International Journal of Water Governance 2 (2014) 61–82
DOI: 10.7564/14-IJWG59

Irrigation development in the Vietnamese Mekong Delta: Towards polycentric water governance?

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Vietnam's irrigation development policy directions are divided between the objective to continue increasing rice production through agricultural intensification and to improve farmer's livelihoods through crop diversification and integrated farming. While the first objective requires the construction of new large-scale irrigation system in deeply flooded area of the Vietnamese Mekong River Delta, the latter demands the modification in management of existing irrigation physical infrastructure for non-rice crops, in particular brackish aquaculture in the coastal zones. This article looks at Vietnam's irrigation policy formulation processes in the last three and half decades in relation to the idea of polycentric governance. It discusses the current shortcomings and potential role of polycentric governance networks to capture stakeholders' interests at multiple governance levels essential for future policy development. It partially sheds light on the dark side of water governance, bringing to light the fragmented polycentric decision-making processes in Vietnam's irrigation development policies.

Keywords: irrigation development, rice production, policy evolution, polycentric governance, Mekong River Delta

1. Introduction

Vietnam irrigation development policy has always been driven by the objective to increase the country's rice production, not always link to the need to improve farmer's household income. At present, however, national policy directions in irrigation development are divided between the objective (i) to continue increase rice production through agricultural intensification (from 33 million tons in 2000 to 40 million tons in 2010, including 7–8 million tons of exported milled rice), and (ii) to improve farmers' standard of living through for instance crop diversification or aquaculture with a target of raising rural household incomes by 2.5 times, reducing rural poverty rate by 2% per year (Ministry of

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Agriculture and Rural Development [MARD], 2012). To achieve the first objective the government would have to continue with infrastructure development and construct new large-scale irrigation system in deeply flooded areas in the Mekong River Delta. This infrastructure-oriented development approach would ensure the continuation of irrigation systems development for freshening the whole delta to increase rice production, ensure national food security, and maintain Vietnam's position as one of the largest rice exporters in the world. The second policy objective, on the other hand, urges the need to increase farmers' household incomes and thus does not necessarily give high priority to rice farming (due to its low revenues to farmers). According to the Vietnam General Statistic Office, the country's achievement to reduce rural poverty (from 45.5% in 1998 to 27% in 2010) is closely related with the diversification policy that allows farmers to cultivate other crops such as vegetable, perennial trees and aquaculture, next to its focus to maintain 3.8 million ha of high yield rice land (MARD, 2012). Recent experience has proven for instance the important role of aquaculture (i.e. shrimp farming using brackish water) as a higher source of income for farming household compare to rice farming (Hoanh et al., 2009). Technically, the second objective requires some modification of the existing irrigation systems to enable brackish aquaculture for shrimp farming.

The government views irrigation infrastructure development as a key factor for the country's agricultural development. This is reflected by the annual budget allocated to line ministries. In 2006, the budget of the (MARD) ranked second behind that of the Ministry of Transport. MARD received a total annual budget of 3,154 billion VND (US$197 million) of which 2,018 billion VND (US$126 mil, 64%) was allocated to infrastructure investment, mainly irrigation (Ministry of Finance, official government website: http://www.chinhphu.vn/portal/page/portal/chinhphu/solieungansachnhanuoc?categoryId=839). At lower levels, provincial and district authorities decided which irrigation systems to be invested or strengthened (MARD, 2012).

Government's tendency to continue with large-scale infrastructure development was also evidenced from the way it shaped donor-funded projects to mobilize funds for the construction of water control infrastructure. In 2009 for instance a World Bank mission prepared a project on Mekong Delta Integrated Rural Development for 2011–2015. As part of this project, the Vietnamese government tried to get new financial supports for the construction of two large sluices, the Cai Lon and Cai Be (location in Figure 3) to completely enclose and freshen the central part of Ca Mau Peninsula. Later, a review on the implementation of water control after Master Plan 1994 was done to prepare for new water control projects (Ministry of Agriculture and Rural Development, Southern Institute of Water Resources Planning [MARD, SIWRP], 2010). Based on this review, a new project for developing an integrated long-term Mekong Delta Master Plan (Mekong Delta Plan) was started in 2011 with funding from the Government of Netherlands that include infrastructure development under climate change and sea water level rise.

In recent years, however, the government also began to consider land use options that can convert about 350,000 ha of rice land with low yield in the country into other land use types with higher revenues, such as vegetable, perennial trees and aquaculture

(MARD, 2012). The most significant changes in the land use and irrigation system were in the saline zone where farmers converted their agricultural land into brackish water shrimp fields as happened in the Quan Lo Phung Hiep region (Hoanh et al., 2009). Total areas of aquaculture in the Mekong River Delta were expanded from 135,700 ha in 1991 to 289,400 ha in 1995 and 571,700 ha in 2002.

In a changing and globalized world, decision-making in irrigation development is more difficult than ever before. Following the country's economic reform (*doi moi*) in 1986, Vietnam became part of the global market economy. Obviously, decisions on irrigation development are no longer made by the Ministry of Water Resources (MWR – merged into MARD in 1995) alone, but involve other key decision makers, primarily those who control the allocation of large funds at macro level such as the Ministry of Planning and Investment (MPI) and the Ministry of Finance (MoF). In an attempt to broaden the focus of water resources management from the historical focus on irrigation to integrated water resources management (IWRM), the government has formed the Ministry of Natural Resources and the Environment (MoNRE) to share responsibility in water resources management with MARD (Molle & Hoanh, 2009).

