Pro-poor Intervention Strategies in Irrigated Agriculture in Asia

Poverty in Irrigated Agriculture: Issues and Options

VIETNAM

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International Water Management Institute

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Problems

- Unfavorable natural conditions
- Farmers' lack of production resources
- Lack of pro-poor-oriented policies in irrigation-investment projects
- Management of water not fully responsive to farmer needs
- Lack of linkages between agencies and stakeholders
- Lack of legitimate and clear rules

Options

- Natural storage utilization
- Improving farmer access to production resources
- Strengthening on-farm water-management institutions and organizations
- Strengthening coordination between research and policy
- Utilizing the traditional village as the basic/terminal unit in conjunction with a hydrologic-boundary approach to overall management

Actions

- Improving the water-control infrastructure (drainage)
- Providing credit, irrigation, education, extension
- Strengthening the policy environment
- Developing action/policy-oriented research
- Innovating irrigation management
- Achieving financially/managerially self-sufficient irrigation institutions

Contents

Chapter 1

Study Background

This report documents research conducted over a period of approximately two and a half years for the ADB-funded project "*Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia"(RETA no. 5945)*. The main objective of the study is to identify practical and realistic interventions to increase the poverty alleviation impacts of irrigation in irrigated agriculture. To accomplish this goal, it was necessary to examine and establish the linkages between irrigation and poverty and management of irrigation and poverty. This was necessary so that a definite connection between irrigation and poverty could be established to justify irrigation as a suitable intervention on which to focus poverty-alleviation efforts. The examination of irrigation-management performance and poverty was necessary to establish which aspects of irrigation management, if improved, would be most beneficial for poverty alleviation. The research necessary to examine this linkage is complex and involves a number of steps. While many conclusions are based on rigorous empirical research with quantitative methods, other results are based on expert opinion and experience. Overall, it is felt that this type of approach yields the richest body of knowledge and information. This chapter details the first step in the analysis by examining the context within which the study was formulated.

Vietnam Context

Vietnam is located in the tropical monsoonal area of Southeast Asia. Mean annual rainfall ranges from 1,700 mm in the north to 2,000 mm in the south. The temperature ranges from 13 ^{o}C to 35 ^{o}C, which is favorable for agricultural production, especially for paddy rice cultivation. The total area of Vietnam measures approximately 333,000 km^2 with 62 provinces in 7 officially declared socioeconomic zones (figure 1.1). The seven zones are the Red river delta, Northern mountain and Midlands, North Central Coast, South Central Coast, Central Highlands, Southeast and the Mekong river delta. The population of Vietnam was about 79.93 million in 2002.

Since the introduction of *doi moi* in 1986 and land reallocation to farm households, agricultural output and productivity have risen dramatically. These have contributed significantly to the rapid growth of the national economy at an average annual rate of 8.4 percent. These reforms have further aided in reducing the rate of food poverty from 25 percent in 1992 to 15 percent in 1998 (Poverty Working Group 1999). Other poverty measures indicate similar improvements in poverty reduction. However, Vietnam remains one of the world's poorest countries and poverty remains primarily a rural problem. Moreover, the spatial pattern of poverty in Vietnam varies greatly among the seven different regions of Vietnam (table 1.1). Often, these variations can be linked to lack of access to

Figure 1.1 Vietnam and its 62 provinces.

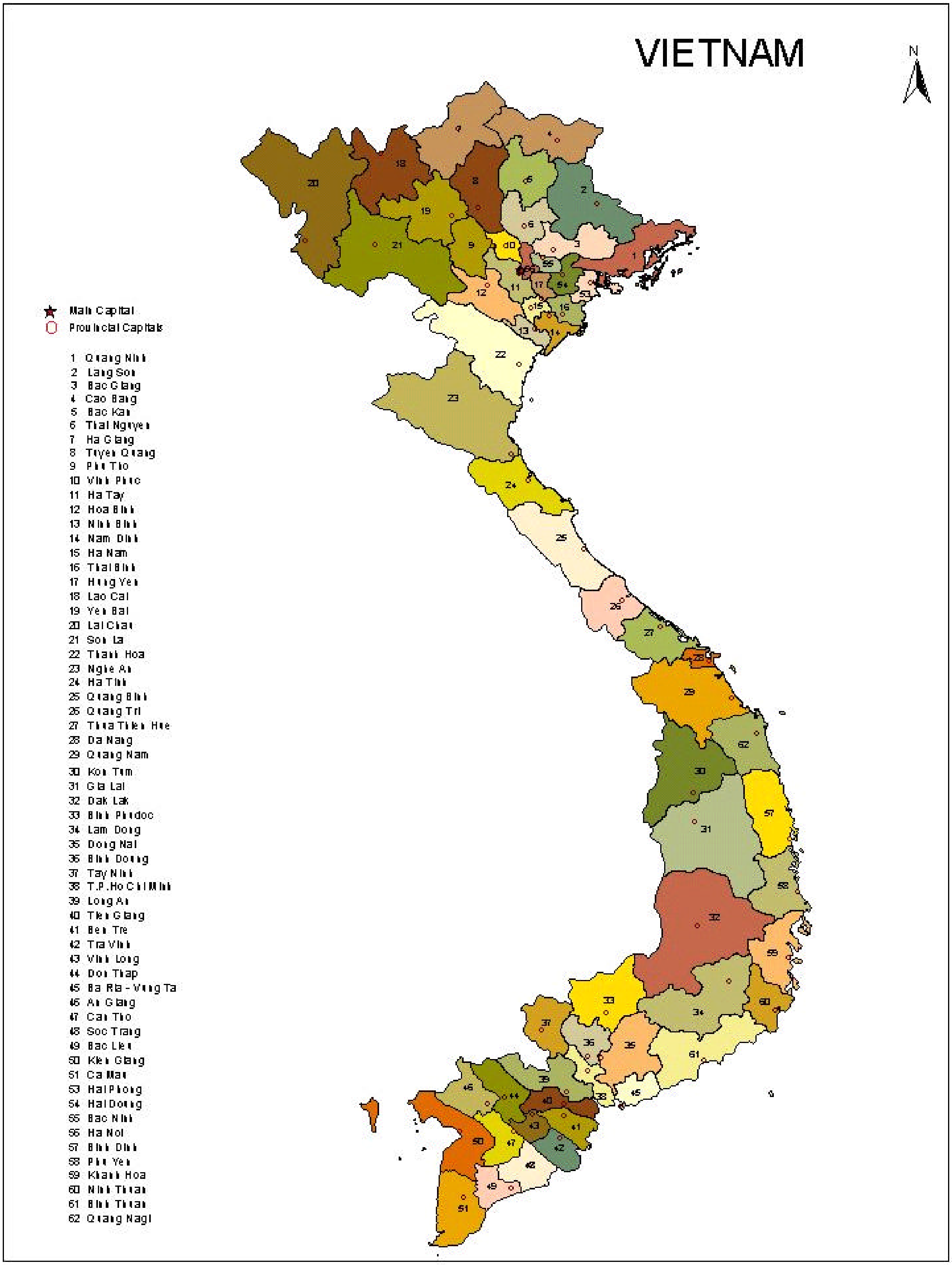

Table 1.1 Regional variations in the incidence of poverty in 2000.

Region	WB estimate	MOLISA*
Northern mountains	52.1	13.5
Red river delta	20.1	5.25
North Central	39.5	16.05
Central Coast	30.0	11.17
Central Highland	45.8	13.1
Southeast	3.6	3.5
Mekong delta	33.5	11.14
Whole country	30.5	10.0

*Source: *MOLISA (Ministry of Labor, Invalid and Social Affairs*) 2001.

different key resources, such as health, markets or education. Access to quality irrigation is one of the key resources that people, particularly the poor, depend on.

Rural poverty in Vietnam has clear regional characteristics with the highest poverty rates in the North Central Coast, Central Highlands, and the Northern Uplands. Within each region, however, the poverty rate varies from province to province and the poverty rate can be quite high (more than 40%) in some well-off regions, such as the Red river delta (Minot and Baulch 2001). Therefore, the Government of Vietnam pays special attention to the eradication of hunger and reduction of poverty, seeing them as constituting a noble social revolution and a key theme in its 2001–2010 socioeconomic development strategy.

Rural poverty is associated with mono-culture practices and low yields due to a lack of water resources and water-control infrastructure. A survey by MOLISA in 2000 indicated that a lack of safe water supplies and irrigation were the biggest issues related to poverty. The study recommended that infrastructural development should be based on a community's need to facilitate economic growth and stabilize people's lives. Infrastructural development should focus on issues such as irrigation, schools and clinics.

As a rice-based production country, land and irrigation are the two most important factors affecting farm production in rural Vietnam. Cropping intensity in the irrigated land is 5.4 times higher than in rain-fed areas (Svendsen 1995). Many studies have pointed out a very close correlation between farm size, irrigated area and farmer welfare status within the country. Generally, the more well off a group, the larger the landholdings and irrigated land areas belonging to the group (World Bank 1995).

Irrigation can raise farm incomes by increasing the cultivable land area, enhancing crop choice, increasing cropping intensity, allowing the option to use high-yielding varieties, and provide the conditions for land groupings to boost labor productivity. Irrigation also brings many spill-over effects, such as increased and more evenly distributed farm labor opportunities, improved wage rates, reduced out-migration, improved security against impoverishment, low food prices, better nutrition throughout the year, growth in non-farm employment, greater urban-rural contact and new social networks, and more water for nonagricultural uses.

Substantial funds have been invested for the construction of new irrigation infrastructure and the rehabilitation of existing irrigation schemes. To support these investments, several laws and decrees have been issued. These include, for example, a water fee requiring water users to pay for water, a financial decree on the irrigation company's financial auditing, a law for the protection of irrigation infrastructure, the recent law on the formation of Cooperatives, and the Law on Water

Resources. In response to these efforts, nearly 43 percent of the country's 7 million hectares of arable land is irrigated (MARD 2000).

The emphasis on irrigation has so far been focused on technical and production issues. Irrigation development has concentrated on technical design, increases in irrigated area and production. Policy, institutional and poverty dimensions are often neglected. Thus, despite heavy investment in the irrigation sector, the current total irrigated land area of 3 million hectares is less than 70 percent of the designed capacity of the existing irrigation systems. Many irrigation schemes are in need of rehabilitation after only a few years of use. Yields, cropping intensities and crop diversification are constrained because of inadequate irrigation and drainage in the peripheral areas of irrigation systems. This is true even in areas with the heaviest investments in irrigation. There is high potential for increasing irrigation performance and thus, the well-being of the rural poor by identifying and adopting appropriate political, economic, financial, institutional, governance and technical interventions in the irrigation sector.

During the last 50 years, great achievements have been made in the global fight against poverty. A significant factor in realizing these gains came from the expansion of irrigation (Barker et al. 2000). Benefits from irrigated agriculture include increased production, lower food prices and increased employment. As these gains were being realized, however, the concept of poverty was changing to include access to resources and opportunities necessary to build and sustain an acceptable standard of living. In response, poverty in irrigated agriculture has also changed to focus on the concept of water scarcity rather than simply low production values (Barker et al. 2000). In agriculture, when water supplies are uncertain farmers may reduce the area planted to increase the water applied to the planted unit rather than risk crop failure (Perry and Narayanmurthy 1998). Uncertain water supplies can lead to increases in a farmer's vulnerability and reductions in productivity or income.

Irrigation will have an indirect effect on poverty. This is because irrigation is an input into productive processes, which requires that the poor use it in order to realize poverty-alleviation benefits. This is a very important point: simply providing irrigation water to the poor will not improve their situation unless they make good use of the irrigation water, regardless of how well the irrigation system is functioning. In this study the focus is on irrigation water used as an input into the production of crops and, therefore, changes in poverty alleviation benefits will come in the form of changes in yields or changes in Gross Value Product per hectare (GVP/ha). The GVP/ha measure has a benefit over the yield measure as it normalizes crop output for different cropping choices, including leaving a field fallow. If irrigation has a positive impact on poverty, then there should be a significant negative relationship between availability of irrigation water and poverty. This result, however, assumes that the farmers are making good use of the water.

Additionally, farmers may have income from non-crop sources. This raises the question of whether irrigation-related production is a significant source of income in relation to poverty, expenditures or income. In this respect, there are two aspects of the income. First, is this income significant in raising income levels? Second, is irrigation-related income significant in reducing downward moves below the poverty line?

