils, salt-/brackish water conditions) has emerged as favoring factors for aquaculture development. Today, however, large scale water control projects that were built in the last decades, solely with the purpose of harnessing land for rice production, do not satisfy the needs of aquaculture farming to an appropriate water management system. Käkönen et al. (2006: 36) state that aquaculture development and crop diversification can be seen as one of the major challenges for the present water management in the Mekong Delta. They note that “especially in Ca Mau peninsula, many farmers do not like the [centralized saline water protection] systems because it prevented possibilities for brackish water aquaculture. The diversification policy from 2002 onwards has allowed the re-entry of brackish water to many areas and the control systems have gone through modifications in their operations. But the search for their ideal use is still going on” (Käkönen et al. 2006: 36). Farm households in coastal areas are nevertheless particularly vulnerable because they still face many problems with regard to salinity intrusion and water scarcity during the dry season.

Recent data indicate that the aquaculture boom in Vietnam and especially in the Mekong Delta has not stopped and is further on the move. Water area used for aquaculture and aquaculture production is still increasing in all provinces in the Mekong Delta as well as the production per head. The poverty task force (2003: 4), however, argues that the aquaculture resources are fully exhausted due to overexploitation. Furthermore, an article by the SPIEGEL-magazine (11/2009) points out that aquaculture farmers in the Mekong Delta recently face problems to produce profit in their business. The claim for constantly low fish prices combined with high quality standards and increasing import taxes, particularly in the United States, add pressure on the local aquaculture production systems in the Mekong Delta. Hence, the profits for producers are steadily decreasing and some farmers come to realize that aquaculture is not worthwhile anymore. Moreover, brokers’ purchase of aquaculture products from the local producers is significantly decreasing since the profit margin reduced. Further, the article predicts that the number of (small) aquaculture farmers will decrease in the coming years while large-scale producers will dominate the market.

Another recent agricultural trend in the Mekong Delta is the **diversification of crops**, which is also a result of the diversification policy since the late 1990s. Although rice is still the solely dominating crop, recent data from the statistical survey indicate a clear tendency to crop diversification, especially to fruits and other perennial crops. Some numerals underline this as follows:

On average, the planted area of annual crops and especially rice decreased in about 6 % from 2001 to 2006 in the entire Mekong Delta. At the same time, the planted area of perennial crops increased by approximately 4 % in the entire delta (GSO 2006). The largest amounts of fruit cropping areas are detected in the coastal provinces (Ca Mau, Ben Tre, Kien Giang, Soc Trang). In Ben Tre the amount of land used for fruit cultivation (85,780 ha) is even larger than the amount of land used for paddy cultivation (37,500 ha). This, however, is a unique case within the delta.

Following the Provincial Statistical Yearbooks (2007), in all provinces where these kinds of data are available, a significant increase in the planted area for fruit cultivation occurred. The highest rates between 2000 and 2007 are observed in Long An and Vinh Long with increasing rates of +85 % or +74 % respectively. The smallest increasing rate is in Can Tho with only 5 %. In this case, however, it is not sure to what degree the administrative reform from 2003 is considered. Looking at the number of farms classified according to their cultivation purposes, on average 97 % of all farms in the Mekong delta are annual crop farms, and thus basically paddy cropping farms. Only less than 1 % of all farms in the Mekong Delta are classified as fruit cultivation farms. However, in Ben Tre and Tien Giang about 50 % of all farms are fruit farms which reflect the highest amount of fruit farms in the delta (GSO 2006).

Switching from paddy to fruit farming is only possible when access to fitting agro-hydrological conditions and to money and knowledge is given (Biggs et al. 2009: 211). The requirement of different irrigation patterns and the modernization of on-farm and larger irrigation systems are highly cost intensive. This leads to contradicting interests comparable to those outlined above regarding aquaculture development. In the “closing off” phase major water control constructions for salinity and flood control were implemented, especially in the coastal area. These constructions are primarily designed for rice irrigation (freshwater security). However, saline water intrusion is now a key factor for aquaculture development in the coastal provinces and supporting aquaculture development would need fundamental modification in water control (Käkönen et al. 2006). That is true for supporting crop diversification and especially fruit cropping since perennial crops/fruits need a significant different water management concept. Hence, the state faces the increasingly difficult challenge of beginning another “cycle of investment” in new infrastructure for fruit diversification and aquaculture development while at the same time maintaining older works for rice farmers which are still the majority among farmer groups in the Mekong Delta (Biggs et al. 2009: 211).

On the other hand investment in new infrastructure would stress social inequality since better situated farmers would benefit more from these investments. Already today, there exists a significant gap between well situated and poor farmers. Käkönen et al. (2006: 35) state that there has not been enough attention on poor farmers while promoting agricultural growth by diversification and especially in the domain of aquaculture support. Particularly, poor people did not and do not have the resources in form of finance and knowledge to place high investments and manage the risks of starting aquaculture production or crop shifting. For poor farmers, access to credits is hard. Only richer farmers can afford seed capital for starting high-productive (aquaculture) farming and continue in investing for better cultivation techniques.

This is well in line with some findings from the GSO Living Standard Survey (2006). A comprehensive survey with farmers on the reasons for their increase or decrease in yielding between 2000 and 2005 was carried out on the commune level. 74 % of the farmers in the Mekong Delta said that a change in cultivation techniques was most responsible for an increase in their income. 60 % said that their income increase is due to new varieties, and 44 % said this is due to improvements in irrigation techniques. With special regard on fruit farming, respondents said that the support of regional agrarian promoters was very important for their income improvements (45 %). This finding demonstrates the state’s efforts to implement their diversification policy.

Farmers who are affected by decreasing income see the most important reason for this in the occurrence of natural disasters. However, change in cultivation techniques, which was the most important reason for an increase in income in the first group, is the third most important reason for a decrease in income in this group of farmers. Moreover, 59 % of farmers in this group stated that the access to capital for investments was the major reason for problems in their agricultural production. This underlines that access to money is crucial to hold on with agricultural development. If access to money is not given, it is not possible to profit from changes (=improvements) in cultivation techniques. This marks a crucial point in explaining the increasing gap between well-situated and poor farmers and, therefore, a changing pattern of social differentiation in the Mekong Delta.

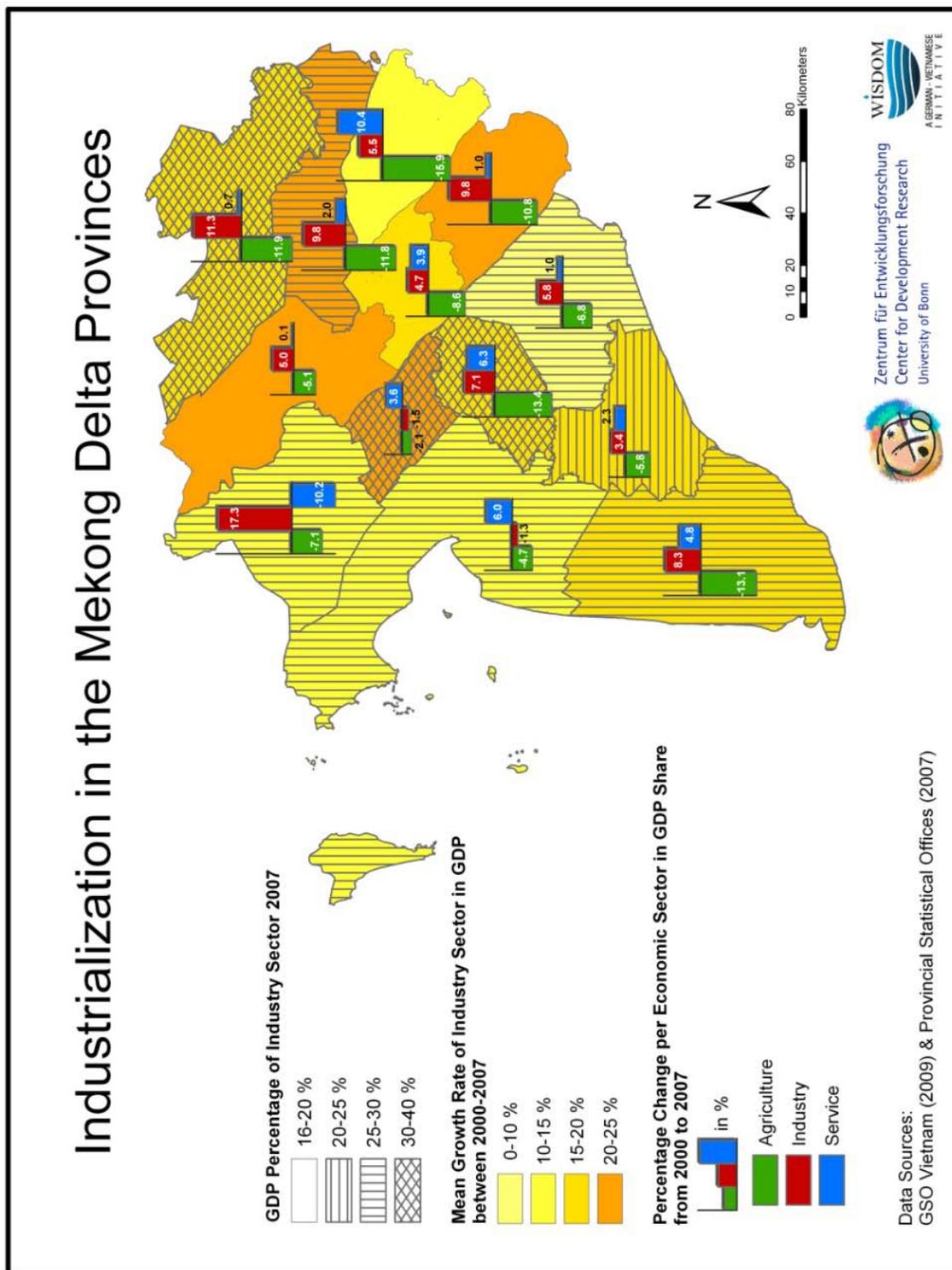
### 3 Recent socio-economic trends in the Mekong Delta

#### 3.1 Industrialization and Urbanization

Although agriculture and aquaculture still constitute the major economic branches in the Mekong Delta, a clear trend of **industrialization** can be observed. Export-oriented food-processing industries and construction industries as the main industries developed in the region. On average the share of the industry sector on the Gross Domestic Product (GDP) of the Mekong Delta in 2008 was about 32 % (GSO 2009). On

the province scale, however, the picture is a little more diverse. Fig. 2 displays a map showing three indicators that quantify the recent trend of industrialization in the Mekong Delta provinces:

Figure 2: Map on Industrialization in the Mekong Delta Provinces between 2000 and 2007



Source: Figure by author; data source: Provincial Statistical Offices 2007 & GSO 2009.