This article discusses Vietnam's irrigation policy formulation processes in relation to the idea of polycentric governance. It brings to light the importance to incorporate all stakeholders' points of view, either through participatory or informed top down approaches in the overall decision-making processes, as a means to come up with the best policy decisions. For this purpose we look at how the government made policy decisions and formulated irrigation development programs in the Mekong River Delta during the last three and half decades. The article discusses how decision-making processes in irrigation policy development in Vietnam do not always include the whole range of perspectives from relevant stakeholders, revealing the actually very fragmented polycentric governance networks. Nonetheless, the current decision-making system seems to function as evident in increase rice production and partial improvement of farming households' income. We illustrate that the current functioning of such a fragmented polycentric governance network relies mainly on a mixture of formal-informal, legal-illegal, cooperative-competitive, top down-bottom up, and centralized-decentralized processes. While this reveals the `dark side of water governance`, it also illustrates how decision-making processes in Vietnam had evolved. Understanding this evolution process is crucial to help the government design future irrigation development policies.

2. Polycentric decision making in water governance

Current debate on global water governance in general and on irrigation development in particular centers on polarized views towards centralization and decentralization (Fontenelle, 1999; Fritzen, 2006; Oorthuizen, 2003). Advocates of centralized decision making argue that centralized governance is necessary to manage and operate highly technical, large-scale irrigation systems (Wittfogel, 1957), if these systems were to function the way they were designed. Molle, Mollinga, & Wester (2009) emphasize on the

role of the irrigation bureaucracy in shaping irrigation systems management. Supporters of decentralization argue on the other hand, that irrigation systems management should involve farmers and local population (Chambers, 1997; 1988). Decentralization has been at the center stage of global water governance policy and program (Bardhan, 2002; Burki, Perry, & Dillinger, 1999). Major funding agencies such as the World Bank had made decentralization an integral part of its reforms agenda (World Bank, 2000). While potential advantages of decentralization: policy accountability, effective and responsive governance system, better service provision, greater possibilities for stakeholder participation have attracted many supporters, nowadays these 'advantages' are disputed (de Vries, 2000). Decentralization has become a subject of constant debate in recent years (Crook, 2003; Smoke, 2003). There is also indication that governments in both developed and developing countries are taking prudent steps towards recentralization (Cummings, 1995; Popkewitz, 1996; Suhardiman, 2008).

In our attempt to move beyond the polarized discourse towards centralization and decentralization, we show that current research in water resource management can look at water governance as a process of network formation (Suhardiman & Giordano, 2012), constantly shaped and reshaped by various actors and stakeholders at multiple, sometimes overlapping governance levels. Viewing water governance as a process of network formation would give us better understanding of the complex systems and mechanisms that shape and reshape water governance practices. In this light, we highlight the importance of polycentric governance concept (Neef, 2009; Ostrom, 2009; 2010) both as theoretical framework and analytical tool to understand governance processes in natural resource management in general, and irrigation policy formulation processes in Vietnam in particular.

The concept of polycentric governance was first introduced by Ostrom and others back in the 1960s (Ostrom, Tiebout, & Warren, 1961). The concept was developed primarily from studies of collective goods in metropolitan areas in the United States. Yet, Ostrom's research interest at that time to develop methods for measuring inter-organizational structure in a consistent manner (Ostrom, 2010) provides a robust scientific foundation for applying the concept within the wider context of water governance and natural resource management later on. These early studies on polycentric governance networks focused on understanding structures created by government officials and citizens to influence decision-making processes as well as the consequence of these structures in shaping the overall governance processes. In recent years, the concept has also been implied in various theories and concepts from respectively political science and policy science. These include Institutional Analysis Development (IAD) framework (Ostrom, 1999), actors network theories (Klijn, 1996), and Advocacy Coalition Framework (ACF) (Sabatier & Jenkins-Smith, 1993). Polycentric governance regimes have been described as *"complex, adaptive systems without one central authority dominating all of the others in regard to all policy arenas"* (Andersson & Ostrom, 2008, p. 78).

The concept of polycentric governance has the potential to help us cope with future challenges in natural resources management by connecting relevant institutions and actors

at multiple governance level through various networks and linkages. From the perspective of knowledge (re)production, the concept of polycentric governance can enable institutions and stakeholders to blend local with scientific knowledge (Berkes & Folke, 1998; McGinnis, 1999). It could link state agency's macro knowledge and understanding of system management with other stakeholders' and farmers' local knowledge and experience with regard to their micro level farming practices. As stated by Andersson and Ostrom (2008, p. 78): *"The key to the successful design of institutions is their multiple scales and their generation of information that allows participants operating at many different scales to learn from experience. The complexity of the environment involved is simply more than any single corporate entity can absorb and manage"*. Polycentric governance allows a certain degree of experimentation in developing institutional and policy rules to fit a range of conditions (Ostrom, Schroeder, & Wynne, 1993) within the context of changing socio-economic, political, and agro-ecological environment. This characteristic is very important in shaping the system's flexibility and adaptability. Conceptually, polycentric governance has the potential to resolve the scaling constraints for both centralized (down-scaling) and decentralized (up-scaling) decision-making processes. Moreover, polycentric governance offers an alternative to cope with the present physical and institutional inertia embedded in decentralization trends (Herring, 2001).

Current discourse on polycentric governance has highlighted challenges in creating highly complex institutional frameworks that can capture all the potentials of polycentric governance networks, such as their ability to experiment with new rules of the game, integrating expert and lay knowledge in managing natural resources, and creating a room for manoeuvre for a broader range of non-state actors (Ostrom, 2005; Merrey et al., 2007; Molle et al., 2007). Taking the discourse forward, our Vietnamese case study illustrates that the creation and the shaping of polycentric governance networks cannot be analyzed in isolation from the issue of power struggles, and the overall notion of power asymmetry, when more powerful actors dominate decision-making processes, often at the expense of the less powerful groups. A polycentric governance structure does not guarantee policy accountability. Similarly, it does not always represent the idea of deliberation. As stated by Neef (2009, p. 56): *"Polycentricity may be seen as the number and density of nodes (actors) and links (interactions) in a resource governance regime, while deliberation refers to the power relations among these actors and the frequency, quality and depth of interactions"*.