Two other important linkages to be explored are between irrigation availability and poverty and between irrigation performance and poverty. This is made more difficult in Vietnam because of the lack of monitoring devices. Most irrigation performance monitoring is based on the perception of either the water manager or the farmer. As stated above, the level of performance of an irrigation system will be unrelated with farm output unless the farmers use the water fairly efficiently and uniformly. This linkage relates a system or section-wide variable with a farm-level indicator. Therefore, a great variety in farmer water-use efficiency can hide the impact of different irrigation-performance levels.

Objective

The ultimate goal of the study is to promote economic growth and poverty reduction in rural areas through pro-poor irrigation interventions in Vietnam (Hussain and Biltonen 2002). The immediate objective is to evaluate the extent and impact of current irrigation infrastructures, institutions and policies on the livelihood of farmers and to make recommendations for irrigation interventions to improve the returns to poor farmers in the low-productivity irrigated areas while improving the overall performance and sustainability of the established irrigation systems.

Scope

This study focuses on selected representative low-productivity irrigated areas of medium and large-scale surface irrigation systems, which are the Nam Duong pump irrigation system in the Red river basin and the Nam Thach Han gravity irrigation system in North Central coast regions. Special focus will be placed on their peripheries where large numbers of people live under persistent poverty. The selection of the North Central coast region is because it is Vietnam's poorest region. Irrigation is generally agreed to be the most efficient pro-poor intervention. Although the Red river delta is not relatively poor, there is evidence that high poverty rates exist in the peripheral areas of many irrigation schemes in this region.

Research Hypotheses

The breadth of research required for this project is quite large. In order to adequately address the research topic, a number of relevant research hypotheses were developed (Hussain and Biltonen 2002). The specific research hypotheses as identified in the original work plan are listed in the following numbered points.

1. Command areas of specific canal reaches receiving less irrigation water per ha have lower productivity and a higher incidence of poverty.
2. Under existing conditions, small, marginal and poor farmers receive fewer benefits from irrigation than large and non-poor farmers.
3. The greater the degree of O&M cost recovery the better the performance of irrigation management.
4. Effective implementation of PIM and/or IMT leads to improved irrigation system performance that, in turn, reduces poverty.
5. The absence of clearly defined water allocation and distribution procedures and of effective and clear water rights (formal and informal) adversely affects the poor more than the non-poor.
6. There is scope for improving the performance of irrigation systems under existing conditions, with effective and improved institutional arrangements.

Organization of the Report

This report is divided into three parts. After a study background, which provides details on the context within which the study was formulated, the needs, objective, scope and research hypotheses are given in part 1. Part I (chapter 2) discusses the previous studies and projects on poverty and irrigation in Vietnam. Part II consists of 8 chapters. Chapter 3 presents the approach and methodological framework for conducting the study in Vietnam. Chapter 4 analyzes the two irrigation systems selected for the research project. The survey, sampling and data obtained from those study systems are also described. Chapter 5 examines the spatial dimension of poverty in the study irrigation systems while emphasizing the differences of poverty rate along the main and secondary canals. Chapter 6 utilizes the income poverty line for the quantitative analysis of major causes of poverty in the selected irrigation systems. Chapter 7 analyzes the overall irrigation system performance of the study irrigation systems using IWMI's performance indicators. The impacts of irrigation performance on the poor are detailed using 5-year occurrence of drought and inundation as proxies. Chapter 8 describes water-management institutions in Vietnam. The national- level agencies and legal frameworks are first examined. An in-depth look at the institutional arrangement of selected systems is then taken. Chapter 9 provides an analysis of constraints and opportunities for increasing crop productivity in the study area. Special attention is paid to irrigation and drainage. Chapter 10 analyzes the strengths and weaknesses of the existing institutional arrangements in the selected systems, and describes the effectiveness of a technical intervention. The ultimate purpose is to recommend the institutional and technical interventions that are pro-poor.

Part III consists of the two final chapters. Chapter 11 reviews and assesses the various constraints and opportunities that have arisen from the study. Chapter 12, based on the outcomes of the study, proposes a menu for country pro-poor interventions and actions in irrigated agriculture.

Part I

Chapter 2

Review of Past Work

This chapter discusses some of the previous studies and projects on irrigation and poverty in Vietnam. In general, past work on irrigation has tended to examine irrigation from an operational and engineering point of view. Past work on poverty also tended to view this issue in a broad context. The result is very little work that directly addresses the link between poverty alleviation and irrigation. However, a diversity of results exists to draw indications of the importance of this link. There remains the need to specifically examine this link in a rigorous empirical manner, which this report attempts to do. Within Vietnam there is a very strong aspect of agriculture which involves poverty. Recent data show that 61 percent of Vietnam's population is engaged in agriculture and that people in agriculture account for 79 percent of the nation's poor (GSO 1999). The purpose of this chapter is to document past work and to illustrate existing knowledge on the linkage between poverty alleviation and irrigation. The chapter will attempt to link these disparate results to formulate a conclusion on the existing knowledge of the linkages between irrigation and poverty. Additionally, this chapter will review past work done in the areas of water rights and legal aspects, PIM and/or IMT, and water charges as special areas for management innovation.

Past Research on Irrigation

Past research on water use and irrigation systems in Vietnam did not place a specific focus on the relationship between irrigation and poverty alleviation (Sandoz 1995). The type of irrigation research conducted previously typically focused on the topics of:

- Agricultural water-control systems and water demands
- Agricultural production parameters and water-control-dependent agricultural systems and production
- Issues on general agriculture-sector economics
- Agro-economic assessments of agricultural water-control development

This type of research lacked any specific focus on poverty.

In general, the key research question from past projects and research has been "How to achieve sustainable, effective irrigation system (O&M) in Vietnam?" Research conducted in this area identified the most urgent challenges for water-resources management as follows:

- Poor institutional and policy frameworks (e.g., duplication of water regulations, too much inspection rather than problem-solving)
- Ineffective management (e.g., duplication of organizations, too many levels of management, poor implementation of policies and regulations)

- Technical problems (e.g., fragmented landholdings, the irrigation system does not meet technical specifications, obsolete technologies and equipment, poor quality of construction and maintenance of systems)
- Financial constraints (e.g., lack of funds for investment in new systems, mismanagement of water fees)
- Inadequate participation in management (e.g., lack of understanding and involvement in water control)

Although cause-effect relationships between these challenges and poverty have not been fully established by research programs, they are likely to be the most important objectives and issues to be addressed by research on pro-poor policies and actions in Vietnam today. Among development objectives set by projects under UNDP-Vietnam activities, the first objective is "hunger eradication and poverty alleviation" (Silver 1999).

However, many reports prepared by international and national agencies on the water- resources sector often have not paid attention to poverty eradication. Poverty issues have not been raised in development goals for the governance of irrigation or in recommended actions (World Bank et al. 1996). One major report stated that the maintenance of the existing infrastructure, including the irrigation sector, is central to the agricultural activities in the Red river delta. This report contained much in the way of technical and economic data on the current status of irrigation, drainage and water resources in Vietnam, but made no mention of poverty or poverty-related irrigation issues in the region (Binnie & Partners 1994). Only very recently has enhancing access to irrigation infrastructure been mentioned as a tool for poverty alleviation in the poorest communes in the country (JBIC 2001)

Irrigation in Vietnam

Over the past years, a total of VND 100,000 billion has been invested in the formation of 8,265 irrigation systems involving 743 medium- and large-scale reservoirs, 1,017 weirs, 4,712 irrigation and drainage gates of medium and large scale, and nearly 2,000 pumping stations (JBIC 2001).

Tremendous changes have made it difficult to document the current state of irrigation and irrigation management in Vietnam. One comprehensive study documented much on the current state of irrigation in Vietnam (Svendsen 1995). This research showed that Vietnam has about 2.4 million hectares of irrigated land. The great bulk of the irrigated area (2.1 million hectares or 88%) is devoted to rice, which is cultivated approximately 2.6 times per year. The Ministry of Agriculture and Food Industries (MAFI) gives a 1993 national paddy rice area of 4.08 million cultivated hectares and a total sown area of 6.46 million hectares, while the Ministry of Water Resources (MWR) data indicated that 2 million cultivated hectares of riceland were irrigated in 1993, with a total sown irrigated area of 5.41 million hectares. This suggests that just under half of the national riceland is irrigated, but that 83.7 percent of the rice-sown area receives irrigation. This demonstrates that, in spite of the high levels of annual rainfall the country receives, irrigated production is the backbone of Vietnam's rice economy. The study further found that, of the total area irrigated in 1994, pump and gravity irrigation each comprised about one-quarter of the total area. The other irrigated areas appeared to consist of land irrigated not by formal government systems, but by swing baskets, buckets, small private pumps, and small gravity diversions.

In Vietnam, gravity irrigation is widely distributed within the Mekong delta, North Central, and Central coastal regions together accounting for about three-fifths of the total. Pump irrigation is concentrated in the two deltas accounting for almost two-thirds of the total. Some 59 percent of the pump irrigation capacity is electric, with the remainder relying on oil engines. Pumping is overwhelmingly electric in all regions, except in the Mekong, where oil engines dominate. This condition is likely the result of a lack of access to electricity for large areas of the rural Mekong delta.

As a direct result of growth in the area of spring and autumn irrigated rice crops, cropping intensity for irrigated crops has risen from 2.2 to 2.6 over the past 14 years. Because the area of summer irrigated rice has held constant at around 2 million hectares for most of this period, and it typically comprised the largest area irrigated for any season, the summer rice area is taken as the irrigation capacity, i.e., the physical area capable of being irrigated. However, the study also found that cropped irrigation areas total about 5 million hectares. If these are assumed to correspond to design rather than actual irrigation-service areas, then the overall irrigation-area cropping intensities average only about 1.7 times/year.

The relatively strong growth in irrigated rice area that has occurred over the past 14 years has resulted largely from a process of intensification. There has been little investment in new irrigation capacity or in rehabilitation of facilities. Growth has taken place largely within the bounds of the existing irrigation facilities through expansion of the areas producing spring and autumn crops occurring predominately in the Mekong delta region.

Irrigation helps improve the paddy yield and, consequently, contributes substantially to the steady increase in the rice harvest over the last decade. The rice yield is estimated to have increased by 16-35 percent after the implementation of irrigation infrastructures. Irrigation is an indispensable factor in shifting toward high-value cash crops and livestock (JBIC 2001).

The major findings of this irrigation-sector research can be classified under two broad categories: a) outdated agricultural control systems (including physical infrastructure and system management) and b) demand for agricultural water (water-use assessments and development planning) (Svendsen 1995). Under the category of obsolete agricultural water-control systems, it was found that irrigation is still predominantly based on exploitation of surface water resources. Constraints in some areas include low dry-season flows and water shortages. At the field level, simple irrigation technology is rarely used, while labor-intensive methods generally dominate. The study also found that system-level physical infrastructure works are often antiquated or of insufficient size. Additional conditions included frequent embankment and canal seepage and leakage as well as sediment deposition and soil erosion.

As for system management and O&M activities, these were found to be generally undertaken in accordance with government directives, standards and guidelines. However, interpretation and application of these guidelines vary significantly between systems. The study identified several common causes of O&M inefficiencies, including:

- poor communications and transportation
- poor data management
- poor system monitoring and analysis procedures and equipment
- an absence of computerized methodologies

Investments to upgrade community-managed mountain and other small irrigation systems may, in some cases, improve system security and service reliability, but economic justification and long-term sustainability may often not be assured.

Regarding the demand for agricultural water, the study found that designed irrigation service areas total about 3 million hectares. However, on average, only 68 percent of this total area represents actual irrigation-service areas. Reasons for this under utilization include:

- fund shortages
- water availability shortfalls
- under-capacity of systems
- planning or design changes or deficiencies
- incomplete construction of works
- lack of secondary or tertiary canal systems
- system damage or degradation
- poor system operations
- nonagricultural land uses within system-command areas.

There are some quite significant seasonal and regional variations in field-level crop- irrigation requirements due to differences in climatic and soil characteristics. Overall irrigation efficiency values encountered in the review range approximately from 65 percent to 80 percent for paddy rice crops and from 40 percent to 50 percent for other crops. The higher efficiency values tend to correspond to small systems and to relatively new, well-operated and/or well-maintained systems.

These research findings clearly illustrate the positive impact of irrigation on agricultural production. The research shows that water-control systems were not in accordance with the requirements of *doi moi* policies and rural development. Overall, water use management is poor and not suitable for modernization of rural areas.

Poverty in Vietnam

Poverty has received ample attention from the international and national development agencies. Understanding the situation of poverty is the first step towards effectively addressing poverty-alleviation efforts. In Vietnam, the rate of poor households (according to the international standard) has decreased dramatically from 51 percent in the early 1990s to 37 percent in 1997–1998; however, the rich-poor gap has been widening (World Bank 1999). The Government of Vietnam holds a strong commitment to pro-poor policies of economic growth and development. The government aims to reduce the rate of poor households from 15 percent in 1998 (according to Vietnam standards) to below 5 percent by 2010 (World Bank 1999).