The provinces with the highest percentage of the industry sector on the GDP in 2007, 30-40%, are Long An, Hau Giang and Can Tho City. This pattern is determined by the neighborhood of big cities. Can Tho City itself is the largest city in the Mekong Delta and the industrial engine for the whole region. Hau Giang, until 2003 a part of Can Tho Province, surely benefits from its close location to Can Tho City. Finally Long An, in the very north of the delta, is bordering immediately south to Ho Chi Minh City, the economic capital of (South-)Vietnam, and surely benefits from its pulling effects.

The mean growth rate of the industry sector between 2000 and 2007 can be exorbitantly large (up to 25 %). The highest growth rates are observed in Dong Thap, Tien Giang, Tra Vinh and Can Tho City. The high growth rates of Dong Thap and Tra Vinh are surprising to some extent. But although these two provinces have high growth rates in the industry sector, the total percentage of the industry sector in GDP share is quite low (16-20 %).

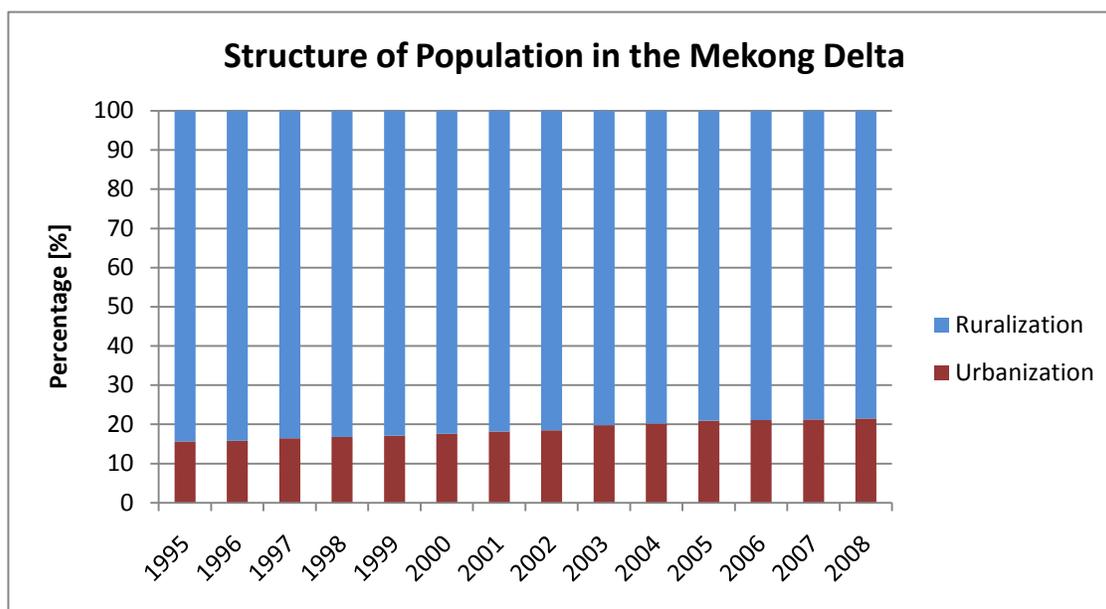
The bar charts in the map give the absolute percentage change per economic sector in the GDP share between the mentioned seven years. Here it becomes very apparent that the share of the agriculture sector (including forestry and fishery) is declining in every province, but most significantly in Ben Tre (-15.9 %), Long An (-11.9 %), Hau Giang (-13.4 %) and Tien Giang (-11.8 %). The percentage change of the industry sector in the GDP from 2000 to 2007, on the contrary, is positive in almost every province with the exception of Kien Giang and Can Tho City. But here, the decreasing rate is very low and almost negligible. All in all, Can Tho City, as the economic and administrative center of the Mekong Delta emerges as the unit with the highest level of industrialization in the region.

A remarkable correlation that is suggested by the map is that the highest growth rates of industrialization are primarily observed in those provinces which border or cross the main channels of the Mekong River. However, this pattern can be easily explained since infrastructure provisions and transportation facilities are major economic location factors, and the Mekong River is still the main traffic artery in the delta.

Urbanization is also a recent trend in the Mekong Delta and closely connected to industrialization. The percentage change of urban population in the entire delta between 1995 and 2008, accounts about 5.8 %. In 1995 the urbanization rate in the Mekong Delta was 15.6 %, and today, the urbanization rate is larger than 21 % [Chart 4]. This signifies an urban growth rate of almost 37 %, which is larger than the mean urban growth rate for the whole Vietnam (35.5 %) during this time period.

Can Tho City, as the economic engine of the entire delta is the fastest growing city. Between 2000 and 2007, the amount of urban population increased by almost 19.3 %, and currently almost 52 % of the population of Can Tho City live in urban areas (Provincial Statistical Office 2007). To some extent this may sound controversial, since in a city urban population ought to be much higher. But due to the administrative reform in 2003, Can Tho province was split up into Hau Giang province and Can Tho City, which on the one hand has the administrative status as a city but on the other hand covers also rural districts. Nonetheless, Can Tho City is one of the fastest growing cities of the country. For comparison, the growth rate of the urban population of Ho Chi Minh City accounts only +4.8 % within the same time period. Besides Can Tho, Hau Giang and An Giang show the largest change in the structure of population with an increase in urban population of 13 % and 7 % respectively. The smallest change occurred in Vinh Long, Soc Trang and Ca Mau, each with less than +1 % urban population growth.

Chart 5: Change of Structure of population by residence form in the Mekong Delta between 1995 and 2008

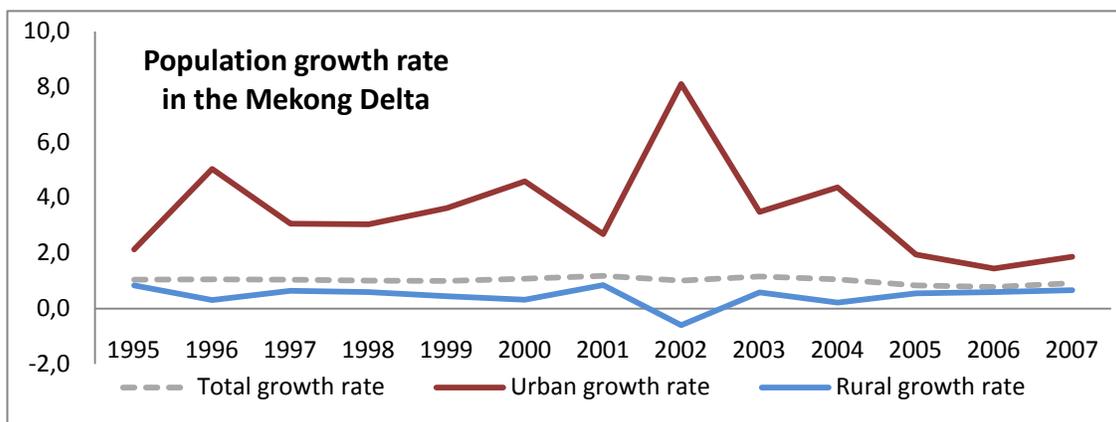


Source: (Figure by author; data source: GSO 2008 & GSO internet source (16.3.2010): [http://www.gso.gov.vn/default\\_en.aspx?tabid=467&idmid=3&ItemID=8652](http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=8652)).

The findings above are in line with the population growth rates in the Mekong Delta divided by residence [Chart 5]. Here it becomes clear that on one hand, the urban population growth has been much larger than the total population growth until 2004. On the other hand, the rural population growth is much slower than the total population growth. The same pattern is true for the years after 2004 but with a smaller magnitude. The mean urban growth rate accounts for +3.5 % and is a little smaller than the country average with +3.8 %. The total population growth rate of the Mekong Delta meanwhile, is also smaller and accounts for +1.0 % instead of the nationwide average of +1.4 %. The average rural growth rate is approximately in line with the nationwide average of +0.5 %.

The fast growth in urban population correlates well with the trends of industrialization as described above. With the economic reforms in the late 1980s a new period of development was introduced along with industrialization and modernization (Loi 2004: 120). Since industrialization usually takes place in urban centers, the process of industrialization also speeded up the urbanization process. The magnitude of urban population further indicates a significant rural to urban migration in the Mekong Delta, which may lead to a considerable change in the population structure (Loi 2004: 121). Issues on migration in the Mekong Delta will be further outlined in chapter 3.4.