The notion of power asymmetry will shape and reshape the overall process of knowledge (re)production in favor of those in power. The notion of power asymmetry does not only bring to light the probability of intransparent decision-making processes, for instance when powerful actors withheld important information merely to sustain their power, but it also highlights the politics of knowledge (re)production and its implications to the overall shaping of decision-making processes.

This issue of power asymmetry partially explains why polycentric governance cannot be viewed as prescriptive governance approaches. Theoretically, truly polycentric governance networks can only be formed when there is no central authority dominating all of

the others. The way irrigation development policies in Vietnam are shaped and reshaped through the sustenance of dominant power holder and the incorporation of other's opinion highlights the fragmented polycentric governance structure. While far from perfect, we argue that fragmented polycentric governance framework and processes played an important role in shaping current policy debates and in defining future direction of irrigation development in the country. Within the context of centralized planning system and strong state's power in Vietnam, fragmented polycentric governance resembles the very embryo for irrigation and water sector reform. Our Vietnamese case study shows how (fragmented) polycentric governance can sometime enables 'inclusive' decision-making processes to occur even within the context of power asymmetry. The concept of polycentric governance (even in its fragmented form) provides a subtle entry point to promote change, as it can still be applied without strong pretext to change or disturb the current balance in power relationship. In this light, the merit of polycentric governance approach lies more in its ability to gather relevant information and incorporates it into policy decisions, and thus less in its role to promote change.

In the next sections we describe how the Vietnamese government has directed their water resources management policy through a fragmented polycentric governance networks. It highlights the issue of power domination rooted in power asymmetry in irrigation decision-making networks. As policy decisions are often made based mainly on policy elites' interests, or without incorporating various stakeholders' development aspirations, this often manifests in the policy coordination and enforcement problems later on. Nonetheless, our Vietnamese case study also shows that such fragmentation does not necessarily have to result in policy disintegration. It reveals how government actors and farmers to a certain extent shape and reshape the rules of the games (i.e. irrigation policies, farming practices) in accordance with respectively the country's national development strategies and farmers' farming households' strategy. While this continuous process of rules shaping is crucial for our understanding of the complex water governance networks and mechanism, there are very few studies that looks at how government and other stakeholders shape such process, partially revealing the dark side in water governance.

The next section illustrates and discusses the Mekong River Delta's important role for the country's irrigation and agricultural development for the last three and half decades.

3. The Vietnamese Mekong River Delta

The Mekong River Delta (location in caption map, Figure 1) is the last region through which the Mekong River reaches out into the South China Sea (called East Sea by Vietnamese). It comprises a vast flood plain with an elevation of 0–4 m above mean sea level formed of eroded sediments from the upper basin (Fedra, Winkelbauer, & Pantulu, 1991). The delta has a total area of four million hectares for over 17 million Vietnamese inhabitants in 2012, about 20% of the country population. Annual average runoff volume per capita representing the water resource in the Mekong River Delta is very high, about

27,000 m^3/capita. Due to high seasonal variation, over 90% of rainfall and surface water are concentrated during the flood season from May to November. In this context, the great potential for agriculture and aquaculture production in the Mekong River Delta depends highly on flood control and irrigation improvement during the dry season.

Massive irrigation development in the Mekong Delta highlights the area's importance for the country's agriculture development. Vietnam was still a net rice importing country in 1985, but it exported 1.4, 4.6 and 5.6 million tons in 1989, 1999 and 2010, respectively, of which the Mekong River Delta contributed more than 90%. This remarkable increase in rice production and export is related to the rapid growth of rice planted area in the past 20 years aided by the expansion and increased density of the irrigation and drainage system that occupying 9% of the delta area (An, 2002). Many water control projects were constructed by central government from 1975 onwards. These include floodgates, saline protection dams and dykes, sluices, and pumping stations (MARD, 2003). Currently, the Mekong River Delta is one of the most productive zones for rice and aquaculture in the world, supplying more than 70 and 50 per cent of Vietnam's foreign export amounts of these staples.

The Mekong River Delta can be divided into three main water resource zones: the high flooded, the low flooded fresh water and the salinity intrusion (see Figure 1).

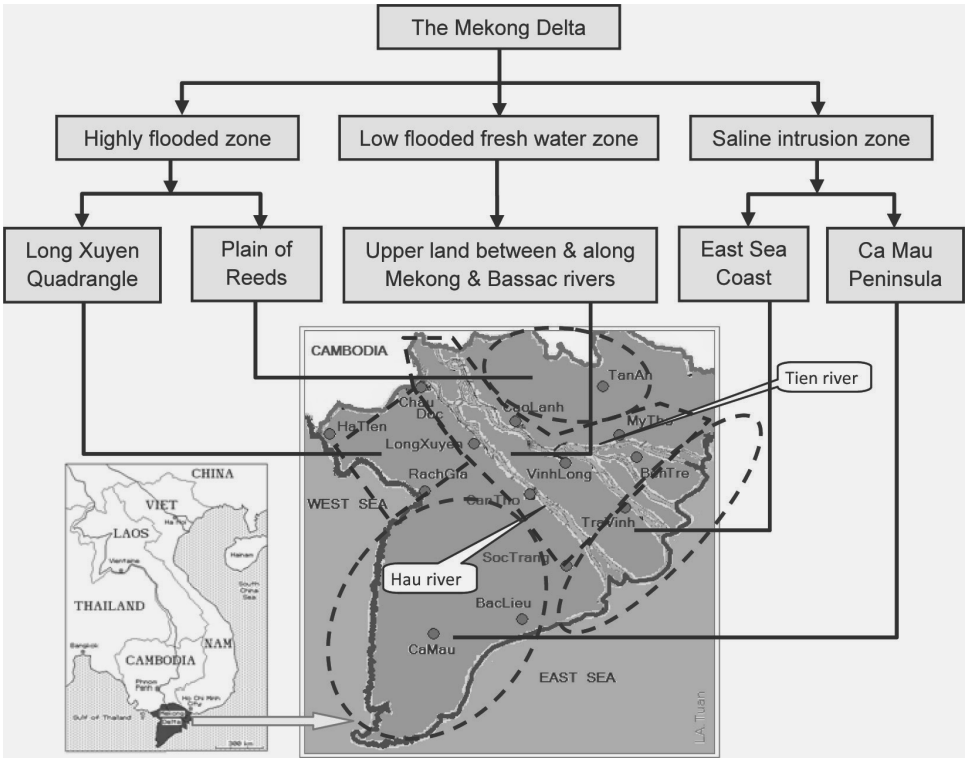

Figure 1. Three main water resource zones in the Mekong Delta.