Definition of Poverty

There are two primary definitions of poverty used in Vietnam: one calculated by the international community and one devised by the government. The international poverty line used in Vietnam is further classified into food poverty and overall poverty. The food poverty line is calculated based on a minimum consumption level of 2,100 calories per person per day, while the overall poverty line adds additional non-food basic needs to the calculation. For 1998, the food poverty line was set at VND 1.3 million (US$92) and the overall poverty line estimated at VND 1.8 million (US$128) per person per year (World Bank 1999).

The official government poverty line as calculated by MOLISA is also calculated for a basic minimum basket of goods. This poverty line, however, has three classifications to account for differences in the cost-of-living standards for different areas of Vietnam. For this definition of poverty, the poverty line for the mountainous and coastal areas is set at VND 80,000 per capita monthly income; for the lowland rural areas, it is set at VND 100,000; and for the urban areas at VND 150,000 per capita monthly income. Applying these poverty lines yields an overall poverty rate for Vietnam that "increases" from about 10 percent in 2000 to 17.2 percent in 2001 due to a redefinition of the actual amount itself. The poverty rate is very high in mountainous and remote areas: 25.6 percent in Northern Central Coast, 24.9 percent in Central Highlands and 22.2 percent in Central Coast, compared to 9.8 percent in the Red river delta (MOLISA 2001). However, it is widely recognized that Vietnam has made significant strides in alleviating poverty.

As shown in the research examining trends and patterns of poverty reduction in Vietnam, the poverty rate has declined during the recent last few years. Despite the dramatic gains in poverty reduction during 1993–1998, progress in alleviating poverty remains quite fragile (table 2.1). Other significant findings from recent research are discussed below.

The poor are predominantly farmers (75% of the total poor) with low levels of educational attainment and limited access to information and functional skills. Agricultural activities remain the dominant source of income (table 2.2). Poor households have small landholdings and landlessness is becoming more widespread, especially in the Mekong delta. Households with many children or fewer laborers are disproportionately poor and are particularly vulnerable to high and variable health and education costs. Poor households may be socially and physically isolated. Poverty is widespread among ethnic minority groups and migrants to urban areas. Poor children are less able to attend school and are trapped in a cycle of inherited poverty and feel insecure.

Poverty reduction is due to rapid growth and agricultural diversification. In urban areas, living standards have risen faster than in rural areas, but opportunities have been less evenly distributed.

Poverty reduction is accompanied by a modest increase in inequality, largely due to the widening of rural-urban gaps. Gender inequality remains an issue, with gains made in some areas. Increased participation of the poor in policymaking is very helpful to make public policies and programs more pro-poor. The government's grassroots democracy decree is an exciting initiative for improving governance at local levels.

The poor remain extremely vulnerable to a variety of shocks. Public safety nets and government poverty programs are small and weakly targeted.

With over 80–90 percent of the poor living in rural areas and involved in agricultural activities, the governance and development of irrigation have definite pro-poor directions. Studies on irrigation and poverty in Vietnam should not, however, be limited to examining only income levels in irrigated area to define the poverty situation, but they should aim to find determinants of poverty and ways to reduce poverty. Irrigation-related factors are likely to be some of the most important factors. The appropriate poverty-reduction measures have varied by region and it is only some areas that involve irrigation. In some areas, other water-control interventions would have a bigger impact than irrigation on living standards.

Table 2.1 *Poverty incidence by regions in Vietnam (1993–1998).*

Regions	% of poor of the total population		% of the poor of total population		Population of 1998	
	1993	1998	1993	1998	Million	%
1. Northern mountain	21	28	79	59	13.5	18
2. Red river delta	23	15	63	29	14.9	20
3. North of central part	16	18	75	48	10.5	14
4. Central sea coast	10	10	50	35	8.1	11
5. The Highland	4	5	70	52	2.8	4
6. East of the South	7	3	33	8	9.7	13
7. Mekong delta	18	21	47	37	16.3	21
National	100.0	100.0	58	37	75.8	100

Note: Poverty level = Expenditure per capita in 1993 is VND 1.2 million (US$83)/person/year. In 1998, it is VND 1.8 million (US$128)/person/year.

Source: (World Bank 1999).

Table 2.2 *Per capita income by source and region, at current prices, 1998 (VND '000).*

	All regions	Seven regions: North Mountain	Red river delta	Northern Central Coast	South Central Coast	Central Highlands	Southeast	Mekong river delta
All	3,389	2,155	3,264	2,325	2,723	2,796	7,423	3,040
Farming	1,051	1,246	804	885	933	2,051	567	1,437
Off-farm	893	367	970	493	722	317	2,437	711
Wages/salaries	754	203	666	386	685	249	2,479	549
Pension, support	114	106	201	181	52	31	93	42
Other sources	577	233	624	380	332	148	1,847	301

Source: GSO 1999.

Who Are the Poor?

Recent research provides detailed description of the poor in various areas as follows (World Bank 1999):

- Households that are unable to make a living from the land find few opportunities for stable income generation off the farm.
- Newly formed households go through an initial phase of poverty, aggravated by limited access to land. Poor households are also frequently caught in a debt trap.
- Poverty among ethnic minority groups has declined, but not as rapidly as in the majority population. Ethnic minorities face many specific disadvantages, which should be addressed through an Ethnic Minority Development Program.
- Migrants to urban areas who are poor and who have not secured permanent registration face difficulties in accessing public services and may also be socially marginalized.

- Children are over-represented in the poor population. Poor children are less able to attend school and are trapped in a cycle of inherited poverty and feel particularly insecure.
- Low diverting of agricultural patterns, low quality and high cost of agricultural production, low competitive capacity:
    - o low effectiveness in exploring agricultural and rural potential
    - o inappropriate agricultural infrastructure
    - o slow innovation of production relationships
    - o weak state management structures in agriculture

More specific findings from research describe poverty at the meso level. Research on poverty at the meso/provincial levels identifies the basic causes of poverty. These reasons are clearly demonstrated in a report on poverty alleviation in Quang Tri province up to the year 2000 (Quang Tri People’s Committee 1995).

Generally reported causes of poverty in Quang Tri Province include: a low economic growth rate, difficult socioeconomic conditions, history-related constraints, a backward, agriculture-dominated economy, mono-cultivation in agriculture, subsistence production, an undeveloped commodity market, weak technological implementation and innovation, poor material and infrastructure, inefficient economic operations, low productivity of labor, high cost per output unit, small farm size, and low cultivated land per capita.

Poverty in Quang Tri is also adversely impacted by its severe climate. Due to the complex nature of the weather in the Quang Tri Province, many natural disasters have occurred and caused negative impacts on the production and life of the province’s inhabitants.

Another important factor concerning poverty in Quang Tri is the poor infrastructure in many areas. This includes things on a technical and material basis, such as systems of irrigation, transport, electricity, and health care network, which are generally unable to meet the demand of production and daily life of the inhabitants. The Province is also lacking in investment capital to develop agriculture, other necessary skills and services.

The Province experiences a low level of social welfare and social services. Many households lack experience in production and conducting business activities. These households are especially lacking in the skills and knowledge necessary to apply technological and scientific advances. This low living standard is often accompanied with social problems. For example, many households face difficulties in their lives including a shortage of manpower. There are a considerable number of invalids resulting from two severe wars, who suffer from hard living conditions.

The population growth rate is still too high in Quang Tri. Proper healthcare for the people is not guaranteed. Also, problems with illiteracy have exacerbated the poverty situation in the Province. There are serious limitations as to the role of the local authorities and mass organizations due to the lack of resources and experience.

It appears that there is a group of people (likely the bottom 20% in each district) who are trapped in a type of poverty that is difficult to escape. Many of these chronic poor are landless, and it appears that returns to selling wage labor (the only viable income- generating activity available) are so low that it is difficult to save enough to purchase assets, such as land. Compounding this problem, most of these people are also in debt to government-lending programs and/or private moneylenders.

Another study conducted at the same level (provincial) using similar methods provides other description of poverty as follows (Action Aid in Vietnam 1999): Poverty in the Ha Tinh Province has decreased substantially over the past few years and most people's lives have dramatically improved. These improvements have resulted from a number of factors, including beneficial government policy changes, public investment in infrastructure and the development of opportunities for diversified and intensified agricultural production and secondary sources of income. Effective management by institutions of local government, such as village managers and mass organizations, has also helped improve the lives of local people.

While many local people are optimistic that their lives will continue to get better, others are more pessimistic; those who are optimistic predicate their optimism on the need for certain changes and improvements. Some programs and policies aimed at improving the well- being of the people were also found to be ineffective. Many households noted the need for improvements, such as increased loan capital, investments in increased agricultural production, the development of off-farm employment opportunities, and better health and educational services. A number of households also said that they lacked opportunities for participation in discussions on program and policy implementation.

Some of the poorest in the Ha Tinh Province are being left out of development programs and remain desperately poor. These poorest Ha Tinh residents, often made up of elderly people, families newly separated from their parents with small children, or single parent families (usually female-headed), have been unable to take advantage of the many opportunities to improve their standard of living. Many well-intentioned policies and programs aimed at poverty alleviation are not reaching them. They also continue to be weighed down by personal and economic crises such as illness, crop failure, animal disease and other factors like heavy and regressive taxes and their inability to access inexpensive loan capital.

Other research finds similar reasons for poverty as follows:

- The lack of financial capital is clearly regarded to be the main reason for poverty.
- The second most important reason is the low knowledge and education levels. Issues relating to land shortages and constraints on crop production also rate highly, including a lack of arable land, food shortages, poor quality land, a lack of tools and agricultural inputs and not applying improved agricultural technologies.
- The poor quality of infrastructure and limited transportation are amongst the main factors contributing to poverty.

In the northern mountain region, limited education and knowledge emerge as one significant underlying cause of poverty—even though local people do not directly express it as a main cause. In remote areas, lack of formal education contributes to the high level of illiteracy and inability to speak the national language. This situation is further exacerbated by the lack of knowledge and information attained through other channels, such as mass media, extension services and interaction with others outside one's community.

Poverty and Women

Poor women are particularly affected by disadvantages in accessing employment and social services. According to the research findings in 1999, poor women are likely to have (Report of Lao Cai, A participatory poverty assessment by Vietnam-Sweden Mountain Rural Development Program, 1999):

- Long hours and heavy workloads: women worked harder than men and they had more responsibilities. It is clear that the constraints on men's and women's livelihoods differ considerably as a result of their different rights, roles and priorities and the division of labor. Women have the assumed dual responsibility of taking care of the family and to work on production and income-earning activities.
- Lack of time for relaxation: Women's tight time schedules do not allow them much relaxation time, unlike men who often have time to drink. One implication of this is that women also do not have much time to socialize. Because women's work almost always continues into the evenings, women miss out on opportunities to participate in community life and evening classes to eliminate illiteracy.
- Less access to education and knowledge: Women are severely discriminated against when it comes to child preference for schooling. This is due to both cultural and economic reasons. In most poor families, especially in remote areas, families can only afford to send one child to school. Girls are often seen as a source of labor for the family and returns to girls' education will accrue to her husband's family.

Causes of Poverty

Causes of poverty in the study areas of Vietnam are said to range from a lack of land, lack of off-farm employment opportunities, low farm yields and inability to farm effectively due to age, accident, or lack of family labor (Biltonen et al. forthcoming). The reasons for poverty vary from region to region and relate to the way the poor respond to their living conditions. One Province-level research found the following results (Great British Oxfam 1999).

The chronic poor are not demonstrating improvements in education, health or income levels. On the contrary, the lack of a viable safety net, combined with cash incomes that are insufficient for accumulation of saving or assets (or even paying schools fees, in many cases) implies that this new class of people will have limited choices and opportunities in the future.

Increased socioeconomic differentiation is visible throughout the two districts as asset markets become more flexible and as successful farmers begin to benefit from larger-scale production and diversification. Differentiation is strongly (though not exclusively) associated with landlessness and land consolidation. Many farmers attempt more lucrative activities to generate significant surpluses, and can then buy more land, diversify production, build up assets to protect against economic shocks, and hire laborers to help them.

Yet, for those who fail, there are often no second chances. They are saddled with debt, and as a last resort, must sell their land to repay these debts. At this point, they are in danger of becoming the static poor. Current government services, which focus on providing small loans (but include other types of assistance as well) to the poor appear to be of limited help. Many people who took the "first round" of HEPR-type loans in the early 1990s have failed because they lacked skills, were unlucky, or did not take repayment seriously. As a result, local bodies are less willing to extend loans to the same families or individuals again, fearing that people who have previously defaulted will likely do so again.