Chart 6: Urban, rural and total population growth rate in the Mekong Delta between 1995 and 2007



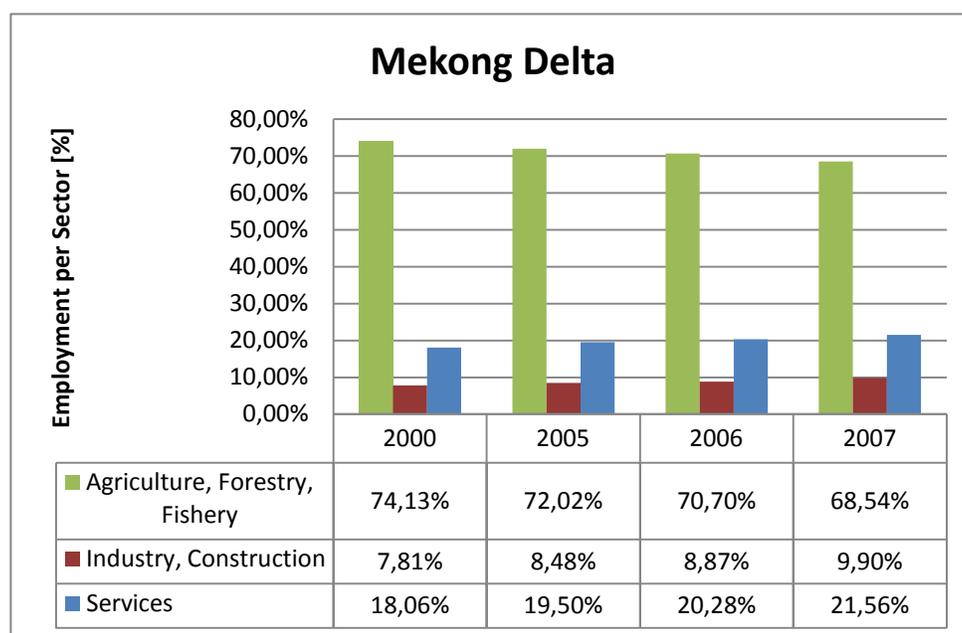
Source: Figure by author; estimated from: GSO 2008 & GSO internet source (16.3.2010): [http://www.gso.gov.vn/default\\_en.aspx?tabid=467&idmid=3&ItemID=8652](http://www.gso.gov.vn/default_en.aspx?tabid=467&idmid=3&ItemID=8652).

In spite of a significant urban population growth in the Mekong Delta, it must be emphasized that the delta is still a distinctive agricultural region, and rural residences therefore are still the predominant residence form. This is also well expressed by Chart 6. However, the trends of industrialization and urbanization will presumably continue, since the government of Vietnam plans to develop the Mekong Delta as a key economic region in the country. But since agricultural land and water use has already extended to approximately the maximum of its potential, the delta's on-farm activities are ought to be unusable for further extensions. Hence, future plans are likely to emphasize on off-farm activities and on the continuation of crop diversification along with high quality crops instead of high yielding varieties (Käkönen et al. 2006: 36).

### 3.2 Employment, Income, and Education

The exposed trend of industrialization and urbanization in the Mekong Delta is also reflected in the structure of employment share between the economic sectors. Between 2000 and 2007 (Provincial Statistical Offices 2007, GSO 2009), the total number of employees has steadily increased in all provinces without any exception. This reflects that the economic growth is still going on in the entire delta. However, the share of employees within the agricultural sector either stagnated or even decreased in all provinces in 2005. On the Mekong Delta average this is expressed by a decrease of the employment rate within the agriculture, forestry and fishery sector from more than 74 % in 2000 to about 68.5 % in 2007. At the same time the employment share of the industry and construction sector as well as the service sector has increased about 2 % and 3.5 % respectively. This becomes apparent in Chart 7.

Chart 7: Employment share by economic sector in the Mekong Delta between 2000 and 2007



Source: Figure by author; data source: Provincial Statistical Offices 2007 & GSO 2009.

As mentioned above, the pattern of decreasing employment rates within the agriculture, forestry and fishery sector to the benefit of increasing rates within the industry and service sector is basically reflected by all provinces in the Mekong Delta. However, the magnitude is a little different from province to province. The highest rate of employment in the industry sector is to observe in Can Tho City (17.5 %), followed with a relatively large gap by Tien Giang and Vinh Long (both slightly more than 11 %). The provinces with the lowest rates of employment within the industry sector are Ca Mau (4.5 %), Dong Thap (8.4 %) and Soc Trang (8.5 %). The provinces showing the highest growth rates of employment in the industry sector reflect the same pattern of those provinces with the highest growth rates of the industry sector in the GDP. Namely, these are Dong Thap, Tien Giang, Tra Vinh and Can Tho City (comp. Fig. 2: map on industrialization).

In 2007, the percentage of population in entire Vietnam aged from 15 working in non-farm areas was close to 30 %. This number is much higher as those in the previous years (in 2002: 22.3%, 2004: 26.3%, 2006: 28.7%). The GSO Living Standard Survey (2006), however, reported on an unbalanced distribution within this 30 % working in non-farm areas regarding poor and rich households. They detected a correlation that the richer the households are, the more household members work in non-farm areas (GSO 2007a: 26). This is in line with the ratio of income. Referring to NCFAW (2004: 55), on the national scale, the income is the lowest in the agriculture sector, but the largest in the industry sector. The Mekong delta provides a similar pattern, although the income in the agriculture sector is larger compared to the nationwide average in agricultural income. On average, more than 40 % of the monthly income per capita, which is the highest nationwide record, stem from agriculture, forestry and fishery. The dominating position of agriculture in employment and income is also expressed by the wages being paid to agricultural wageworkers. They are located clearly above the nationwide average (Mekong Delta: 32.3 VND/day, Vietnam: 28.5 VND/day). However, the gap in income between women and men is especially significant in the Mekong Delta compared to the Vietnam average. While in the Mekong Delta female wageworkers earn just about 77 % of the wage of male wageworkers, the percentage for entire Vietnam is 87 %.

The average monthly income in Vietnam was 636,500 VND in 2006. Compared to the average monthly income in 1996, this number has almost tripled over ten years (1996: 226.700 VND). In the Mekong Delta,

the average monthly income accounts for 627.600 VND in 2006. This is less than the nationwide average but on the regional scale the third highest average monthly income in Vietnam. Only the Red River Delta (653,300 VND) and the South East (1,064,700 VND) are regions with a higher average monthly income. On the provincial scale, Can Tho City as the economic center of the Mekong Delta has the highest average income with 780,000 VND. Can Tho City is followed by the provinces An Giang (691,000 VND) and Ca Mau (666,000 VND). The province with the lowest average monthly income is Soc Trang (495,000 VND), followed by Tra Vinh (509,000 VND) and Vinh Long (580,000 VND). Since the latter provinces are either coastal or very downstream provinces, it seems to make sense to detect a relationship between environmental water struggles due to salinity intrusion and low average income. However, this correlation can not be maintained since Ca Mau, also a coastal province with salinity intrusion problems, has the third highest average income in the Mekong Delta. That is one proof that socio-economic conditions can hardly be explained solely in a geo-deterministic manner.

As an aim of this study is to analyze the social-water engineering relationship, the correlation between the average monthly income in the Mekong Delta provinces and the irrigation density within the province was studied. The result was that there is almost no correlation at all (Pearson correlation coefficient = -0.25). That means, the assumption that income in agriculture strongly depends on the agricultural output and thus also on irrigation infrastructure can not be kept up by the present data. It is rather the other way around. Provinces with high irrigation densities have a lower average monthly income. However, the statistical significance level of this correlation analysis only accounts for 0.4 which means that this potential relationship is to more than 60 % randomly. A much more coherent relationship results from the analysis of the proportion of the average monthly income by source of income and by province (GSO 2007a). Here the analyses results indicate that the relatively largest proportion of income in those provinces with the highest average monthly income do not come from agriculture, forestry and fishery. The proportion of income coming not from agriculture, forestry and fishery are highest in Can Tho, An Giang and Ca Mau with 27.7 %, 27.0% and 26.4 % respectively. That means it can be assumed that the relatively high average monthly income in these provinces is more depended on the degree of industrialization than on water control facilities.

The **unemployment** rate in urban areas in the Mekong is lower than the nationwide average. While the urban unemployment rate in 2008 of Vietnam was 4.65 %, this was 4.10 % in the Mekong Delta. The peak of unemployment in urban areas after Doi Moi in the 1990s was reached in 1998, with a rate of almost 7 % in entire Vietnam and 6.4 % in the Mekong Delta. Since 1998 this rate has been continuously decreasing in both entire Vietnam and the Mekong Delta at the regional scale. To calculate the unemployment rate in rural areas is very difficult due to the fact that most people in rural areas are involved in some kind of work (AusAID 2002). Nevertheless, the 2006 Population Change, Labour Force and Family Planning Survey (GSO 2007b) provided some data on rural unemployment. Here the picture differs to that in urban areas to some degree. The rural unemployment rate accounts for 2.35 % in the Mekong Delta, which is more than twice the rate of whole Vietnam (1.5 %).