4. Irrigation development in the Mekong River Delta

The Mekong River Delta's agricultural development potential has been acknowledged as early as the 18th century. From 1860 to 1930 many canals were excavated and cultivated area was enlarged rapidly under the French colonial rule (Biggs, Miller, Hoanh, & Molle, 2009). In the 1930s first projects to build "Dutch dikes" and saltwater dams and irrigation canals began. Implementation of large irrigation projects during 1945–1960 was restricted due to the war, but reinitiated after 1960 such as the My Phuoc project in Soc Trang province by SOGREAH in 1963, the Plain of Reeds by US Army Corps of Engineers, and the Go Cong project in Tien Giang province by Korean government in 1971 as well as the Tiep Nhut project in Soc Trang province by Nippon Koei in 1972 (project locations in Figure 3).

In 1975, the re-unified Vietnamese government commenced a 'rice everywhere' campaign to address the problem of severe food shortage in the country. For this, the government embarked upon a number of new reclamation projects. In practice, 'rice everywhere' strategy was used to justify investment in flood-protection dikes, canals and pumping stations for irrigation, especially following the severe flood of 1978 which devastated most rice crops. During this time, the government viewed water control infrastructure as key elements to increase rice production. Here, saline water was considered a constraint to agriculture, and flood was a threat to intensification. Later, this perception of saline water as a constraint changed, when farmers introduced shrimp farming, which relies on brackish water (Biggs et al., 2009). After 1975 irrigation development in the Mekong River Delta can be split into five periods based on different policies formulated and introduced by the government.

4.1. Bringing experiences from Red River Delta to the Mekong River Delta (1975–1978)

In the aftermath of the war in May 1975, irrigation development was directed without any specific plan on how it might contribute to country's overall development goals. Rather, it was focused primarily to occupy the labor force that existed in the communities (the 'public service labour' contribution – "*lao dong cong ich*" in Vietnamese), as the government feared that a free labor force might result in or contribute to the country's political instability, and also intended to promote the communist concept to people in the South Vietnam. Small canals were dug by hand in every province of the Mekong River Delta without proper planning and design. Such unplanned development led to several problems, in particular in the areas of acid sulfate soils (ASS) where disturbing surface soils caused serious pollution of acidity into canal systems and spread over the fresh water zones at the beginning of rainy season (Kham, 2008).

In response to this lack of plan, the Ministry of Water Resources (MWR) formed a Water Resources Planning Team (WRPT) to prepare a new plan for irrigation development in 1976. The first report, entitled "Direction for Water Resources Planning for MRD in 1977–1978", prepared by the WRPT, was a basic reference for irrigation development in

1976–1980. The plan proposed to increase rice production in the Mekong River Delta by the introduction of large pumping stations and large canal systems following experiences from the Red River Delta (RRD) model applied during the war (Kham, 2008).

In practice, however, many large pumping stations were abandoned or operated for very limited service areas compared with design. Unlike in the RRD where large stations with capacity of few hundred m3/hour using Russian pumps with 5–10 m pumping lift are required to supply irrigation water for service areas of 1,000 ha, in the Mekong River Delta pumping lift is much lower, only 1–3 m. In addition, soil property with high clay contents often caused cracks and leaching of water in surface canals after a short distance. For these reasons, farmers preferred to use their portable low-lift pumps independently rather than depending on large pumping station operated through government-induced cooperatives (Kham, 2008). These cooperatives were formed as part of the government's land collectivization policy (Directive 29/CT-TW, 26 December 1977 issued by the Central Committee of Communist Party). In line with the land collectivization policy farmer's portable low-lift pumps were viewed as individual production equipment of capitalism. With this political view, the government obliged farmers to contribute their portable pumps as cooperative properties. Moreover, the government controlled the operation of individual pumps through administrative measures such as control of gasoline and distribution of pump spare parts.

4.2. Irrigation policy formulation by political will (1978–1980)

In 1978, the government took a strongly politicized decision as a response to severe shortage of rice in the country, a shortage caused by both the land collectivization policy that made farmers abandon their fields and the severe flood in the Mekong River Delta. In line with the government's political interest, increased rice production in the Mekong River Delta became the government's target in irrigation development regardless of its social, economic and environmental impacts. The Ministry of Water Resources, provincial and local authorities made a great effort to expand rice area in dry season because with the abundant solar radiation in this season rice yield is much higher (4–6 tons/ha) than that of rainy season (1.5–2.5 tons/ha). The expansion of two dry season crops, summer-autumn from May to August before the flood and winter-spring from November/December to February after the flood was based on the expansion of irrigation systems.

In practice, however, the government continued to face many constraints to achieve the defined target to increase rice production. Lack of dredging equipment, petrol and capital were the major constraints reported by the MWR. Responding to these constraints, the country's top leader instructed the organization of large public fields for digging canals by hand and urged the state to print more money (Kham, 2008).