Provision of another loan to a static poor family will probably fail if the loan is made in isolation. The static poor do not, in most cases, have the land, labor skills (which in turn are constrained by low education and bad health) or additional cash to make an investment succeed, and lift them out of poverty. The fact that so few landless people have been able to purchase land or accumulate assets is powerful evidence supporting this finding.

Poverty is strongly associated with other factors such as education and health care (Canadian Centre for International Studies and Cooperation and Rural Development Services Centre 2001). Findings of recent research by the Canadian Centre for International Studies and Cooperation and Rural Development Services Centre on the Perspectives of the Poor on Health and Education in Vietnam show that:

- Health and education have a great value for the poor.
- Poverty is directly associated with poor health and low education levels.
- Good health is valued inherently in a spiritual sense as well as being essential for productivity in the household. Poor health reduces labor and drains family resources.
- Education of children is seen as an investment in the family economy and a contribution to society.
- Poor families will invest in the education of at least one child, usually a boy, as much as possible to change their situation in the future.
- Wealthier families will send children to school according to interest and ability.
- Education is perceived as important for acquiring new knowledge about cultivation, income generation, health and social affairs.
- Social sectors have improved over time since the introduction of reforms
- Services in health and education are available more at the commune level, while improvements in infrastructure have also allowed greater access to people.
- Education and health services are more costly than in the past. The cost of schooling is higher despite low tuition, due to numerous additional fees and expenses.
- The overall situation of the poor in relation to health and education is not perceived to be deteriorating. However, lack of resources prevents people from accessing the new services that are available in order to change their situation.
- The quality of service in both health and education at the commune level is a major concern for the rural population, particularly in remote areas.
- Doctors and nurses at the commune health center were perceived to be generally uninterested in their work, inattentive to the needs of the population, poorly skilled, and in some cases unfriendly. Their attitude and frequent absences were the major barriers to the use of the local health services.
- Teachers were perceived to be poorly qualified and, in some cases, de-motivated and inattentive to the children’s needs. Generally, teachers were seen to lack skills both in teaching and in keeping good relations with parents. Poor teaching and poor behavior lead to drop out of students.
- Participants valued life-long learning and felt the need to keep up with new information in order to improve their situation. Overall, participants reported that their demand for new knowledge was not met.

The Impact of Irrigation on Production

Cause-and-effect relationships between waer distribution and agricultural production have been examined in some previous projects. For example, it was reported that improved water distribution has contributed considerably to an increase in paddy yields, where paddy production rose from 5.2 tons/ha in the winter-spring season of 1995 to 5.8 tons/ha in that same season of 1997 (Ehera 1998). Irrigation has also been linked with increased cropping intensity for rice crops in Vietnam (Svendsen 1995).

The Impact of Irrigation on Income

Given the large proportion of the Vietnamese population living in rural areas, increasing agricultural productivity is a key to poverty reduction. It is widely reported that people in irrigated areas can realize increased and more stable incomes through increased cropping intensities, improved production levels, new farm enterprise/technology mixes, and the appreciation in the value of land with access to irrigation. One study focused specifically on the impact of irrigation on household income and poverty reduction throughout the country's regions (Litvack 1995). This research on water resources and poverty in Vietnam produced several important findings.

Irrigation can raise farm income by increasing the cultivable land area, enhancing crop choice and cropping intensity and providing the option of using high-yielding varieties. At present, about 2.1 million hectares are under controlled irrigation in Vietnam, roughly two-thirds of which are in the two large deltas (37% in the Red river delta, and 27% in the Mekong delta). Around 53 percent of the area under cultivation is irrigated. The average cropping intensity on irrigated land is 220 percent. Most readily irrigable land in the two large deltas is already under irrigation.

The benefits to household crop income of a small amount of additional irrigated land are generally quite small, but are different across regions and population groups. The impact of this additional income will also have different impacts on poverty reduction throughout the country.

The Impact of Irrigation on Poverty Reduction

The impact of irrigation on poverty can have a compounding effect and result in greater poverty reduction than indicated by its annual change (Litvack 1995). Measurements of poverty incidence were projected here until the year 2000 under cases of no additional irrigation with 5 percent more additional irrigation.

Results of the simulation indicate that if 5 percent more of the nonirrigated land was irrigated, household consumption would rise such that poverty would be lowered by 1.28 percent annually. This impact varies throughout the country. It is largest in the Northern Uplands, which would experience an annual drop of 3.62 percent in poverty. Poverty reduction in rural areas of the Southeast would be the second highest at 2.73 percent per year. Although the impact on income is lower in the Southeast than in the other parts a small increase in income pushes more people over the poverty line. The lowest impact of irrigation on household consumption and poverty incidence would be in the Mekong delta. These projections indicate that the Northern Uplands have the largest impact on poverty reduction if it were to irrigate 10 percent of its nonirrigated land. By the year 2000, 4.5 percent more people would be lifted out of poverty in this region if this investment were undertaken.

Direct effects of irrigation include reduced out-migration and increased return migration, improved security against impoverishment, growth in non-farm employment, greater urban-rural contact and new social networks, and more water for nonagricultural uses, including domestic uses that improve health.

Irrigation benefits can be targeted to the poor through:

- Employment-intensive construction, O&M practices.
- Approaches that allow greater access to water particularly in times of scarcity (owing irrigation systems, selling water for profit, water rights, and allocations of irrigable land and accessing small or marginal quality supplies).
- Compensation and justice for dispossessed cultivators.
- Institutional reforms to give security of water supply to the poor in times of scarcity.
- Mobilizing small or marginal quality supplies to help disadvantaged rain-fed farmers.

JBIC reports that the distribution of existing water works is uneven among all regions and indeed may indicate some relation to poverty. The investment in waterworks in more developed regions, namely Red river delta, Mekong river delta, North Central and Southeast regions accounts for 60–80 percent of the country's total investment in water works. On the other hand, the area of irrigated land in the poorest communes only accounts for 15.5 percent of the total arable land area. Approximately 40 percent of the total number of the poorest communes have access to irrigation systems. Non-development of irrigation systems in poor areas is caused by under-investment by the state, low level of production and unfamiliarity of the local population to irrigation-supported cultivation. Under these circumstances, the poorest communes are found to be short of appropriate irrigation systems (JBIC 2001).

Institutional Arrangements for Irrigation Management in Vietnam

Institutions

Since the introduction of the *doi moi* economic reforms, agriculture and irrigation have grown and changed tremendously in terms of production and operations. Unfortunately, institutional and policy changes have often lagged behind what is required. One important report examined the trend of irrigation management institutions at the national, provincial and system levels. Specifically, research on agricultural water management institutions in Vietnam has focused on the topics of functions, financing, and sustainability (Svendsen 1995). This study highlighted key issues which will influence the success of reforms currently underway in the irrigation sector and pose recommendations.

A study that examined the development of operational rules for the La Khe Irrigation System considered the simultaneous need for technical and institutional development (Turral et al. 2002). The approach of the study consciously aimed to improve management within the existing infrastructural constraints of the system. The process made use of a computer model to help develop operational rules that improved equity and reliability. Identified institutional needs included detailed surveys for gaining understanding of the irrigation system and training of staff in effective tools for comparative analysis and monitoring. Finally, the devised operational rules were developed with the consultation of all stakeholders. This is a key ingredient to developing and improving the necessary institutional arrangements.

Sanyu Consultant Inc. 2003, summarized the policy, practice and legislative framework, which established responsibility for the management of water resources and the operation of Irrigation and Drainage Management Companies (IDMCs) during recent years, includes the following:

- The Law on Water Resources, 20 May 1998
- The Land Law, 1993
- The Cooperative Law, 1996
- Decree 112-HDBT on Water Fees, 25 Aug. 1984
- Circular 860-CT/VN, Guidelines for Restructuring IDMCs, 7 May 1992
- Ordinance on the exploitation and protection of irrigation systems, 31 Aug 1994
- Decree 73/CP, on Functions and Responsibilities of MARD, 1 Nov 1995
- Decree 98/CP, on Use and Maintenance of Irrigation Systems, 27 Dec 1995
- Circular 90/1997/TTLT-TC-NN of 19 Dec 1997 is a joint policy agreed by the Ministers of MARD and Finance to facilitate financial autonomy of IDMCs
- Circular 6/1998/TT-BNN-TCCB, on Guideline on the organization and operation of IDMCs, 9 Mar 1998
- Decision 1959/BNN-QLN, on the strengthening, consolidation and reforming organization of irrigation management at the lower level, 12 May, 1998
- Circular 134/1999/TT-BNN-QLN, on Guideline for canal lining, 25, Sept 1999
- Instruction 66/2000/QD/-TTY, on Authorizing funds for lining canals, 2000

Though substantial policy, practice and legislative frameworks were in place, it is often argued that many of them failed to enable effective management. JBIC (2001) pointed out that financial regimes applicable to waterworks operators, stipulated in the Ordinance on Operation and Protection of Water Works, are not elaborate and fail to enable them to ensure a financial autonomy. Irrigation fees are not equitable enough to oblige the beneficiaries to fulfill their financial responsibilities for repairing and maintaining water works. Responsibility of the state for providing financial assistance under certain circumstances is stipulated in the Ordinance on Operation and Protection of Water Works. An institutional mechanism where local people can effectively participate in planning, decision making and implementing the waterworks (under the guidance of decree No. 29/1998/ND) is essential.

Water Fees/Charges

The existing structure of water-use charges does not cover the full financing needs for system O&M of the IDMCs (Svendsen 1995). Fees collected represent only about 60 percent of the total charges. Although the financial shortfall is met partly from other sources, there remains significant and ongoing system deterioration.

Results of most research reports stress the importance of strengthened policy reform and the importance of water-user participation in water management and poverty reduction. A survey of 800,000 farmers in 1,000 communes documented that only 13 percent think the water tariffs being applied are inappropriate because the service delivered is not worth the tariffs, 8 percent say these tariffs are too low and the rest think these water tariffs are affordable. In comparison with other costs for producing paddy, water fees equal 30–50 percent of fertilizer and/or compost costs (Tiep 1999).

People's contribution in terms of finance is an important research topic (Tiep 1999). The study of the issues concerning water tariffs in Vietnam has informed that after 14 years of implementing the Water Tariff Decree, in addition to positive results gained, several problems remain to be resolved. There are numerous systems that are managed with the aim of collecting sufficient fees to cover expenses for repairs, but quite a few systems could not collect enough money to pay electricity bills and other expenses, while some systems (mostly in highlands) collect no fees at all.

Even so, the amount collected from water fees cannot cover the expenditures. Although the State has been providing about VND 100 million each year, mainly for pumping excess water from inundated fields (i.e., electricity bills), there is still a shortage of VND 400–500 billion (excluding capital for rehabilitation, upgrades and repairs due to natural disasters).

The water tariffs have been set at a low rate. Several Cooperatives failed to collect water fees fully and some commune people committees misappropriate the fees. Overdue debts are typically 5–20 percent because of fluctuations of rice prices in the market. The farmers also experienced great difficulty when they had large harvests because of consequent low prices. As a result, levels of fee collection levels were low. Therefore, water tariffs that depend on the market price of a commodity (usually rice or rice equivalent) do not reflect the value of irrigation water and its reliable delivery.

The research showed it was important that water fees be collected fully and accurately. Water fees should be paid and should be calculated based on all input costs and system operational costs. Training in water payments is necessary for successful collection of water fees.

Participatory Management Approaches/Irrigation Management Transfer

It is widely reported that developing participatory irrigation management involves increasing the role of farmers and other water users in governing water systems. This includes a shift from administrative determination by bureaucratic agencies, command-and-control, to participatory management institutions in which users, regardless of their rich or poor economic status, have a much greater say in the governance of irrigation.

Another research study aimed to identify the existing constraints to improved performance in O&M of the systems and farmers' participation through the O&M transfer strategy within the overall institutional framework (Ehera 1998). This study focused on the IDMCs managing the main diversion, main canals, and secondary canals covering over 500 hectares. The study showed that the Water User Cooperatives (WUCs) manage hydraulic boundaries of canals serving less than 500 hectares. This research also documented that the program enabled farm households to increase food production beyond current levels for their own consumption and significantly increase marketable surplus to augment their cash incomes.

Many research studies on farmer-managed (or participatory) irrigation have proven that, with the participation of water users on water management, better services are provided to users while irrigation facilities are improved.