From a gender perspective it must be noticed that the nationwide unemployment rate of women in urban areas is 0.9 % lower than those of men (3.9 % versus 4.8 %). In the Mekong Delta in particular, there is no significant difference (3.5 % versus 3.4 %). These numbers stem from the 2006 Population Change, Labour Force and Family Planning Survey (GSO 2007b). However, data from the Gender Statistics Book (NCFAW 2004) report a very different pattern. Here it is said that in 2003 the urban unemployment rates were 6.9 % and 4.4% in women and men respectively. Moreover, in the period between 2000 and 2003 the urban unemployment rate tended to decrease for men but increase for women. It was stressed that this trend was supposed to be continued in the following years. The data from 2006 (GSO 2007b), however, does not confirm this assumption. The question is why and the example illustrates once more existing problems with the reliability and comparability of data from various Vietnamese sources.

In the last decades, Vietnam reached considerable success on **education**. Results from the 2006 Population Change, Labor Source and Family Planning Survey indicated that in 2006, 94 % of the population aged over 10 in entire Vietnam reached literacy. These are three percentage points more than in 1999 and six percentage points more than in 1989 (GSO 2007b). On the regional level, the literacy rate in the Mekong Delta is a little smaller with 92.7 %. The inequality between male and female literacy rates is relatively low (NCFAW 2004: 57). This is especially valid for the age group between 10 and 19 years. The gap between male and female literacy rate in older age groups in contrast, increases constantly. Hence, the data indicate that the gender gap in education has almost been closed in the last decade(s).

Compared to other developing countries, Vietnam's primary school enrolment rate is relatively large, reaching almost 100 % (AusAID 2002). High enrolment rates, however, do not necessarily imply that all children receive a standard primary education. One third of all pupils in Vietnam drop out of primary education during the first five years of schooling (GSO 2007b). Moreover, the Vietnamese school year is very short compared to international standards, and additionally, many pupils receive only half-day schooling. The rate of pupils who have never attended school is relatively low on the country's average. Less than 8 % of children aged 6-9 have never attended school (GSO 2007b). However on the regional level, in the Mekong Delta this number is three percentage points larger (11 %), which indicates some disadvantages in education compared to the national standard. This is also reflected by data on regional enrolment rates to upper secondary school. The Mekong Delta is one of the regions with the lowest enrolment rate in upper secondary school (16.6 %). Furthermore, the Mekong Delta has the lowest percentage distribution of population going to colleges and universities in the whole country. In Vietnam, in general, children in urban areas have better opportunities and chances to continue their school career to the highest level of education than rural children have (GSO 2007b).

This pattern is in line with the regional percentage distribution of employment by education level. In the Mekong Delta about 92 % just have a basic education. This is the highest number in entire Vietnam. At the same time the percentage distribution of employed population with a college or university degree is the lowest in the Mekong Delta with 1 % and 2 % respectively.

To sum it up, a future challenge for the people in the Mekong Delta will be to gain better and higher education. This will be especially crucial if the development towards industrialization, modernization and high quality agriculture moves on. Knowledge will be a fundamental requirement to prepare for this development. Thus, on the one hand people must change their perception on the role of good education, and on the other hand the government must offer and promote higher education facilities in the delta and facilitate the access to higher education for many more scholars than to date. This seems especially important with regard to the government's plan to develop the Mekong Delta into a key economic region in the country.

### 3.3 Poverty

Looking at the total amount of population living in poverty, it is obtained that Vietnam has reached great success in poverty reduction during the last decade. In 1993, about 58 % of Vietnam's population lived in poverty<sup>3</sup>. Until 1998, this number has decreased to 37 %, and in 2006 the poverty rate of entire Vietnam accounted for about 16 %. Following the Poverty Task Force (2003), the decrease in poverty is also reflected by a declining number of poor households, increasing food consumption and need for non-food

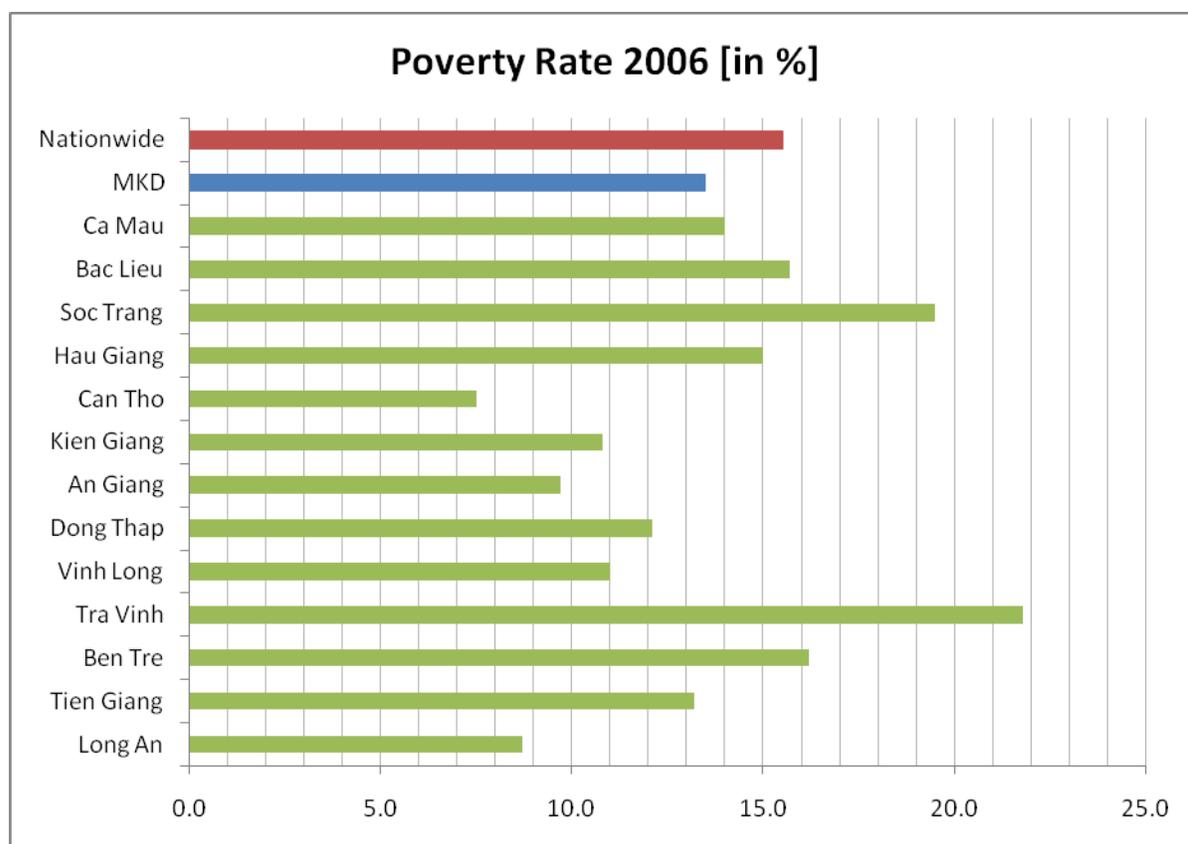
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<sup>3</sup> Within this study the definition for poverty by GSO was used. There, "the general poverty rate is rate of poor people which is calculated by monthly average expenditure per capita and general poverty line provided by the GSO and the WB with monthly average expenditure per capita for different years as follows: 2002: 160 thousand dongs and 2004: 173 thousand dongs and 2006 : 213 thousand dongs" (GSO 2007a). Note also that there is big difference between poverty data provided by official offices and poverty perception coming out from people's self assessment.

consumption, and better infrastructure. On the regional scale, the Mekong Delta with 13.5 % is one of the three regions with a poverty rate below the nationwide average. Only the South East and the Red River Delta have lower poverty rates with 4.6 % and 10.1 % respectively. Poverty in entire Vietnam and especially in the Mekong Delta is highly concentrated in rural areas. The decline of poverty in urban areas was nearly twice the rate than in rural areas (AusAID 2002: 15). Temporally, the decline in poverty is well in line with the growth in agriculture and aquaculture. Driving forces for decreasing poverty in the Mekong Delta were the impact of agricultural credit programs, infrastructure improvements, relative stable prices in agriculture and a low frequency in disaster occurrence (Poverty Task Force 2003: 14). However, although the Mekong Delta provides one of the smallest poverty rates of all eight regions in Vietnam<sup>4</sup>, the total number of poor people, more than 4 million, is still the nation's highest. Moreover, following AusAID (2002: 9), the Mekong Delta has even the highest percentage of people being vulnerable to fall back into poverty.

On the provincial scale, the poverty pattern is very diverse [Fig. 3]. Some provinces have poverty rates far above the average of the Mekong Delta; other provinces have poverty rates clearly below the average poverty rate of the Mekong Delta. The provinces with the highest poverty rates are Tra Vinh (21.8 %) and Soc Trang (19.6 %). The provinces with the lowest rates are Can Tho (7.5 %), Long An (8.7 %), and An Giang (9.7 %). The latter provinces are those with either a high degree in industrial output or with high production and gross output in agriculture and aquaculture.