4.3. Role of scientific evidence in policy formulation processes (1981–1985)

Previous policy failure to increase rice production in the Mekong River Delta made the government realized that decision based only on political will without scientific

knowledge did not work (Ninh, 2003; Dieu, 2006). This realization manifested in the formation of State Programs for understanding the real situations and finding proper alternatives for rice production. These programs include State Programs 60–02 and 60B focusing on biophysical, socio-economic survey and State Program 06–03 for integrated water resources management. Complementing these programs, hydraulic and salinity models were developed and regularly refined with updated data to simulate and predict better water conditions under different water control options. In addition, an elevation map at scale 1:25,000 was produced (Deltares, Delta Alliance, & DWRPI-South Vietnam, 2011), cross-sections of main rivers and canals were updated and a network of over 100 hydrological stations was installed to monitor water level, flow and salinity and also flow at some key stations (Hoanh, 1987).

Based on the collected information, the government formulated the development plan for 1986–1990. The main objective of this plan is still to increase rice production to 9–10 million tons in 1990 and up to 15–16 million tons by 2000. But unlike before, the government divided the Mekong River Delta into 5 large water control zones, namely Long Xuyen Quadrangle, West Hau River, East Tien River, Transitional Zone between Tien and Hau Rivers, and Ca Mau Peninsula (Figure 1). These zones were divided by a dense canal network (Figure 1) into 120 water sectors, and irrigation projects were formulated for each or a group of sectors (Netherlands Engineering Consultants [NEDECO], 1993).

In line with the defined plan, irrigation development was carried out in various part of the Mekong River Delta using various rather than uniform/standardized (non) technical approaches like previously. For example, in the Northern part where the land is deeply flooded, covered by acid sulfate soils and fresh water source is limited in the dry season, main canals were excavated from the Tien river to the Vai Co river (or Vam Co river in Vietnamese), from the Tien river to the Hau river, and from the Hau river to the Gulf of Thailand (called West Sea by Vietnamese) for irrigation. A low dike system was built to protect from the August flood (lower than the flood peak that usually occurs in September or October) to assure for the harvesting of the summer-autumn rice. After this crop was harvested, floodwater is allowed to flow into fields for trapping fertile sediment and leaching out pollution. In the Central part of the Delta where the land is moderately flooded but fresh water is abundant, existing canal network was improved with denser canals, and dike for full flood protection was built so that rice crops can be cultivated throughout the year (Figure 2). In the Southern part which has to contend with saline water intrusion and limited fresh water resources, dike and sluices for protection from salinity intrusion and irrigation network was improved to increase cropping intensity from one to two rice crops per year (NEDECO, 1993).

Despite significant improvement in irrigation infrastructure, strong government control of market chains hampered farmers' motivation to invest in farming. As a result, rice production did not increase as fast as expected although irrigation water was provided for growing 2–3 rice crops per year. Nevertheless, irrigation infrastructure development in the Mekong River Delta during this period enabled farmers to increase rice production from 4.7 million tons in 1975 to 7.0 million tons in 1985.

Figure 2. A typical canal network with settlements along canal bank in the Mekong River Delta. (Imagery@2009 DigitalGlobe, Cnes/Spot Image, GeoEys from Google Wikimapia)

When irrigation policy development is formulated based on findings and recommendations from scientific studies (conducted by national universities as well as government research and planning institutes), potential social and environmental impacts became part of policy consideration. This scientific-based policy formulation approach gave more opportunities for relevant stakeholders (including those at the local level like farmers and commune leaders) to become part of policy discussion processes. For example, at the beginning the excavation of new canals in the Plain of Reeds received strong objection from national scientists at various universities and research institutes as well as international scientists who experienced with the reclamation of acid sulfate soils in other countries (Kham, 2008). They argued that these canals would drain out acid water into the Mekong River and cause pollution to the existing rice areas. At the same time, the voice of Provincial People Committees (PPC) was stronger. Referring to the analysis provided by his scientific advisory group that were contradictory with the opinion of scientists and planners of MWR, the Chairman of Dong Thap PPC indicated to the Minister of MWR during field visit that the new Hong Ngu canal (location in Figure 3) will lower the groundwater table and lead to more severe acid water situation, hence he strongly requested to stop the excavation of this main canal (Kham, 2008). The excavation could only be continued after a long argument between two groups. After this canal was linked to the West Vai Co River (location in Figure 3), acid water was pushed into this river by strong flow from the Mekong River and gradually moved downstream and diluted with large water volume in the estuaries. This movement caused some difficulties in water use for irrigation at downstream of the West Vai Co River during a short period at the beginning of rainy season. However, this acid water, mainly from the dredged acid sulfate spoils along canal embankments, disappeared after few years due to leaching effects on rain and flood water.

Although water quality in the acid sulfate soil areas was improved and became suitable for rice cultivation, the excavation also has some environmental impacts. With the

excavation, the Plain of Reeds lost its characteristics as a natural floodplain and thus its flood storage function, resulting in higher flood depth at downstream and upstream, and also drought and salinity intrusion problem in coastal provinces in the dry season. Similarly, the process of transforming the Plain of Reeds to an agriculture area involved high economic costs for many farmers who sold their land in their home provinces to come to acquire land in the newly opened area, as they suffered from successive years of crop failure due to acidity. Nonetheless, based on this experience, many canals were excavated through other acid sulfate soil areas in the Mekong River Delta. Likely the impacts on local people in certain places could not be weighted with the policy will for developing larger areas.

4.4. Irrigation development within the context of economic reform (1986–1995)

During this period, the government also realized the importance to strengthen all sectors development, not only limited to irrigation and agriculture. In 1986 the policy shift from a centralized economy to a "socialism-oriented" market economy after *doi moi* allowed competition in supplying and consuming of products and had significant effect in the production systems. Driven by the expected high profits, farmers started to explore the full capacity of irrigation systems by using their small low-lift pumps. Areas of double and triple rice cropping (i.e. two or three rice crops a year), either under supplementary irrigation at the beginning of the rainy season or fully irrigated during the dry season, were expanded from 619,000 ha in 1985 to 1,023,000 ha in 1990 and 1,163,000 ha in 1995. The rate of conversion from one rainfed rice crop to irrigated double/triple rice cropping during 1985–1990 was about twice that during 1976–1980. With irrigated rice in the dry season, average rice yield increased from 3.0 tons/ha in 1985 to 3.7 tons/ha in 1990 and 4.0 tons/ha in 1995.