Some research has pointed out that with the long-term land allocation to farm households, the role of agricultural Cooperative in water management is decreasing while the role of traditional communities is increasing and seems to be the most suitable for terminal units in water management

A review and assessment of existing formal and informal irrigation-related institutions strongly show that any improvements in irrigation water require more comprehensive policy reforms and better participation of farmers, communities and local authorities.

Research on the irrigation sector and poverty widely shows the importance of human resources development and involvement in irrigation-sector control and management. One research found that (ADB 1998):

- At present, the IDMCs are responsible for O&M activities but the capacity of the staff does not meet the requirements. The equipment for O&M activities is inadequate. The IDMCs have constant financial deficits (for payment of electricity, major repairs, etc.), inadequate water fees collected to cover the O&M expenditures, redundant procedures in payrolls, etc.

- The formality of management of on-farm systems varies and is being set up by farmers themselves. The performance of these systems is still poor.

- There is no clear distinction of responsibilities and cooperation among policymaking agencies. The O&M activities involve many ministries, and sectors at the central and provincial levels. The MARD is responsible for state- level management of these activities. The Ministry of Planning and Investment (MPI) is responsible for allocation of the state budget for upgrading and construction of irrigation systems. The Ministry of Finance subsidizes the shortfall of O&M activities. The General Department of Hydrology and Meteorology is responsible for collecting and providing information to the activity of performance of irrigation and flood control. Despite the good cooperation among the ministries, some problems still exist: the investment plans for repair work do not meet the requirements and the subsidy fund for O&M is insufficient and not timely.

- The responsibility for allocation between MARD and the People's Committees of Provinces in investing, repair and construction of irrigation projects is not proper.

- The access to credit for on-farm development did not improve resulting in the limitation of the performance of irrigation systems.

An argument in the proposed strategy and program for O&M development in the irrigation sector with farmers' participation is that the institutional framework plays a decisive role in the irrigation sector (Tiep 1998).

Although the irrigation systems serve multi-sector objectives and long-term construction requiring significant investment capital, their efficiency may not be realized in the short term. Appropriate training includes workshops and training courses, which must supply knowledge and skills to achieve certain objectives making a change in people's attitude to O&M development.

The role of agricultural Cooperatives has changed dramatically since 1986, when the government formally introduced the reform policies in rural areas. There is an important research that analyzes the degradation of the role of the agricultural Cooperatives and increasing the role of water user Cooperatives (WUCs) in water management at a pilot project (Dinh Quang Duong 1998). The research paper documents that the agricultural Cooperatives are in a degradation status, caused by various factors whose management is not appropriate (especially, the irrigation management at commune and Cooperative levels). There has been no direct participation of farmers in O&M. Strengthening participatory irrigation management will improve the technical understanding of farmers on water use techniques and technical operations.

The formation of WUCs for irrigation water is more equitably, timely and sufficiently distributed to meet requirements of the production and domestic uses. When a drought occurs there is no longer conflict in irrigation water use. Leaders of the communes do not worry about dealing with disputes over water distribution as earlier. Consolidation of the community is better.

Irrigation works have their real owners. Any damages to structures on flow obstructions are timely repaired or removed, in that order. Breach of the canal for illegal abstraction of water is limited to the minimum level. Crop yields at the heads and tails of the canals are rather even.

Water fees are collected successfully to obtain a high percentage. This creates good conditions for the IDMC to make investments in the improvement of the water works. Relations between farmers and workers are strengthened and improved. Farmers are trained on water management, structural management and legal aspects of irrigation systems. The relations between the IDMC and the WUCs, water user associations (WUAs), and households are much closer. The application of new technologies of the water works offers a good opportunity for O&M to be undertaken. The WUCs and WUAs begin to have a belief in IDMC.

A report on the establishment of farmer-managed irrigation system in the Huong Van District of the Thua Thien Hue Province states that the project will have positive impacts on its beneficiaries by increasing incomes for the beneficiaries and improving their living standard. The water users in the location as well as local authorities have appreciated this as the model being set up has shown its effectiveness in managing the construction. It has also proven to be suitable for the Huong Tra District's actual situation.

Research on the impact of production privatization of on-farm water management in the Red river delta of North Vietnam (Tuan et al. 1996; Tuan and Satoh 1998) has shown that during the centralized economy, the Cooperative, formed on the village base, was an effective body for mobilization and involvement of farmers in irrigation and drainage construction and in on-farm water management. Due to this, major achievements in irrigation and drainage have been gained at both the system level and the farm level.

The transition of the economy to a more market-oriented one along with the gradual change of the role of the Cooperative as a production management body to a service body, the integrated body for on-farm water management is gradually weakening. As a result, uneven water distribution is increasing and on-farm facilities are being damaged. The areas irrigated by the state irrigation and drainage companies have decreased due to unstable and unreliable water supplies in the downstream areas. The farmers who live where the Cooperatives can mobilize resources for small pumping stations can get return water flow for irrigation at a high cost. In other cases, the farmers suffer from severe water shortages, and delay water-fee payments. Ways should be sought to ensure that the constructed facilities are not damaged and the ability to undertake the collective action for successful irrigation is not lost. The equity policy in water distribution and cost payment should not be neglected as it reduces the burden shouldered by small downstream-area farmers and motivates them to participate in projects and increase irrigation and drainage efficiencies.

Equity was the guiding principle in land redistribution. Equal land redistribution, however, could not be done for a commune as a whole, although it was done within each traditional village and hamlet independently. Depending on local conditions, land in villages and hamlets was divided into area units, which were homogenous in soil, irrigation and drainage conditions, and an equal acreage of these units was given to each person. The total acreage of all family members in an area unit made up a plot, which was located randomly.

The equal land allocation was done to equalize the risk of drought and flood damage, equal duties, and equal harvest for each household. It enabled the communities to overcome poor irrigation and drainage by optimum water-management decisions. However, it brought about fragmented and scattered landholdings, thus requiring intensive labor input in cultivation.

Water Rights

There exists custom or traditional water rights but no research or report has so far been conducted on water rights in Vietnam. Most of the reports, by donors, urged for the establishment of water rights.

Data

Data is a necessary component of accurate research and effective management. Data in Vietnam are hindered by two main constraints. The first is a lack of existing measurement devices needed to collect the data. This prevents volumetric measurement and water pricing within the irrigation systems. The second major constraint is a lack of willingness to share existing data among relevant parties. The end result is that the compilation of relevant data (local climatic, hydrologic, land resources, agronomic and system characteristics) is not readily available or accessible, and in some cases is not fully adequate (Svendsen 1995). It is important to collect both quantitative and qualitative data and information on poverty and irrigation issues. In addition to income measures of poverty, the expenditure and investment measures are very helpful defining poverty in Vietnam.

Conclusion

Most of the existing literature on poverty, irrigation and water management in Vietnam has been collected from libraries, offices as well as from donors (World Bank, ADB, UNDP, and some NGOs). The review of literature shows that very little research has been done on the direct relationship between poverty and irrigation. A report prepared by Litvack (1995) used a modeling tool to suggest that irrigation investments are not "pro-poor" and should not be seen as such.

The review of existing literature on irrigation and poverty shows that various methods have been applied in developing programs. Participatory approaches have become widely adopted by action programs and for research on irrigation. Informal institutions have been also explored during survey processes.

However, studies of rural poverty have not taken into account the perception of the people of their poor situation, especially of their ways of work and life. Therefore, these issues and methods of data-gathering should be involved in research and studies on poverty and irrigation. Thus, both qualitative and quantitative data need to be collected, processed and analyzed to better understand and resolve problems in irrigation improvement and poverty eradication.

There are many variables contributing to farmer income. It is very important to take, as much as possible, independent variables suggested in reported models (e.g., models by J. Litvack, framework for economic growth and poverty eradication by the World Bank[1]) to establish the cause-effect relationship between irrigation and poverty. This will help develop a pro-poor irrigation framework for research and recommended actions.

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[1]World Bank. *Vietnam Development report 2002: Implementing reforms for faster growth and poverty eradication*. 2002.

A comprehensive strategy of poverty alleviation requires development policies to prioritize poverty reduction, through action in a range of key areas. This includes increasing growth and promoting balanced growth, designing pro-poor projects, improving bank systems, improving access of the poor to health care, education and ensuring safety nets (Oxfam 2000).

Part II

Chapter 3

Approach and Methodological Framework

This chapter presents the approach and methodology for conducting the study in Vietnam. After establishing the current state of knowledge on irrigation and poverty in Vietnam, based on previous studies, this study moved toward the generation of new knowledge and information. Surveys and interviews were conducted in both irrigation systems. These surveys were applied to farmers, irrigation managers and relevant government officials to generate a broad scope of data.

Field survey on water courses, flow pattern and water delivery pattern were carried out for system characterization. Discharge and water depth were measured for water balance and water-accounting studies at various field and system levels.

Various data analyses techniques were then applied to the data including simple correlation-analysis and various regression-analysis techniques. The aim of this approach was to establish, as conclusively as possible, the linkage between irrigation and poverty. The approach was also designed to elicit information on the most- promising irrigation interventions.

The study used both primary- and secondary-level data and information. Secondary data were obtained from sources such as past research studies, project reports and documents. Primary data were collected through Participatory Rural Appraisals (PRAs), key stakeholder interviews and consultations, and household-level surveys.

Participatory rural appraisals (PRAs)

A variety of tools can be used to undertake PRAs. These tools include open meetings with local people/stakeholders, focus group discussions, semi-structured interviewing, trend and change analyses (e.g., describing changes in land uses, changes in cropping patterns), modeling and mapping (where people are asked to make maps representing their social and resources environments—resource and institutional mapping), seasonal diagramming (describing seasonal variations in activities, processes, resources), and preference ranking (e.g., categorizing households by relevant locally perceived indicators may be an aspect of interest).

In this research, four PRA tools were used: Focus Group Discussion (FGD), Mapping, Household Surveys and Semi-Structured Interviews. FGD was conducted in all communes with the participation of commune leaders (People's Committee Chairman and Party's Secretary) and representatives of organizations (Cooperatives, Women's Union, Farmer Association, etc.) and specialized and responsible cadres (transportation-irrigation cadre, land cadre, etc.) and village leaders. The content of discussions focused on commune's institutions and organizations, socioeconomic situation of the commune, commune policies, agricultural development, and irrigation and poverty issues. FGD also was conducted in villages of target communes. The mapping method was used to define a village's administrative boundary, land distribution pattern, household plot locations and the on-farm irrigation network.

Survey methodology

The survey was conducted using pre-designed and tested multi-topic questionnaires for the purpose of collecting household-level information. The main information topics included information on the basic household, irrigation and agricultural production, income, consumption and expenditure, credit and other poverty-related variables and on indicators. A three-stage stratified-cluster sampling procedures, as suggested by IWMI, were used for undertaking household-level surveys.

Sampling procedure

A three-stage stratified-cluster sampling procedure was used for undertaking household-level surveys.

Stage 1

In stage 1, each of the selected irrigation systems (and its adjacent rain-fed area) is stratified into no more than 6 strata (ideally 4 strata: head, middle, and tail of the system, and the nearby rain-fed area) based on system characteristics, such as cropping patterns, access to water and irrigation infrastructure. The strata are developed such that sampling units (households in this case) must belong to one, and only one, stratum. The purpose of stratification here is to classify the entire system/area into smaller areas that are homogenous in terms of the above broad characteristics. While each of the strata may be homogenous in terms of broad characteristics, there could be intra-stratum variations in terms of specific characteristics (such as differences in availability of water across the head, middle and tail of a distributary within a stratum). This is captured through cluster sampling, as described below. Stratification will help extend the coverage and will ensure representation of all areas with a relatively small sample size.

Stage 2

Cluster sampling further helped reduce the sample size and eased implementing the survey over a wider geographical area. In stage 2, each of the strata is divided into a number of clusters (clusters may be defined as distributaries in case of irrigated areas or villages in rain-fed areas). The clusters may be classified according to their location. One to two representative clusters may be selected along each of the three reaches of the system (head, middle and tail).

Stage 3

In stage 3, a sample of households is selected from each selected cluster (whether village (rain-fed), distributary or watercourse. An essential step in stage 3 is to develop a complete sampling frame (i.e., lists of all households) for each of the selected clusters. The sampling frame is developed only for the selected representative clusters, and not for all the clusters in a stratum (the advantage of cluster sampling is clear now!). Once the sampling frame has been developed, households can be drawn through systematic random sampling.