Chart 8: Poverty rate in the Mekong Delta provinces compared to the delta wide and national average in 2006

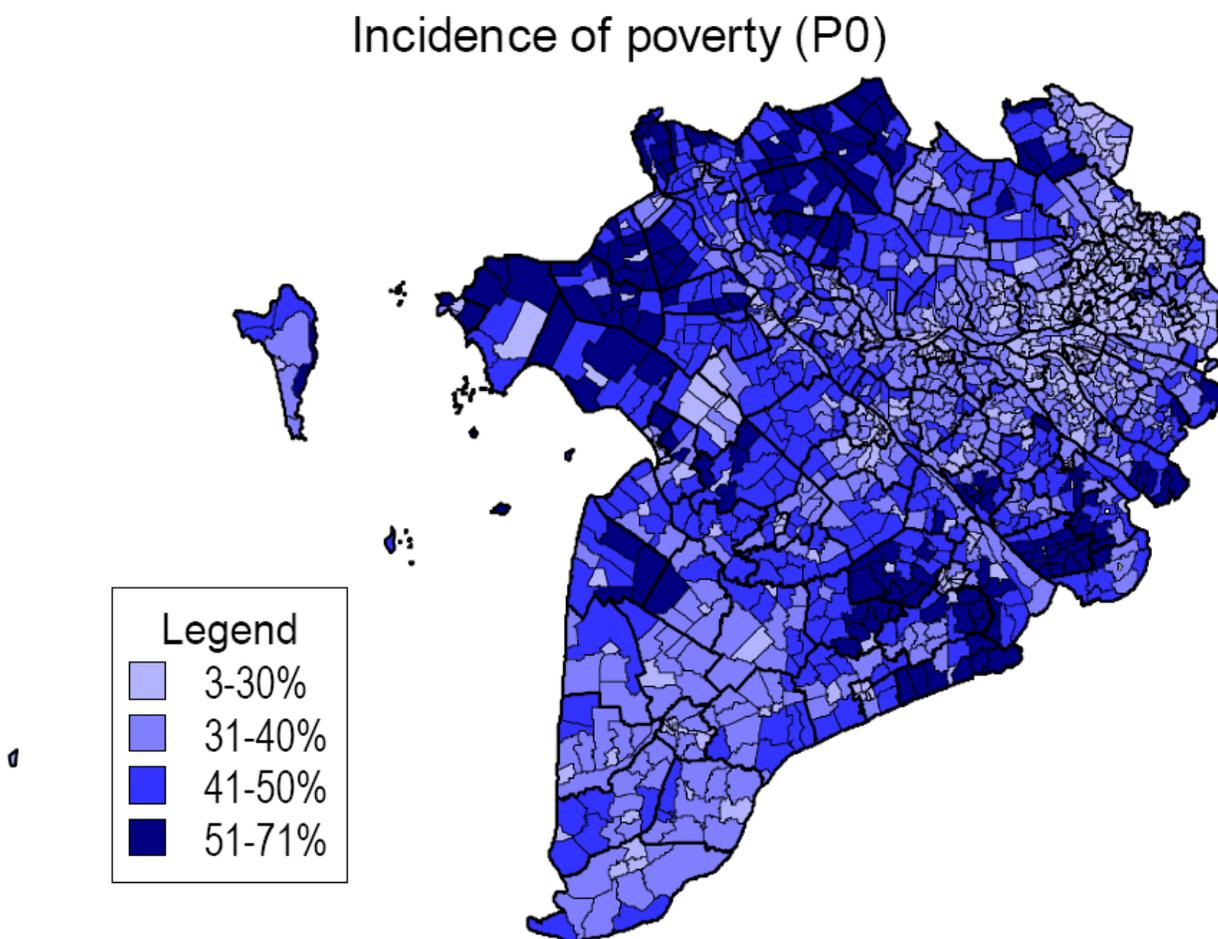


Source: Figure by author; data source: GSO 2007a.

<sup>4</sup> Vietnam is administratively divided into eight regions, which are: Red River Delta, Eastern North Vietnam, Western North Vietnam, Northern Central Vietnam, Southern Central Vietnam, Southern Central Highlands, Eastern South Vietnam, Cuu Long River Delta.

Käkönen et al. (2006: 34) presented a map on the incidence of poverty in the Mekong Delta in 1999 [Chart 8]. They detected a correlation between poverty and the distance to the main tributaries and canals. There, areas which are located closer to the main tributaries, especially in the central delta, have lower incidences of poverty than provinces more distant away from the main channels. Käkönen et al. (2006: 34) argue that the access to freshwater seems to play a key role for poverty rates, since areas in provinces which lack access to freshwater have higher poverty rates. This becomes even more apparent in the bar chart in Chart 8. The provinces with highest poverty rates are those which are heavily affected by saline water intrusion (Soc Trang, Tra Vinh, Ben Tre, Bac Lieu and Ca Mau). All of them offer poverty rates larger than the Mekong Delta average. However, it is also possible that access to main canals as transport lines and access to floating markets play a central role for this pattern of poverty distribution. Moreover, as shown above, urban centers and industrialization emerge and develop primarily along the main rivers since access to transportation facilities plays a crucial role.

Figure 3: Incidence of Poverty in the Mekong Delta communes in 1999



Source: taken from Käkönen et al. 2006.

Explaining the pattern of poverty only by freshwater access would be too simple. Thus, the pattern of poverty in Fig. 3 was additionally explained by the geographical distribution of ethnic minorities in the delta (Käkönen et al. 2006: 34). Käkönen et al. (2006) argue that high poverty rates coincide in areas with high concentrations of ethnic minorities like in Soc Trang and Kien Giang. This is in line with other sources reporting that ethnic minorities are particularly vulnerable to poverty (AusAID 2002, Poverty Task Force

2003). Limited access to land, information and markets, low quality of land, and a limited education including Vietnamese language and literacy skills are selected reasons or explanations leading to high vulnerability to poverty in these population groups.

Another group vulnerable to poverty constitute the landless or land scarce people with a small and unstable income. It has been shown in the previous sections that despite of some trends towards industrialization, agriculture including fishery is still the most important livelihood for the people in the Mekong Delta. Following chapter 3, from an economic perspective agricultural development has been a great success story in the years after Doi Moi. But it has also been said that a significant gap existed between well situated and poor farmers. This gap seems to increase and result in a growing social differentiation (Käkönen et al. 2006: 35). Hence, in spite of a great volume of agricultural production in the Mekong Delta, an increasing number of farmers have less access to the profits produced by agriculture in the Mekong Delta (Taylor 2004b). This is basically linked to inequalities in the land re-allocation process after the central government had given up their collectivization and centralization strategies in the 1980s. In the process of land re-allocation in Vietnam the share of farmers who lost their land altogether was the highest in the Mekong Delta (Shanks 2004). Today, the Mekong Delta has the second highest number of landless people in the country (AusAID 2004: 20). Recent reasons leading to land loss are usually forced sales as a result of economic failure or greater concentration of land in areas with increasing population. Plots inhabited by families often become too small to be productive, which also results in selling or renting the land to greater and well situated land owners (AusAID 2004: 6). As a result, the landless or near-landless population in the delta is increasing and out-migration is stimulated (see chapter 3.4.). Selling and renting land take place with the main intention to access capital, which is often needed to reimburse credits. However, since selling land is usually a consequence of production failures or economic shocks, it must be noticed that selling land is mostly a result of poverty and not the root of poverty (AusAID 2004: 20). But it is also obvious, that landless people are thus vulnerable to poverty since they become dependent on unstable and usually low income from (often only seasonal) laboring. Additionally, landless poor often lack access to employment opportunities since they usually have a low education level and face particular barriers to the job market.

A further striking problem for poor farmers in the Mekong Delta is the limited ability to access credits to invest in modern production systems. Most non-poor farmers apparently have easy access to formal credits offered by banks and / or donors. However, depending on the credit program, these credits are often not suitable or flexible for farmers aiming at investments to change their crop production. Poor farmers in contrast, have great difficulties to access an official credit, since they usually lack the required assets. Thus, they rely on informal credit systems with higher interest rates (AusAID 2004: 23).

To sum it up, while in 1993 more than half of Vietnam's population was poor, today it is only 16 %. In the Mekong Delta in particular this rate is even a little smaller. Furthermore, comparing to the early 1990s when poverty was relevant to the broad spectrum of society, the living standard has improved for the majority of people. However, a "hard core of static poor who have missed the economic and other opportunities opened up in recent years " (AusAID 2004: 7). Especially the rural poor who focus on agriculture have unstable jobs and very limited off-farm employment opportunities. They are characterized by a low level of education, limited professional and business skills as well as a low level of access to credits, physical infrastructure and social services. Poor people in urban areas are mostly new immigrants who are unemployed or do not have any stable job and income (AusAID 2002: 17).