In line with *doi moi* the new development strategy developed from 1987 on reflected in the Mekong Delta Master Plan incorporated integrated development approaches to support all economic sectors, including navigation and transport, flood control, rural development, domestic and industrial water supply (NEDECO, 1993). Improvement of irrigation infrastructure was accompanied, for instance, by construction of new settlements, roads, electricity and public infrastructures such as schools, markets, and hospitals. Sharing of responsibility between central government, provincial, district and commune authorities was also made clearer in this period (NEDECO, 1993), although central government remained in charge for planning and budget management.

In line with the government's objective to increase rice production for export, the government decided to expand water control systems into large flooded zones, the Long Xuyen Quadrangle and the Plain of Reeds, and into large salinity intrusion zone, the Ca Mau Peninsula (locations see Figure 1). This idea of water control was also incorporated into the Mekong Delta Master Plan, which was formulated with UNDP funds from 1990 to 1993. NEDECO, a Dutch group, was selected as the consultant for this project with

the coordination of the National Planning Committee and contribution of line Ministries and 11 provinces in the Mekong River Delta. In accordance with the Master Plan, the government proposed three large water control projects, the South Mang Thit, O Mon-Xa No, and Quan Lo Phung Hiep (locations in Figure 3) focusing on improvement of water resources infrastructure proposed to the World Bank with total investment funds of USD 128.4 million.

4.5. Freshwater for irrigation, brackish water for aquaculture, and flood control in a deeply flooded area (1996–2000)

From 1996 to 2000, the government continued to focus on infrastructure development in the saline water zones, mainly to expand the area of irrigation for rice through prevention of saltwater intrusion to these lands. One example is the Quan Lo Phung Hiep project (location in Figure 3) in the Ca Mau peninsula where 12 large sluices were built along the national highway for protection against saltwater intrusion through the My Thanh and Ganh Hao rivers (locations in Figure 3) and irrigation for 250,000 ha. The construction of the first 3 large sluices in the east was completed in 1993 and effects on water conditions and subsequently on expansion of rice area have been observed since 1994. In 1996, the double-rice area was up to 82,000 ha. In 2000, when 11 sluices had been built, the area of double rice was up to 101,000 ha, mainly in the area of non-acid soils in the east (MARD, SIWRP, 1997).

While the construction of these sluices and dykes benefited rice farmers, it disadvantaged shrimp farmers in the acid sulfate soil area. Unlike rice farmers who preferred freshwater for their irrigation, shrimp farming preferred brackish water caused by intrusion of saltwater from the seas. In the acid sulfate soil area in the west of Quan Lo Phung Hiep project shrimp growers, attracted by the high profits - 2 to 10 times that of rice cultivation - of producing tiger shrimp (Penaeus monodon) for export, switched to stocking tiger shrimp post-larvae, and pond shrimp culture became popular (Brennan, Clayton, & Be, 2000). This high profit explains why the area of shrimp culture increased from about 10,000 ha in 1990 to over 30,000 ha in 1996 (MARD, SIWRP, 2003).

Conflicts in using fresh and brackish water occur at many places. As the sluices in the western fringe became operational after 1998, many shrimp farmers were forced to abandon aquaculture and to convert to less profitable rice farming. Conflicts between agriculture and aquaculture became more serious when shrimp growers broke a large dam, the Lang Tram, in 2001 to intake saline water into the protected area. This event prompted the government to re-examine the original policy emphasizing rice production and explore sluice operation options that would accommodate shrimp cultivation in the west while maintaining intensive rice production in the east. After that year a significant expansion of shrimp area was observed, up to 51,000 ha in 2001 and 64,000 ha in 2002.

In the deeply flooded area, although severe damage occurred in 1991 and 1994 flood control was not immediately applied due to the controversy on “full flood control” and

"living with floods" alternatives. Rather, the government encouraged local people to live on water or move to higher elevation places as canal banks during 4–5 months of flood season. This government's decision to promote the concept of "living with floods" was based on strong objections from many scientists and local leaders to the full flood control plan prepared by water resources planner with the following arguments: 1) sediment in flood water contributes significant nutrients to rice fields; 2) fishing in deeply flooded area provides significant income to the poor; and 3) flood control might cause negative impacts on the environment (in particular acid water pollution). Yet, land reclamation was conducted at high speed to expand irrigated area in the deeply flooded area. An area of 473,000 ha were converted from fallow into cultivated land within 5 years from 1996 to 2000 compared with 282,000 ha and 56,000 ha in the two precedent 10 year periods, 1976–1985 and 1986–1995, respectively (Data from General Statistic Office: Statistical Yearbooks of Vietnam).

With a denser population living in the Mekong River Delta, higher-cost infrastructure and a larger rice-crop area in the deeply flooded area, the "living with floods" concept was revised. Instead, flood control measure was combined with irrigation, transportation and settlement with the following objectives: 1) to protect urban areas, rural settlements and main transport routes; 2) to reduce water level at the beginning and the end of flood season for the safety of two rice crops, Summer-Autumn and Winter-Spring; by improving drainage to the West Sea and West Vai Co River (location in Figure 3); 3) to improve soil properties by supplying flood and irrigation water, in particular in severe acid sulfate soil areas; and 4) to reduce peak flooding depth to lower infrastructure costs to people but assuring insignificant increase of flooding depth in Cambodia.