Sample size

The sample size was different for each stratum and cluster. The total sample size for each irrigation system was 480 households, of which 25 percent, 50 percent and 25 percent of households were selected at the head, middle and tail of each stratum/cluster correspondingly. The sample size was sufficient to measure the actual poverty situation of the study sites. The participatory assessment conducted in conjunction with the surveys provides supplementary information for the quantitative data.

One difficulty in applying the recommended pattern of sample distribution was the pattern of land distribution. Each household has several land plots scattered equally over the village land under the principle of "good with bad, near with far." This makes it difficult to choose households at head, middle and tail of secondary canals and impossible to select tertiary canals as well as households that have all nonirrigated land. Although there is no rain-fed cultivation land near the irrigation systems there is a nonirrigated stratum/cluster. To make "with and without" irrigation comparisons, all irrigated land plots of a stratum/cluster and its nonirrigated land plots were analyzed as two groups to compare cropping patterns, labor and land productivities. Thus, for tertiary canals, the households were selected randomly but the distribution pattern along the canal as mentioned above was not followed. Farmer's plot location along tertiary canals was clarified later, based on their knowledge of the plot location. Drought and inundation frequencies in addition to water ponding depth of each plot were used as the irrigation indicators.

Water balance and water accounting

The water accounting procedure uses a water-balance approach and classifies different outflow components or flow paths into water-accounting categories. Productivity of water is then related to various categories of uses. Water accounting is presented in detail in IWMI's work plan and is not cited here. This study tries to follow as close as possible IWMI's approach and classify the flow components in detail as much as possible. However, due to complication in the real field situation, modification is applied and secondary data are used whenever it was impossible to obtain primary data.

Analysis of Spatial Dimensions of Poverty and Irrigation

The spatial dimensions of poverty are analyzed by mapping poverty rates of survey villages and the use of regression models.

Analysis of Determinants of Poverty

Trend analysis and regression models are used for the analysis of the determinants of poverty in study systems.

Methodology for Analysis of Impacts of Irrigation System Performance on Poverty

IWMI's irrigation performance indicators are used to analyze the performance of the selected systems. The poverty impact of irrigation performance is examined by regression analysis using drought and inundation frequencies as proxies.

Methodology for Analysis of Water Management Institutions and Implications for the Poor

Details of water management institutions are based on the description of national-level agencies and the legal framework and institutional structure of the irrigation systems studied.

Methodology for Analysis of Constraints and Opportunities for Increasing Crop Productivity

The study uses a with-and-without method to analyze the constraints and opportunities for the rain-fed area. In irrigation areas, a regression model is used.

Chapter 4

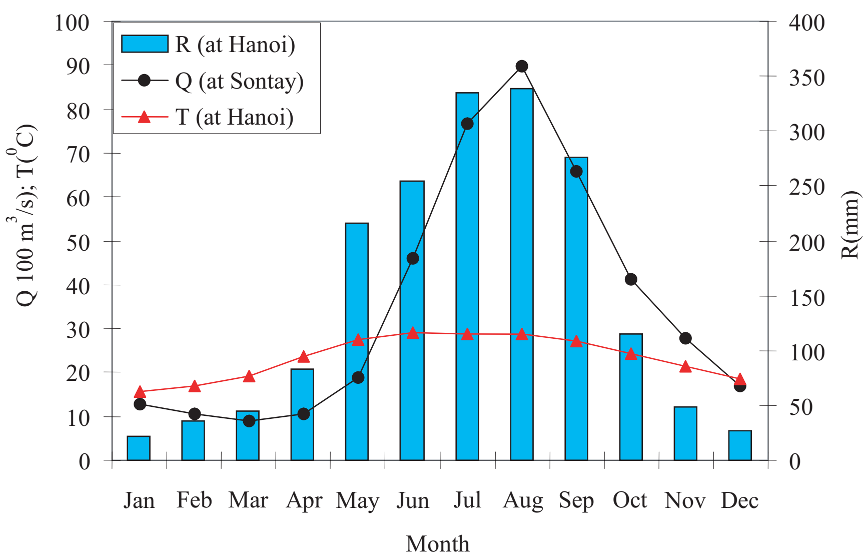
Study Settings and Data

This chapter describes the two irrigation systems selected for the research project. These are the Nam Duong irrigation system (formerly Gia Thuan) located in the Red river delta of northern Vietnam and the Nam Thach Han irrigation system located in the Quang Tri Province in the central part of Vietnam. Questionnaires were administered to a large population of farmers in each of these two systems. The data collected during this survey and additional interviews are described later in this chapter. The Nam Duong irrigation system is examined first, followed by an examination of the Nam Thach Han irrigation system.

Nam Duong Irrigation System in the Red river delta

The Nam Duong irrigation system is a subsystem of the large-scale Bac Hung Hai irrigation system located in the Red river delta in northern Vietnam. The Red river delta officially includes the Provinces of Ha Noi, Hai Phong, Ha Tay, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, Ninh Binh, Vinh Phuc and Bac Ninh. The total area of the delta is estimated at 16,654 km^2 (Binnie & Partners 1994). In 1997, the delta had an estimated population of 20 million. In 1993, the Red river delta was one of the country's poorest regions with a poverty rate of 63 percent. The region has been successful in poverty reduction and the poverty rate dropped to 29 percent in 1998. However, there still exist in the region many Provinces with poverty rates as high as 50 percent.
The climate is generally hot during the summer months, May through September, with the mean temperature varying from 27 ^{o}C to 29 ^{o}C. It is relatively cold during the winter months when the temperature is below 20 ^{o}C between December and March, falling to 15 ^{o}C in January. The rainy season generally starts about May and ends in October with the highest average rainfall occurring in August. Corresponding to the pattern of rainfall is the pattern of discharge in the Red river (figure 4.1).

Figure 4.1 Climate of the Red river delta.

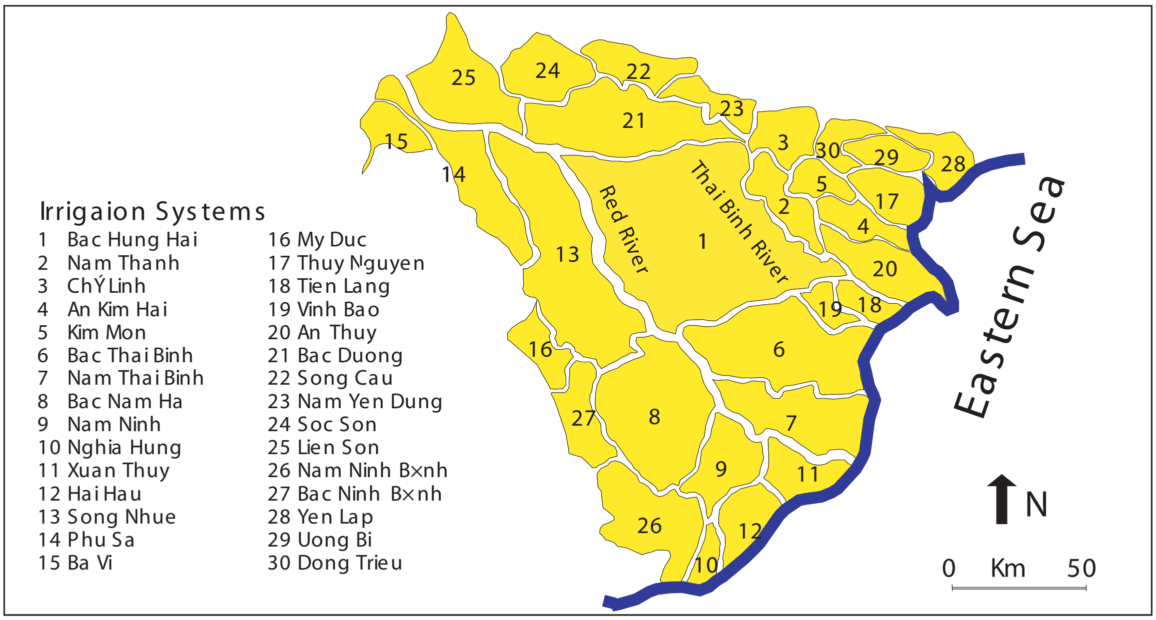


Note: Q = river discharge; R = rainfall; T = temperature.

To the immediate upstream of the apex of the delta, the three main tributaries, the Da, Thao, and Lo rivers, combine to form the Red river, which is the name given to the river downstream of the junction of the Da and Lo at Viet Tri.

The Red river delta region is well endowed with water. The abundance of water stems mainly from the presence of the Red river with an estimated mean discharge of 3,550 m^3/s (or 4,340 m^3/s if the contribution of the Thai Binh system is included). Like rainfall, the river flow is unevenly distributed over the year, with a maximum flow of 9,000 m^3/s in August and a minimum flow of 900 m^3/s in March (figure 4.1). To some degree, the highly variable rainfall and river flow patterns have been regulated and developed through the construction of a number of dams. The center of the delta region is very flat lying between 2 m and 17 m above mean sea level. To protect and encourage development in the delta, extensive dyke and canal systems have been developed.

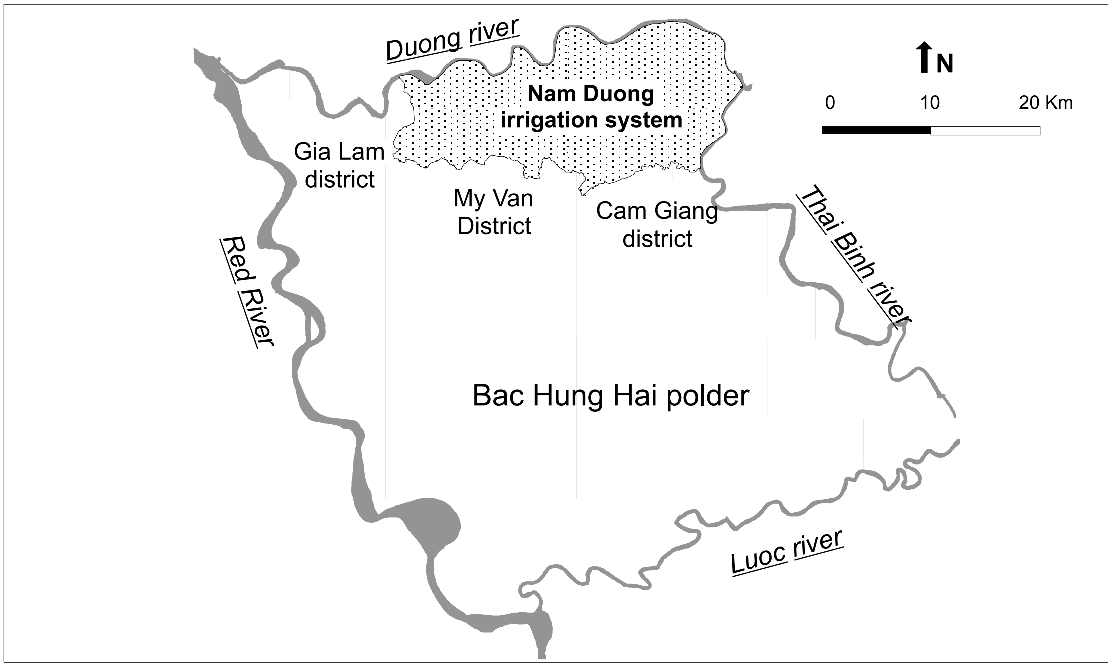
Figure 4.2 Irrigation systems in the Red river delta.



There are 30 principle irrigation systems in the Red river delta (figure 4.2). The Bac Hung Hai irrigation system is bounded by the Duong, Thai Binh, Luoc and the Red rivers and contains a cultivated area of approximately 126,000 hectares. The Xuan Quan sluice is the headwork that takes water from the Red river and distributes it to the subsystems through a canal network. The excess water is drained out to the Thai Binh river via An Tho and Cau Xe main drainage sluices in the downstream portion of the system.

The Nam Duong subsystem, located in the northern part of the Bac Hung Hai irrigation system in the Bac Ninh Province is bounded by the Duong river in the north, the Thai Binh river in the east, and the Hanoi-Hai Phong railway and Lang Tai river in the south (figure 4.3). The Nam Duong irrigation system has a catchment area of 32,400 hectares, of which 23,000 hectares are cultivated land.

Figure 4.3 Bac Hung Hai large-scale irrigation system and location of the Nam Duong sub-irrigation system.



Soil and Pedology of the Nam Duong Irrigation System

The soil in Nam Duong is predominantly loam and sandy loam throughout the area and is divided into three distinct zones with different pedological characteristics:

- In Gia Lam District, the soil is sandy with high percolation,
- The Thuan Thanh District is a low hilly area, primarily silt in origin, and was reclaimed a long time ago. The soil is argillaceous in the north of the District and is heavy argillaceous in the south. In Nghia Dao, there is aluminous soil. As the improvement of this kind of soil has not been dealt with properly, crop yields are limited,
- The Gia Luong District is a low-lying area with aluminous and argillaceous soil. In the area from Minh Tan to Van Ninh (along Thai Binh river) the soil is sandy due to a dyke break during the French domination.