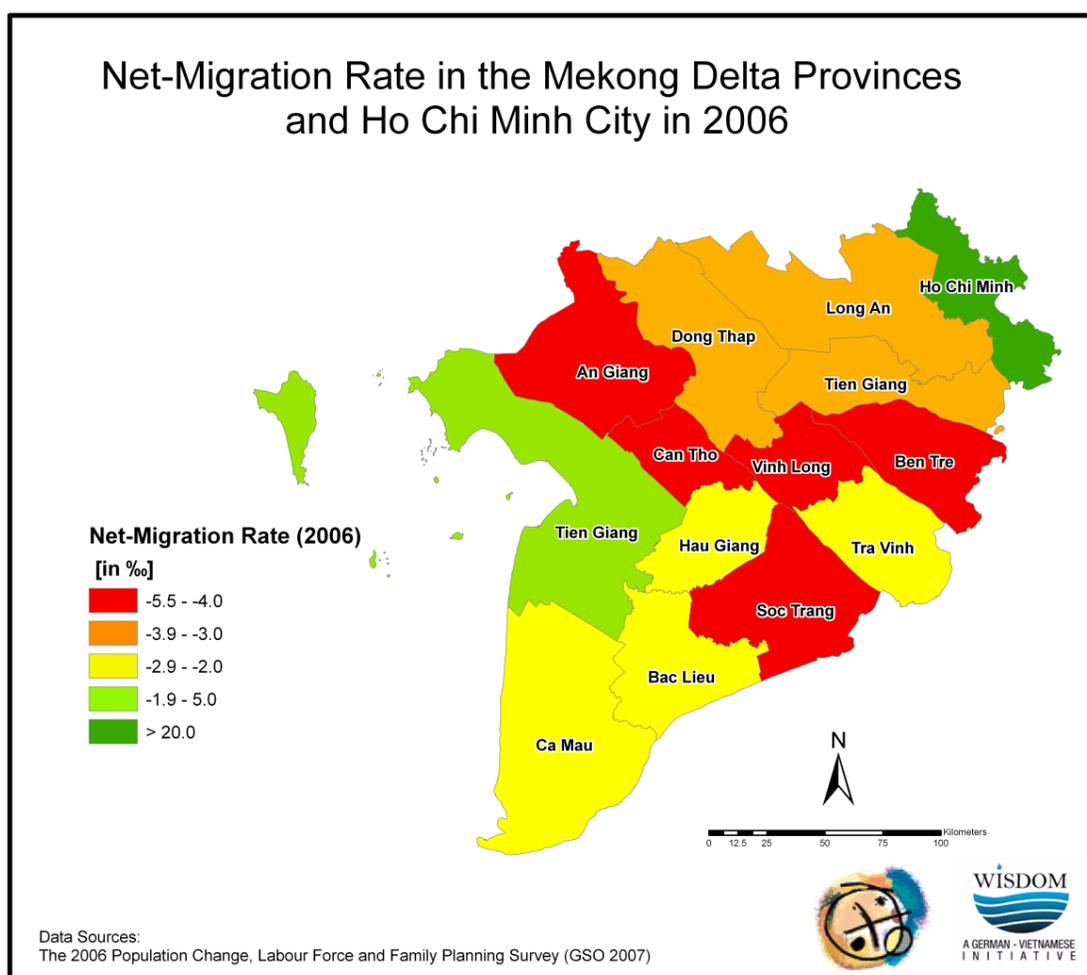
### 3.4 Migration

Data on migration in a regional and provincial resolution were only available from the 2006 Population Change, Labour Force and Family Planning Survey (GSO 2007b). Unfortunately, detailed data were provided for just one year (2006) so that comprehensive trend analyses were not possible. Nevertheless, some interesting observations could be gained from the data.

Generally, the mean migration rate in entire Vietnam in 2006 was higher than in 2005. In the Mekong Delta in particular, the net-migration rate increased from -1.8 ‰ to -3.6 ‰ from 2005 to 2006, which is the second highest net out-migration rate in the country (behind the North Central with -4.4‰). In 2006, the Mekong Delta had the highest amount (in total numbers) of emigrants nationwide; and 24 % of all inter-regional migrants in Vietnam originate from the Mekong Delta.

Looking at the spatial distribution in more detail, in almost all Mekong Delta provinces the net-migration rate is negative [Fig. 4]. The most significant negative net-migration rates are in Soc Trang (-5.4 ‰), Vinh Long (-5.2 ‰) and Can Tho (-5.2 ‰). Regarding Soc Trang, this may be explained by the high degree of poverty prevailing in this province. Poverty as a pushing factor makes people in Soc Trang move to urban or better situated agrarian areas. Referring to this, however, it is astonishing that Can Tho City also provides a high negative net-migration rate. It was outlined within this paper that Can Tho City is the major economic engine in the Mekong Delta. Hence, Can Tho City, in the course of industrialization and urbanization ought to be rather a significant immigration pole than an area with high emigration. The exact reason for this pattern is therefore not obvious.

Figure 4: Net-migration rates in Mekong Delta provinces and Ho Chi Minh City in 2006



Source: Figure by author; estimated from: GSO 2007b.

The only exception in the Mekong Delta providing a higher amount of immigration than emigration is Kien Giang [Fig. 4]. Here the net-migration is positive and accounts for +2.7 ‰ of the entire population in the

Mekong Delta. One third of the immigrants in Kieng Giang in 2006 come from An Giang, and about two thirds of them were men. The exact reason for this phenomenon can hardly be detected. The development of Phu Quoc, a tropical island in the shallow water sea west from the Ca Mau peninsula and administratively belonging to Kien Giang, into an attractive touristic place may play an important role here. Phu Quoc has witnessed a construction boom in recent years, attracting both investors and laborers. Moreover, fishery and the flourishing fish sauce production industry on the island offer income opportunities, too. As a consequence the net-migration rate in Kien Giang becomes positive. However, the lack of migration data for the district level doesn't allow to crosscheck the suggested explanation. On the other hand, these data are only representative for one particular year (2006). Thus, it is also possible that the positive net-migration rate of Kien Giang is statistically an outsider of a mean long-term negative trend.

Ho Chi Minh City is Vietnam's most important and largest immigration pool. In 2006, the net in-migration rate was +21.2 ‰ [Fig. 4], which is 7.7 ‰ more than within the prior year. In total, 185,000 persons moved to Ho Chi Minh City, which is almost 55 % of the total number of all inter-regional migrants in Vietnam. The majority of all immigrants to Ho Chi Minh City, which accounts for 77 %, stem from the Mekong Delta provinces.

On the delta scale, the migration level of Vietnam has been increasing constantly since 2003. This is further stressed, by the statistics on inter-provincial migration between urban and rural areas. Here it is said that significant rural to urban migration is taking place in Vietnam, which indicates that industrialization and urbanization accelerated constantly. These data refer to the nation scale but are also valid for the regional scale to some extent. Here it is said that 56.7 % of all migrants move to urban areas. Among rural-urban migration flows, the rural to urban flow is biggest with almost 40 %. This corresponds well with the industrialization and urbanization process as figured out in chapter 3.1. The rural to urban flow is followed by rural to rural migration which shares 30 % of the total migration flow. Urban to rural migration is the smallest and shares about 13 %. These data also stem from the 2006 population change, labour force and family planning survey (GSO 2007b). About the missing 17 % in the migration statistics nothing is mentioned. Maybe they are representing the percentage of urban to urban migration, but are not mentioned explicitly.

From a gender perspective some difference can be obtained in migration patterns of men and women. Although the difference is almost not significant, the number of female migrants in entire Vietnam is a little larger than that of male migrants (52.1 % female; 47.9 % male). Referring to the Mekong Delta, this pattern is even more distinctive (57.6 % female; 42.4 % male). However, with regard to rural to urban migration, the pattern observed in the Mekong Delta differs from that of whole Vietnam. While in entire Vietnam slightly more women migrate from rural areas to urban areas, it is the other way around in the Mekong Delta (47 % female; 53 % male). On the other hand, the statistics on rural to rural and those on urban to rural migration reports about a positive ratio of females (59 % and 71 % females, respectively). Consequently the ratio of females living in rural areas in the Mekong Delta has increased from 1999 to 2003 of more than 1 % (NCFAW 2004). The study further reveals a figure of 26 % of female-headed households in the Mekong Delta, which is the highest of all rural-agrarian regions in Vietnam. For the Red River Delta, for example, this number is only about 23 %. Unfortunately, the report does not provide any details about the female heads of households, such as family status (single, divorced, widowed) or migration history. However, the finding seems to correspond with the high urban to rural migration rate of females, and the high rural to urban migration rate of males in the Mekong Delta.

The predominant motivation for migration for both women and men is the search for (a better) employment and young people of the age of 15 to 30 years share two thirds of the total inter-provincial migrant population.

## 4 Conclusions

This paper has shown the agricultural development of the Mekong Delta in close connection to water engineering activities. Since the early settlement history, agricultural activity was always closely connected with the expansion and upgrading of water management systems implemented by different actors in the course of time. The impressive successes in agricultural development in the last decades were often solely connected to the renovations of the market and land holding system coming along with Doi Moi in the second half of the 1980s. However, without the long term development of water management and irrigation systems during the time of French colonialism and thereafter, this significant growth in agriculture could not have happened (see also Käkönen et al. 2006: 29).

While earlier water engineering measures such as the construction of canals for transportation, irrigation and drainage resulted in opening up the delta for settlement and agricultural expansion, the latest large scale water engineering project in the course of the 'Mekong Delta Development Plan' aimed at closing off the delta in order to harness more land for paddy production and make people more independent from the natural climate and water flow regime. As a result, traditional living and farming forms previously adapted to the boundary conditions of the natural system were completely replaced by modern and mechanized systems.

The shift from the rice-monoculture philosophy by the central government towards integrative farming systems and crop diversification, however, led to controversy between water users. The most recent water control projects still aim at closing off the delta by protecting land units from either salinity intrusion or flood inundation and allow multiple-rice cropping. However, recent developments in rural farming systems, especially the onset of the aquaculture boom in large parts of the delta highlight the fact that the existing water control measures are not appropriate to the needs of the new economic branches. Here, the perception and evaluation of (even salted) water as a resource by some farmers contrast the interests of rice-farmers who are still the majority among farmer groups in the Mekong Delta. Hence, the government faces problems of investing in new water management strategies while at the same time maintaining older structures. Following Biggs et al. (2009), this dilemma and increased complexity sketch one of the major future problems for agricultural development in the region.