Because of the concerns on impacts of flood control in the past, such combination of flood control with other development purposes might not be decided without the involvement of a strong leader, the late Prime Minister Vo Van Kiet who spearheaded Vietnam's "economic miracle" of the 1990s *reform*. In the Mekong River Delta his name is associated with the Decision No. 99/TTg dated 09th February 1996 on "Long-term direction and 5 year plan 1996–2000 for irrigation, transport and rural development in the Mekong River Delta" (Khai, 2008). This is quite different to the Vietnamese management culture in many years when a decision was always attached to a group as described above. By this Decision, from 1996 to 2000 the total investment for development in the MRD was estimated 15,500 billion VND or 9% of GDP (equivalent to 1.4 billion US$, with US$ 1 = VND 11,000 in 1996). To support this decision a special team of scientists headed by Professor Nguyen Van Hieu, Chairman of the Vietnam Institute for Sciences and Technology, was formulated to study water control alternatives. Although Professor Hieu is neither a water resources planner nor a rural development expert but a well-known specialist in neutrino physics, his position helped P.M. Kiet to bring scientists of different institutes, universities and water resources planners to a compromise alternative that is not too extreme in terms of full protection, but also not simply continuing "living with

floods" under natural conditions as before. Flood control measures were proposed and approved in 1999 for implementation from 2000. To honor P.M. Kiet's contribution to the Mekong River Delta, his name was given later to a 50 km canal in the flooded area (location in Figure 3).

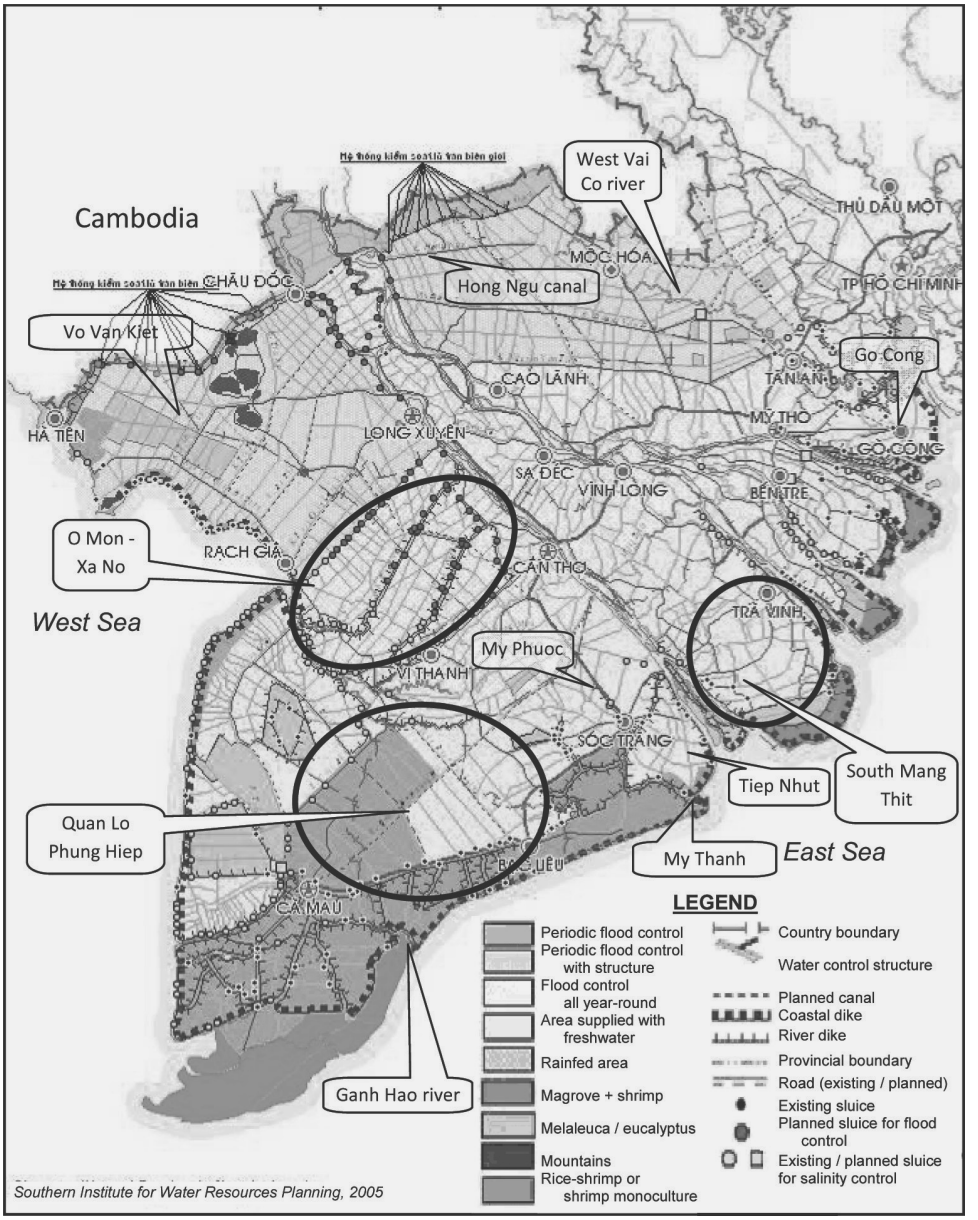

Figure 3. Water resources development plan in 2010 (MARD, SIWRP, 2005).

5. Discussions and conclusions

The Vietnamese Mekong River Delta case illustrates the importance to synergize government's policy objective with farmers' development needs. As described in previous sections, the government was able to achieve its policy target to increase rice production only after the introduction of economic reform (*doi moi*) in 1986. With this economic reform the government partially responded to farmers' needs to increase their household income by allowing competition in supplying and consuming of agricultural products. In turn, driven by their expectation to get additional profits, farmers were motivated to produce more rice. This despite the lack of farmer participation in decision making on irrigation in particular, and with regard to the country's economic development in general.