The land surface of the Nam Duong irrigation system slopes from the northwest to the southeast. The highest area is Gia Lam with an elevation ranging from +4.50 to +6.00 m; meantime, the lowest area is located along the Thai Binh river with a range in altitude variation from +1.10 to +1.90 m. The uneven elevation of this area forms local high areas causing difficulties for irrigation. These areas are scattered in the system and formulate hollow areas, which are difficult for drainage. Natural streams and drainage canals, which serve as both drainage and water sources for local pumping stations at the farm level, are separated into the following zones:

- The Ngu river runs from Dai Bai to Kenh Vang in the west-north direction. The man-made Dong Khoi river connected with the Ngoc and Lang Tai rivers divides the Gia Luong area into three parts: the northern Gia Luong, the eastern Dong Khoi and the western Dong Khoi.

- The Dai-Quang-Binh river starts from Thanh Tuong, along Road No. 182 to Dai Bai where it changes the direction from north to south formulating the border between the Gia Luong and Thuan Thanh Districts.
- The Lang Tai river joins the Dau river at Cuu Yen across My Van (Hung Yen province and runs into Trang Ky river at Cam Giang). This river has a branch connected with the Ban river at the Ba Sinh bridge forming a sub-drainage canal as well as watercourses for local irrigation pumping stations along the Lang Tai river.
- The Dau-Ding Du river originates from Dinh To (Thuan Thanh District) and discharges to the Bac Hung Hai at the Tang Bao conflux.

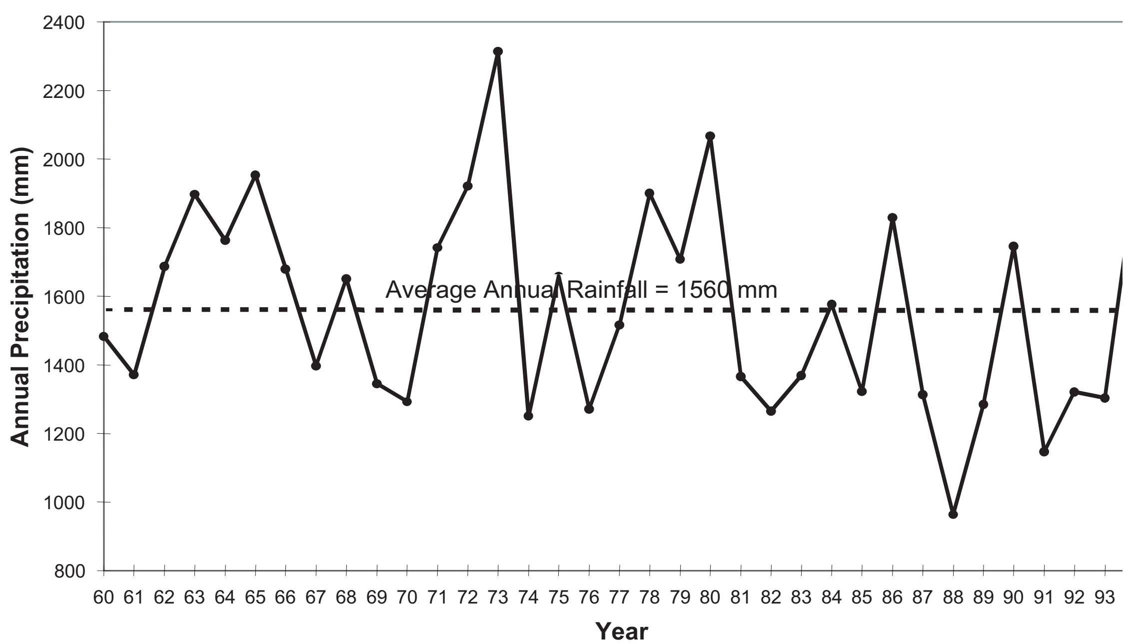
The topography and watercourses form the hydrologic regime and irrigation and drainage mode of the system. Irrigation water is supplied from the Bac Hung Hai canal at the upper part through two main canals. Drainage water follows several drainage courses from the upper part to the lower one. There are two modes of drainage. One is gravity into main drainage courses, then to the Bac Hung Hai canal, during periods of low water levels in the drainage courses. The other mode is by pumping into the Thai Binh and Duong rivers during periods of high water levels in outside rivers.

Hydrometeorologic Characteristics

The climatic features of the project area in the Red river delta include a tropical monsoonal regime with cold temperatures and little rain in winter and a climate that is hot with heavy rains during summer.

Data records of the Bac Hung Hai Irrigation Company show that 34 years' average annual rainfall at the Hai Duong meteorological station, 10 km south of the Nam Duong irrigation system (NDIS), is 1,560 mm. However, the annual total rainfall varies widely from year to year. During the past 34 years, it has been as high as 2,300 mm and as low as 1,000 mm (figure 4.4).

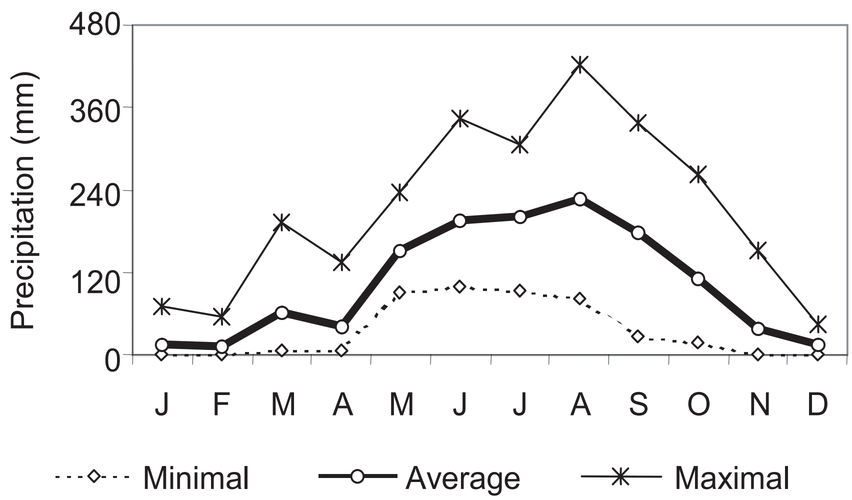
Figure 4.4 Annual precipitations at Hai Duong from 1960 to 1994.



Mentioned data also showed a seasonal variability of precipitation. During the wet season from May to October, monthly rainfall varies from 113 mm in October to 234 mm in August. The cumulative precipitation of this period is 1,340 mm, or is determined as 86 percent of the annual rainfall. During the dry season (rest of the months), monthly precipitation is always less than 62 mm. The cumulative rainfall of this period is only 220 mm, or 14 percent of the annual rainfall.

Figure 4.5 shows that monthly rainfall varies according to years. For August, for example, monthly rainfalls of 1992 and 1994 were 84 mm and 434 mm, respectively, or a difference of 350 mm. This variability is observed also in dry months.

Figure 4.5 Monthly rainfall at the Hai Duong meteorological station.



Crop evapotranspiration

In 1995, Merkley used the Hargreaves equation to estimate reference crop evapotranspiration (ET_o), based on maximum and minimum temperatures recorded at the Hai Duong meteorological station.[2] From estimated ET_o, we can calculate crop evapotranspiration under well-watered condition (called also maximal evapotranspiration) according to the formula $ETM=k_c*ET_o$, where ETM is maximal evapotranspiration and k_c is crop coefficient, which is well known in literature (FAO 1977). Results of calculations for winter-spring rice (from March to June), summer-autumn rice (from July to October) and different upland crops (UC) are presented in table 4.1

Table 4.1 Reference crop evapotranspiration and maximal evapotranspiration (mm/day).

Month		J	F	M	A	M	J	J	A	S	O	N	D	Yearly
ET		2.0	2.1	2.5	3.4	4.2	4.3	4.2	4.0	3.8	3.3	2.8	2.2	1,182
K_c	Rice				1.0	1.2	1.1	1.1	1.0	1.2	1.1	1.1		
	UC	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
ETM	Rice			2.5	4.1	4.6	4.8	4.2	4.9	4.2	3.7			1,010
	UC	1.8	1.9	2.3	3.1	3.8	3.9	3.8	3.6	3.4	3.0	2.5	2.0	1,064

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[2] The Hargreaves grass-based equation is written as: $ET_0 = 0.0023 R_A (T + 17.8)\sqrt{T_{\max} - T_{\min}}$, where, ET_o is the reference-crop (grass) evapotranspiration (mm); R_A is the extraterrestrial solar radiation (equivalent mm of water); T is the mean air temperature (°C); T_{max} is the maximum air temperature (°C); and T_{min} is the minimum air temperature (°C).

Table 4.1 shows that crop evapotranspiration even calculated for conditions of maximal requirement is lower than yearly precipitation (1,010 compared with 1,560 mm). However, it does not mean that precipitation can meet the water requirement of crops. In fact, irrigation is always necessary because of the uneven distribution of precipitation as mentioned above.

Seasonal groundwater levels range from 2.5 m to 5 m. Groundwater in the whole system has a large amount of iron. The underground water level is dominated by the Red river, Duong river and the Thai Binh river.

Characterization of the Nam Duong irrigation system

The irrigation canal system, designed with a maximum irrigation water requirement of 1.1 l/s/ha, consists of main irrigation and drainage pumps, a conveyance canal, 2 main canals with 15 regulators, several conveyance canals of supplementary or independent pumps, 248 secondary canals, and 556 tertiary canals. The secondary canals of the Nam Duong irrigation system are short and rarely extend past a single commune. Tertiary canals are usually confined within an area of a village or hamlet (for details see figures 4.6 and 4.7).

The total irrigated area is 17,000 hectares of which the Nhu Quynh pump commands 12,000 hectares; the remaining area is irrigated by Mon Quan, Kenh Vang, Ngoc Quang and other pumps. There are several small-scale pumping stations, managed by the Nam Duong Irrigation Company or local communities, in the system commanding different part of the area which cannot be commanded by the head works.

Water scarcity is met at the middle section and at the tail end of main canals, particularly in March–April and September–October periods. The water fee collection rate in Nam Duong is 85–90 percent. Irrigation canals including the main and secondary canals have deteriorated seriously leading to low irrigation quality and irrigated area.

Headworks and Main Water Sources

Nam Duong is a complicated irrigation system with pumping stations as headworks and a system of canals as a conveyance and distribution network. Nam Duong IDMC manages 22 pumps, of which 8 are irrigation pumps, 4 are drainage pumps and 10 are dual, irrigation and drainage, pumps. There are approximately 150 small pumping stations managed by local communities and Cooperatives.

The main head work and water-source supplies are Nhu Quynh, Ngoc Quan, which get water from the Bac Hung Hai system, from the southern part; Mon Quan gets water from the Duong river located in the northern part of the system and Kenh Vang gets mainly return and rainwater stored in the downstream part of system.

Nhu Quynh pumping station

Completed in 1965, the Nhu Quynh pumping station has 8 pump units the capacity of each being 7,000 m^3/h. However, this pumping station has deteriorated severely, with the average capacity of each pump reduced to 5.800 m^3/h.

This irrigation system has 5 km of conveyance canal and 2 main canals: the Bac canal from Keo (K0) to Van Ninh (K30+445), and Giua canal from (K0) to Tuyen Ba regulator (K16+300).

The Bac Van Lam and Nam canals irrigate the My Van area. The design command area of this irrigation system is 16,000 hectares with an irrigation coefficient, q, of 0.61 l/s/ha. However, currently it supplies water only to Gia Lam, Thuan Thanh, and 3,500 hectares of Gia Luong (in Bac canal).

Kenh Vang No.1 pumping station

Currently, Kenh Vang No.1 pumping station has 20 pump units, each with a capacity of 1,000 m^3/h. Kenh Vang No.1 has two main canals: Bac Kenh Vang, formerly Bac Nhu Quynh tail end, starts from Kenh Vang pump and joins the Bac Nhu Quynh canal at Van Ninh and Nam Kenh Vang starts from the pump to the Lai Ha village.

Kenh Vang I operation: In the catchment area of Kenh Vang there are 1,000 hectares of water surface, which includes the Ngu river and many ponds and lakes. These water bodies contain relatively large volumes of water, from the previous rainfall, enough for the first 20 days of land preparation. After the initial land preparation, the pump has to stop for 20 days waiting for return flows from upstream paddy fields before it can continue its operation. For the rice-growing period, 100 percent of water for the pump is return flow.