The emergence of the new agricultural branches such as aquaculture and perennial fruit cropping, however, also generates trends towards increased social differentiation. Especially the role of aquaculture is a paradox (Käkönen et al. 2006: 35). Promoted by the government, aquaculture development was supported as a measure for poverty reduction. And while well situated farmers could benefit from the related programs, poor farmers did not. Because they lack the financial resources for risky investments, poor farmers were rarely able to start a new business in aquaculture production. Moreover, a successful diversification highly depends on the availability and access to the needed production technologies. That shifts in production technologies are seen as an important reason for an income reduction within the group of farmers experiencing decreasing yields underline the inability of this group to make the needed investments.

The comprehensive analysis of secondary data allowed detecting and quantifying recent socio-economic development trends in the Mekong Delta. The most significant trend in the delta is industrialization, leading to effects such as changing in employment shares per economic sector and high urbanization and migration rates. It could however be shown that agriculture still remains the most dominant livelihood in the Mekong Delta. However, income from off-farm activities is generally higher than the one generated from agriculture. Nevertheless, the Mekong Delta has the third largest average income per capita in Vietnam. Moreover, poverty reduction was successful in both Vietnam and in the Mekong Delta in particular. The decline in poverty was well in line with the growth of agriculture and aquaculture during the 1990s. However, a hard core of poor people – especially landless people and ethnic minorities – still suffer from poverty without any clear perspective for an improvement in their situation. The resources for further agricultural development

seem to be almost fully exploited. Already today, the pressure on water resources by different types of users is exorbitant and seems to further increase. Therefore, future development strategies for economic growth in the Mekong Delta will have to focus on off-farm activities and on shifting from high yielding to high quality cropping (Käkönen et al. 2006). Moreover, environmental issues connected with water use and water resources have to be specially emphasized. Increasing sustainability in water use should be one of the prior goals in the future development of the Mekong Delta.

One more aspect of this paper was to detect connectivity between agro-economical trends, socio-economic development and water resources (management) in the Mekong Delta. This, however, was not always possible. As already mentioned, the relationship between water engineering and agricultural development is very obvious, but the attempt of a correlation analysis between irrigation density and agricultural output throughout the Mekong Delta provinces did not work. To detect and to quantify inter-relations between water aspects and socio-economic development was only possible in very few cases, and then just in a qualitative manner. For example, it seems that the occurrence of poverty is partly connected to people's access to freshwater, transportation infrastructure and (floating) markets. But it is also obvious that socio-economic patterns are hard to explain by mono-causal reasons. Within the framework of the study of this paper, the detection of further and clearer coherences was not possible because of the limitations and biases of the statistical data available. Some of the data was contradictory, incomplete or poorly resolved. That often led to great problems within the systematic analysis of secondary data, reports and surveys from the various statistical offices and other agencies in Vietnam. Further research is therefore needed to fill the data gaps and allow a comprehensive analysis of water engineering and socio-economic developments in the South of Vietnam.

## References

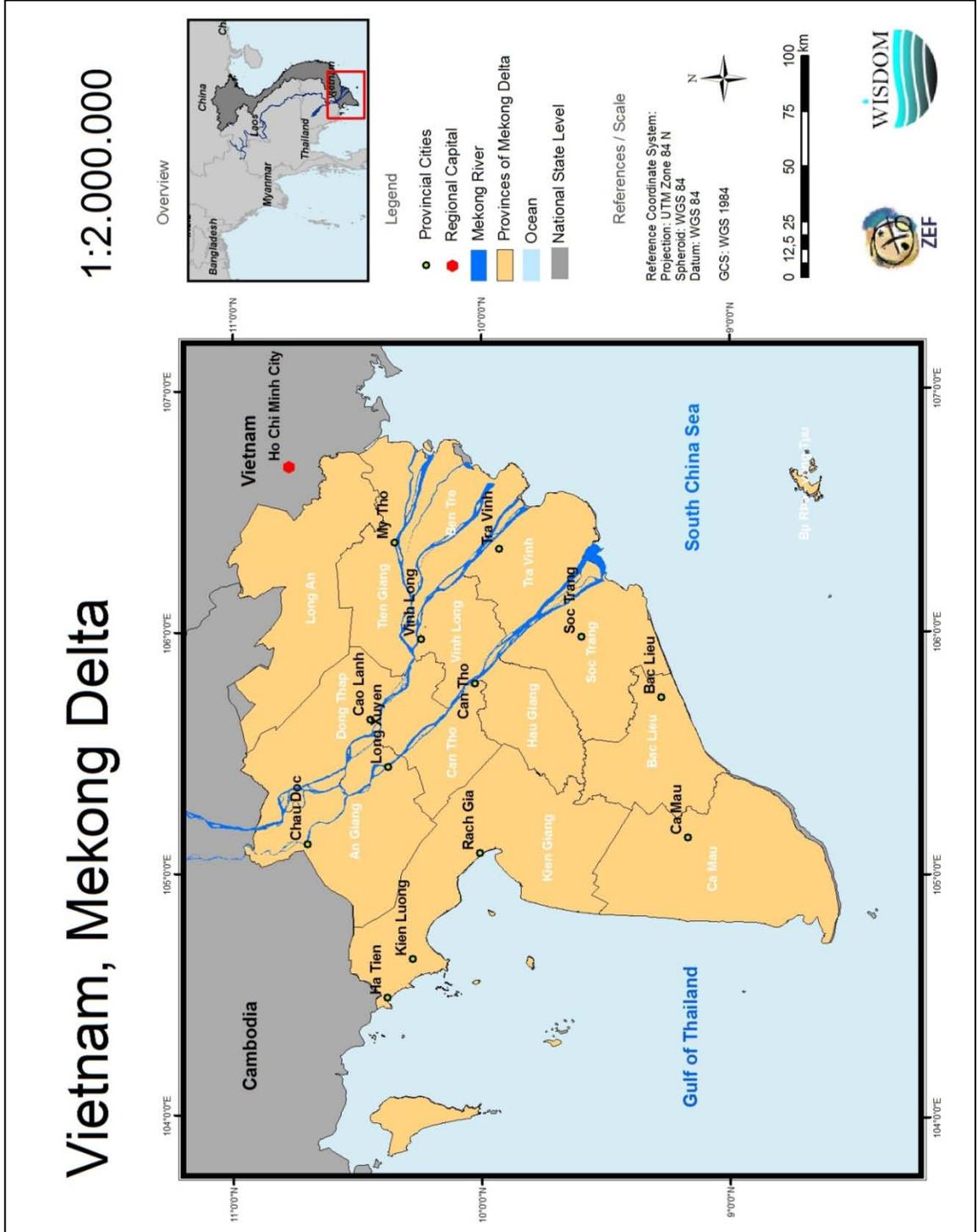
- Australian Agency for International Development (AusAID) and Centre for International Economics (2002). Vietnam Poverty Analysis. AusAID. Canberra, Sydney.
- Australian Agency for International Development (AusAid) (2004). Mekong Delta Poverty Analysis, AusAid: 132.
- Benjamin, Dwayne and Loren Brandt (2004). Agriculture and Income Distribution in Rural Vietnam under Economic Reforms: A Tale of Two Regions. Economic Growth, Poverty, and Household Welfare in Vietnam. P. Glewwe, N. Agrawal and D. Dollar. Washington, World Bank: 133-185.
- Biggs, David (2004). Between the Rivers and the Tides: A Hydraulic History of the Mekong Delta 1820-1975, Department of History. Washington, University of Washington.
- Biggs, David, Miller, Fiona, Chu Thai Hoanh and François Molle (2009). The Delta Machine: Water Management in the Vietnamese Mekong Delta in Historical and Contemporary Perspectives. In: F. Molle, T. Foran and M. Käkönen, Contested Waterscapes in the Mekong Region. Hydropower, Livelihoods and Governance. London, Earthscan: 203-221.
- Evers, Hans-Dieter and Simon Benedikter (2009). Strategic Group Formation in the Mekong Delta - The Development of a Modern Hydraulic Society. ZEF Working Paper No.35. Center for Development Research. University of Bonn, Bonn.
- Fuhrmann, Eva (2008). Regulating Water in the Mekong Delta. Südostasienwissenschaften. Bonn, Friedrich-Wilhelm Universität. **Diploma thesis**.
- General Statistics Office (GSO) (2001a). Statistical Data of Vietnam – Agriculture, Forestry and Fishery 1975-2000. In: Ministry for Agriculture and Rural Development (MARD) Department of Planning and Projection (2002). Statistics of Agriculture and Rural Development 1996 - 2000. Hanoi, MARD.
- General Statistics Office (GSO) (2001b). Rural Agricultural and Fishery Census of 2001 In: Ministry for Agriculture and Rural Development (MARD) Department of Planning and Projection (2002). Statistics of Agriculture and Rural Development 1996 - 2000. Hanoi, MARD.
- General Statistics Office (GSO) (2007a). Result of the Survey on Household Living Standards 2006. Statistical Publishing House. Hanoi.
- General Statistics Office (GSO) (2007b). The 2006 Population Change, Labour Force and Family Planning Survey - Major Findings. Hanoi, Statistical Publishing House.
- General Statistics Office (GSO) (2008). Statistical Yearbook of Vietnam 2007, General Statistics Office (GSO).
- General Statistics Office (GSO) (2009). Socio-Economic Statistical Data of 63 provinces and cities. Integrated Statistics Department. Hanoi, Statistical Publishing House.
- Hashimoto, Toru (2001). Environmental Issues and Recent Infrastructure Development in the Mekong Delta: Review, Analysis and Recommendations with Particular References to Largescale Water Control Projects and the Development of Coastal Areas. University Of Sydney, Australian Mekong Resource Centre: 70.
- Käkönen, Mira, Keskinen, Marko, Varis, Olli, Ngo Thuy Diem Trang, Ngo Thi Thanh Tuc, Tran Thi Trieu, Le Truong Giang, Le Duc Toan and Nguyen Van Lanh (2006). Hydrological, Environmental and Socio-Economic Modeling Tools for the Lower Mekong Basin Impact Assessment, Mekong River Commission (MRC).
- Käkönen, M., M. Keskinen, et al. (2006). Mekong Delta Socio-Economic Analysis - Interconnections between water and livelihoods in the Mekong Delta of Vietnam. WUP-FIN Phase II - Hydrological, Environmental and Socio-Economic Modelling Tools for the Lower Mekong Basin Impact Assessment. Mekong River