In contrast to the common rationale behind the need to form a farmer organization to ensure farmer participation for successful policy outcome (in terms of the policy accountability and relevance), our research findings reveal how farmers could partially benefit from government policy without any form of participation. Despite the lack of participation from farmers in the overall policy formulation in irrigation, farmers partially benefited from the government decision to reform the economy. Between 1986 and 1995, a rapid increase in rice production was achieved through development collaboration between the government and farmers through the government`s policy decision to expand agricultural and irrigated area and their motivation to change/adapt their cropping system and increase irrigation water use accordingly. While the irrigation policy evolution in the Mekong River Delta shows the importance to capture farmers' actual development needs within the defined policy framework, it is also indicative of the dark side of water resources governance.

The creation of a fragmented polycentric governance network brings to light the importance to understand the existing power asymmetry and how this predefines the actual functioning of the networks, and vice versa. Our case study highlights the dominant role of state actors (government) in creating such networks. This fragmented polycentric governance network is most apparent from the lack of stakeholders (farmers and other non-state actors apart from the special team of scientists lead by Professor Nguyen Van Hieu) involvement in the overall decision-making process, the absence of general rules that ensure transparent decision-making, and the lack of coordination and enforcement in the overall policy implementation.

Fragmented polycentric governance network results in limited policy accountability and reduced potential for deliberation. The fact that policy discussion is focused on a technical issue in water resources management, not always involving farmers and other non-state actors, shows that such discussion was still framed within the top down decision-making pattern in irrigation development context at that time. In this context, stakeholder participation and involvement in the decision-making process becomes a less prominent

issue vis-à-vis government's ability to gather information that is crucial for defining the outcomes of the proposed policy.

Nonetheless, the government's decision to involve researchers (comprise mainly of a special team of scientist led by Professor Nguyen Van Hieu) in the overall decision-making process in irrigation policy development has to a certain extent created a room of manouevre, space for policy discussion, which functions as a medium to gather (technical) information. The role of researchers in stimulating policy debate/discussion in irrigation development is an important first step towards the establishment of a polycentric governance regime (Neef, 2009). As discussed in the earlier sections, scientific discussion on the issue of flood control enables the provincial government to question the central government's plan and thus negotiate their development perspective vis-à-vis the defined policy guideline or decision. Through this discussion, the government agreed to develop flood control measures, which are not too extreme in terms of full protection, but also providing more protection than the 'living with floods' approach. Similarly, the way irrigation system impacts on environment and socio-economic development were assessed differently by various agencies and researchers had made decision makers considered all possible impacts and tradeoffs more carefully before making the final decision. For instance, in the case of the Hong Ngu canal in Dong Thap province, the Minister of Water Resources and his group made more efforts to study the impacts and convince the provincial authorities to accept their plan. These highlight the notion of checks and balances as suggested in polycentric governance regime.

Our Mekong River Delta case study reveals that the existing governance system has adaptive capacities and emergent properties that cannot be forecasted. Farmers' ability to convert agricultural land into brackish water shrimp fields, as well as their ability to modify small-scale irrigation systems towards integrated farming, evidenced that the existing technical characteristics of the irrigation system should not be treated as a static element in irrigation development. In this light, we conclude that while Vietnam's future development choices are partially constrained by the weight of a history of past choices (Biggs et al., 2009), the creation of highly fragmented polycentric governance networks with regard to Vietnam's irrigation policies highlights the government's ability to adapt to changing development demands.

Annex 1

Table 1 presents an overview of the policy evolution in irrigation development in the MRD from the 1975 onwards. The comparison of this evolution throughout the six periods in last 35 years clearly shows that decision varied with policy views and involvement of actors in the process with targets not only for irrigation itself but also for agricultural and water resources management in general.

Table 1
Comparison of irrigation decision in seven periods.

	1975	1976–1977	1978–1980	1981–1985	1986–1995	1995–2000	2000–onwards	Remarks
Main feature	Irrigation development without plan	RRD blue print	Political will at any price	Emerging role of research as part of decision-making process	Irrigation reform	Strong leadership	Diversification in a changing world	
Policy objective	Using existing labour force as a means to ensure political stability	Increase rice production	Increase rice production	Increase rice production	Irrigation as a condition to improve people's livelihoods	Increase rice production through flood control	Divided between increase rice production and crop diversification	The need to increase rice production is linked to its role in improving farmers' living standard
Leading actor	Provincial, district and commune authorities	MWR and farmers	Country's top leaders	Country's top leaders MWR Scientists Provincial People Committees	Farmers/WSGs Irrigation planners Central govern. Provincial & district authorities	Late Prime Minister Vo Van Kiet	MARD Farmers / WSGs	Parallel relationship between state actor (MWR or MARD in late periods) and farmers
Decision-making process	Centralized political decision	Centralized at national level and decentralized at community level	Centralized political decision	Emergence of polycentric decision-making	Centralized quasi polycentric or deconcentration	Strong personal leadership	Centralized & decentralized at the same time	A mix of centralized, decentralized and quasi polycentric
Policy milestone	n/a	Formulation of Water Resources Development Plan (1976-1980) followed by installation of large pumping stations	High investment in irrigation infrastructure development	Formulation of irrigation plans referred to agro-ecological and socio-economic conditions	Incorporation of irrigation development into *reform*	IWRM by integrating irrigation with navigation, settlement and rural development	Expansion of aquaculture area by farmers	Farmers take a more active role in shaping the policy milestone
Policy outcomes	Pollution of acidity into canal system in and around ASS areas	Farmers continued to use small pumps rather than depending on large pumping stations	Rice production did not increase as fast as expected because of lack of farmers' motivation	Same as in previous period	Rapid increase in rice production due to expansion of double and triple rice crop area	Rapid increase of reclamation area	n/a	Farmers' response to the defined policy is crucial in shaping the policy outcomes/ success

Acknowledgement

The authors would like to thank the Challenge Program for Water and Food (CPWF) Project No. 67 funded by International Fund for Agricultural Development (IFAD) and European Commission (EC) on "Improving Mekong water allocation: searching for success with scenarios, environmental flows, dialogues and negotiations" for supporting the study presented in this article. The contribution of many anonymous collaborators and reviewers is also highly appreciated.

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