- Commission. Helsinki, Espoo, Mekong River Commission and Finnish Environment Institute Consultancy Consortium.
- Käkönen, Mira (2008). "Mekong Delta at the Crossroad: More Control or Adaptation?" *Ambio* 37(3): 205-212.
- Kono, Yasuyuki (2001). "Canal Development and Intensification of Rice Cultivation in the Mekong Delta: A Case Study in the Cantho Province, Vietnam." *Southeast Asian Studies* 39(1): 70-85.
- Le Anh Tuan, Chu Thai Hoanh, Miller, Fiona and Bach Tan Sinh (2007). Floods and Salinity Management in the Mekong Delta, Vietnam. *Challenges to Sustainable Development in the Mekong Delta: Regional and National Policy Issues and Research Needs*. Tran Thanh Be, Bach Tan Sinh and F. Miller. Bangkok, Sustainable Mekong Research Network (Sumernet): 208.
- Le Meur, P.-Y., D. Hauswirth et al (2005), The Local Politics of Land and Water. Case Studies from the Mekong Delta. Paris, GRET
- Loi Chu Chi (2004). "Rural to Urban Migration in Vietnam." from [http://202.244.105.132/English/Publish/Download/Asedp/pdf/071\\_7.pdf](http://202.244.105.132/English/Publish/Download/Asedp/pdf/071_7.pdf).
- Miller, Fiona (2003). Society-Water Relations in the Mekong Delta: A Political Ecology of Risk. PhD. University of Sydney.
- Miller, F. Environmental Risk in Water Resources Management in the Mekong Delta: A Multi-Scale Analysis. *A History of Water. Water Control and River Biographies*. T. Tvedt and E. Jakobsson. London and New York, I.B. Tauris: 172-193.
- Ministry for Agriculture and Rural Development (MARD) Department of Planning and Projection (2002). *Statistics of Agriculture and Rural Development 1996 - 2000*. Hanoi, MARD.
- National Committee for the Advancement of Women in Vietnam (NCFAWV) and General Statistics Office (GSO) (2004). The Gender Statistics Book. Sex disaggregated data in Vietnam: 434.
- Pham Cong Huu, Ehlers, Eckart and Saravanan V. Subramanian (2009). Dyke System Planning: Theory and Practice in Can Tho City, Vietnam. *ZEF Working Paper No. 47*. Center for Development Research. University of Bonn, Bonn.
- Poverty Task Force (2003). Mekong Delta Participatory Poverty Assessment, United Nations Development Program
- Sakamoto, Toshihiro, Nhan Van Nguyen, Ohno, Hiroyuki, Ishitsuka, Naoki and Yokozawa, Masayuki (2006). "Spatio-temporal Distribution of Rice Phenology and Cropping Systems in the Mekong Delta with Special Reference to the Seasonal Water Flow of the Mekong and Bassac Rivers." *Remote Sensing of Environment* 100: 1-16.
- Shanks, E., Luttrell, C., Conway, T., Ladinsky, J. and Vu, M. L (2004). Understanding pro-poor Political Change: the Policy Process *Understanding pro-poor Political Change: the Policy Process*. London, Overseas Development Institute. 2: 37.
- Provincial Statistical Offices for the year 2007 (2008):  
 Statistical Office An Giang (2008). Statistical Yearbook 2007. An Giang, Statistical Office An Giang.  
 Statistical Office of Bạc Liêu (2009). Statistical Yearbook 2008. Bạc Liêu Statistical Office of Bạc Liêu.  
 Statistical Office of Bến Tre (2008). Statistical Yearbook 2007. Bến Tre, Statistical Office of Bến Tre.  
 Statistical Office of Cà Mau (2008). Statistical Yearbook 2007. Cà Mau, Statistical Office of Cà Mau.  
 Statistical Office of Can Tho City (2008). *Statistical Yearbook Can Tho City 2007*. Can Tho City, Statistical Office of Can Tho City.  
 Statistical Office Đồng Tháp (2008). Statistical Yearbook 2007. Đồng Tháp, Statistical Office Đồng Tháp.

- Statistical Office of Hậu Giang (2008). Statistical Yearbook 2007. Hậu Giang, Statistical Office of Hậu Giang.
- Statistical Office of Kiên Giang (2008). Statistical Yearbook 2007. Kiên Giang, Statistical Office of Kiên Giang.
- Statistical Office of Long An (2008). Statistical Yearbook 2007. Long An, Long An Statistical Office.
- Statistical Office of Sóc Trăng (2008). Statistical Yearbook 2007. Sóc Trăng, Statistical Office of Sóc Trăng.
- Statistical Office of Tien Giang (2008). Statistical Yearbook 2007 Tien Giang, Statistical Office of Tien Giang.
- Statistical Office of Tra Vinh (2008). Statistical Yearbook 2007. Kế Tra Vinh, Statistical Office of Tra Vinh.
- Statistical Office of Vinh Long (2008). Statistical Yearbook 2007. Vinh Long, Vinh Long Statistical Office.
- Taylor, Philip (2004) Redressing Disadvantages or Re-arranging Inequality? Development Interventions and Local Responses in the Mekong Delta. In: Taylor Philip (ed.) Social Inequality in Vietnam and the Challenges to Reform. Institute of Southeast Asian Studies, Singapore.
- Tran Thanh Be, Bach Tan Sinh, et al., Eds. (2007). Challenges to Sustainable Development in the Mekong Delta: Regional and National Policy Issues and Research Needs. Bangkok, Sustainable Mekong Research Network (Sumernet).

# Appendix

Figure 5: Vietnam, Mekong Delta



- 1 Evers, Hans-Dieter and Solvay Gerke (2005). Closing the Digital Divide: Southeast Asia's Path Towards a Knowledge Society.
- 2 Bhuiyan, Shajahan and Hans-Dieter Evers (2005). Social Capital and Sustainable Development: Theories and Concepts.
- 3 Schetter, Conrad (2005). Ethnicity and the Political Reconstruction of Afghanistan.
- 4 Kassahun, Samson (2005). Social Capital and Community Efficacy. In Poor Localities of Addis Ababa Ethiopia.
- 5 Fuest, Veronika (2005). Policies, Practices and Outcomes of Demand-oriented Community Water Supply in Ghana: The National Community Water and Sanitation Programme 1994 – 2004.
- 6 Menkhoff, Thomas and Hans-Dieter Evers (2005). Strategic Groups in a Knowledge Society: Knowledge Elites as Drivers of Biotechnology Development in Singapore.
- 7 Mollinga, Peter P. (2005). The Water Resources Policy Process in India: Centralisation, Polarisation and New Demands on Governance.
- 8 Evers, Hans-Dieter (2005). Wissen ist Macht: Experten als Strategische Gruppe.
- 8a Evers, Hans-Dieter and Solvay Gerke (2005). Knowledge is Power: Experts as Strategic Group.
- 9 Fuest, Veronika (2005). Partnerschaft, Patronage oder Paternalismus? Eine empirische Analyse der Praxis universitärer Forschungskoooperation mit Entwicklungsländern.
- 10 Laube, Wolfram (2005). Promise and Perils of Water Reform: Perspectives from Northern Ghana.
- 11 Mollinga, Peter P. (2004). Sleeping with the Enemy: Dichotomies and Polarisation in Indian Policy Debates on the Environmental and Social Effects of Irrigation.
- 12 Wall, Caleb (2006). Knowledge for Development: Local and External Knowledge in Development Research.
- 13 Laube, Wolfram and Eva Youkhana (2006). Cultural, Socio-Economic and Political Constraints for Virtual Water Trade: Perspectives from the Volta Basin, West Africa.
- 14 Hornidge, Anna-Katharina (2006). Singapore: The Knowledge-Hub in the Straits of Malacca.
- 15 Evers, Hans-Dieter and Caleb Wall (2006). Knowledge Loss: Managing Local Knowledge in Rural Uzbekistan.
- 16 Youkhana, Eva, Lautze, J. and B. Barry (2006). Changing Interfaces in Volta Basin Water Management: Customary, National and Transboundary.
- 17 Evers, Hans-Dieter and Solvay Gerke (2006). The Strategic Importance of the Straits of Malacca for World Trade and Regional Development.
- 18 Hornidge, Anna-Katharina (2006). Defining Knowledge in Germany and Singapore: Do the Country-Specific Definitions of Knowledge Converge?
- 19 Mollinga, Peter M. (2007). Water Policy – Water Politics: Social Engineering and Strategic Action in Water Sector Reform.
- 20 Evers, Hans-Dieter and Anna-Katharina Hornidge (2007). Knowledge Hubs Along the Straits of Malacca.
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