The pumping station is severely deteriorated. All equipment has not been replaced since 1965. The suction pool and delivery canals have not been dredged for several decades and sedimentary mud is about 0.8–1 m thick.

The Bac Kenh Vang canal runs on sandy ground and, therefore, the seepage coefficient is large and its banks are often broken down. Illegal activities violating the Ordinance on the protection and exploitation of hydraulic works such as planting vegetables or trees on canal banks occur quite often. Therefore, although this pumping station has sufficient water delivery, it still faces many difficult conditions.

Mon Quan pumping station

The Mon Quan pumping station has a capacity of 18,000 m^3/hr. It gets water from the Duong river, which supplements the tail end of the Bac Nhu Quynh main canal.

Ngoc Quang pumping station

The Ngoc Quang pumping station has 5 pump units, each with a capacity of 4,000 m^3/s. It has been operated since 1975 to supplement water from Ngoc Quan to the Nhu Quynh Giua canal section from Tuyen Ba to Phu Hoa (K11+915). Reach I (4.07 km) of this pumping station connects with the tail-end section of the Giua Nhu Quynh canal at Co Lam (K4+070 Ngoc Quan) dividing this section into two reaches: reach II from Colam to Tuyen Ba (Tuyen Ba flume is K16+300 of Nhu Quynh and K7+070 Ngoc Quan) and reach III from Colam to Phu Hoa.

Gravity-Suspended Silt-Water Intakes during Summer, along the Duong River

There are two water intakes, which are Phu My and Mon Quang, getting water at a higher water level during summer in the Duong river. The Phu My intake is 1.4 m wide and 1.8 m high and its design discharge is 7.6 m^3/s. The design irrigated area is 13,000 hectares. The actual irrigated area is approximately 6,000 hectares. The Mon Quan intake is the same size as Phu My but its design discharge is 4.4 m^3/s. The design irrigated area is 6,400 hectares and actual irrigated area is around 3,000 hectares.

Table 4.2 Operation rule of gravity water intake gates.

River water level	5–6 m	6–8 m	>8 m
Gate opening	Fully open	Keeping downstream water level at 5.2 m	Closed
Total operating time of whole season	PM: Tmax=60 ds, MQ: Tmax=50 ds,	Tmin=40 ds Tmin=20 ds	

Secondary canals

Secondary canals were improved in 1971 with a detailed plan of tertiary canals, which are now degraded seriously. Over the past 30 years of operation, the water fee is not enough to cover the costs of system maintenance making it seriously degraded.

Because of increasing water demand and crop diversification, insufficient water supplies occur from time to time. The intake gates with larger dimensions than design were constructed at lower elevations causing imbalance of water in the system. Reduction of water at the head of canals is the main reason for additional intakes and deterioration of canals. Moreover, canal lining has not received sufficient attention from local authorities, but have primarily relied on the mobilization of farmer labor.

Since the economic renovation in late 1980s, water intake into field plots is usually not conducted by Cooperatives, but by farm households. Thinking of water for their own plot needs, farm households often illegally break the canals. Interminable debts from electric costs have led to insufficient electricity for needed pump operations, which has led to insufficient water for irrigation. Canal banks are usually broken for individual purpose of irrigation.

The canal bed is lower than design because its bed was dug to take earth for improvement of banks during rehabilitation and maintenance. The banks are too low to raise the water head to design level. Many reaches of canal are used by people for the purpose of drainage leading to difficulties in irrigation and water losses. Many canals cannot deliver irrigation water, thus banks are broken for manual irrigation. Due to poor pumping conditions, appropriate management and operation are impossible. This is also a cause for degradation of the structure.

Regulators and irrigation blocks

The main canal, by its original function, is divided into four sections. The conveyance canal section is 5.6 km long. There are 22 secondary canals taking water from this canal section irrigating 1,070 hectares. The Bac (Northern) canal is 40.1 km long. There are 109 secondary canals taking water from the Bac canal and supply water for 6,325 hectares. The Giua (Central) canal is 36.5 km long. There are 87 secondary canals taking water from the Giua canal and irrigating 5,635 hectares.

The Phu Sa Alu section, with 7 secondary canals, supplies water to 315 hectares. The other canals, conveying water from their head work pumps, irrigate areas separate from the main canal and these are Nam Kenh Vang, 580 hectares; Ngoc Quan conveyance canal, 655 hectares; Minh Tan, 360 hectares; and Song Giang, 410 hectares.

There are 7 regulators in the Bac canal and 5 in the Giua canal. These regulators play a very important role in water regulation and delivery. They are used to control the water level in the main canal so that water from the main canal can be supplied to different field areas. The function of most regulators is water-level control, to deliver water to areas in higher locations, in canal section upstream of it. However, some have different functions. The Keo regulator is used for water distribution between the Bac and Giua canals. The Alu regulator is used to increase the water level to deliver water to areas located higher in the Keo-Alu section and water distribution between the Giua and Phusa Alu canal sections.

In the Bac canal, the Ho regulator is used to control the water level in the Alu-ho canal section, the Ngamluong regulator to control the water level both in the Ho-Ngamluong section and downstream of it in the Monquang pump operation, the Huongvinh regulator to control the water level in the Ngamluong-Huogvinh canal section, the Thaibao regulator to control the water level in the Huongvinh-Thaibao section, the Dongcoc regulator in the Giua canal to control the water level in the Keo-Dongcoc section, the Quantranh to control the water level in Dongcoc-Quantranh section, and the Tuyenba regulator to control the water level upstream of it and serves as a water division line. Tuyenba and Ngamluong are thus served as the border line between upstream and downstream of the main Bac and Giua canals.

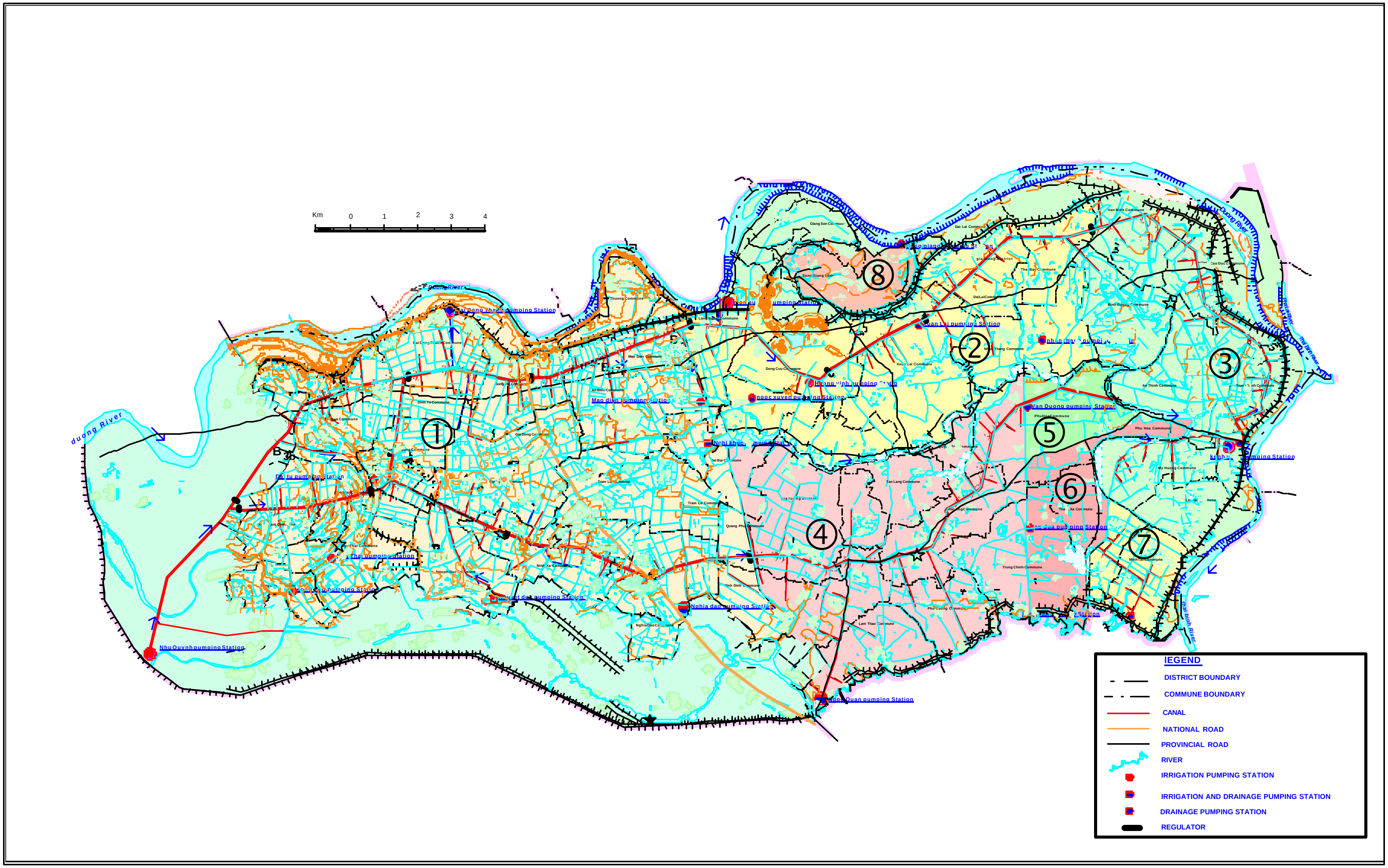
Considering current headworks and water resources, the entire Nam Duong command area is divided into 8 irrigation blocks, numbered from head to tail end (table 4.3).

Each block has several pumping stations, taking water from the main Bac Hung water supply canal or return flow supplies to an area that is sometimes separated by regulators but sometimes connected to Block No.1, which is most upstream, getting water from Nhu Quynh, Ngu Thai, Song Lieu, Nguyet Duc and Nghia Dao pumps. It is separated from the downstream block by the Ngam Luong regulator in the Bac canal and by Tuyen ba in the Nam canal. Block No2 is supplied with water mainly by the Mon Quang, Xuan Lai and Nhan Thang pumps. It is separated from upstream by the Ngam Luong regulator and downstream block by the Van Ty regulator. Block No. 3 is irrigated by the Kenh Vang pump and Block 4 by the Ngoc Quan pump. Blocks 5, 6, 7 and 8 are irrigated by completely independent Van Duong, Ap Dua, Minh Tan and Song Giang pumps, respectively (figure 4.7).

Table 4.3. Irrigation blocks in the Nam Duong irrigation system.

Irrigation block	Pump	Design capacity (m^3/h)	Irrigation subblock	Canal section	Irrigated area (ha) Irrigation subblock	Irrigated area (ha) Canal section
1. Keo-Ngamluong	Nhuquynh	8 x 8,000	Headwork K-Keo	Headwork K-Keo	1,070	1,070
Tuyenba			Keo-Ngamluong	Keo-Alu	2,410	615
	Nguthai	2 x 1,000		PhuSa-Alu		315
	Songlieu	2 x 1,000		Alu-Ho		645
	Nguyetduc	2 x 1,000		Ho-Ngamluong		835
	Nghiadao	2 x 4,500	Keo-Tuyen ba	Keo-Daitu	2,680	410
				Daitu-Quantranh	1,290	
				Qtranh-Nghiadao		670
				Ndao-Tuyenba		310
2. Ngamluong-	Monquang	18 x 1,000	Ngamluong-Thaibao	Nluong-HungVinh	2,850	1,035
Thaibao	Xuanlai	5 x 1,000				
				Hvinh-Dinhdong	665	
	Nhanthang	3 x 1,000				
				Ddong-Thaibao		1,150
3. Kenhvang	Kenhvang	20 x 1,000	Kenhvang	Bac	1,640	1,060
				Nam		580
4. Tuyenba-Vanduong				KchungNQ	3,140	650
	Ngocquan	5 x 4,000	Tuyenba-Vanduong	Tuyen2NQ		875
				Tuyen3NQ		1,600
5.Vanduong	Vanduong	2 x 1,000	Vanduong	Vanduong	480	480
6. Apdua	Apdua	3 x 1,000	Apdua	Apdua	110	110
7. Minhtan	Minhtan	2 x 1,000	Minhtan	Minhtan	360	360
8. Songgiang	Songgiang	6 x 1,000	Songgiang	Songgiang	410	410
Cooperative pumps					2,000	2,000
Total					17,150	17,135

Figure 4.6 Nam Duong irrigation and drainage system and irrigation blocks.



All regulators in the Bac canal are operated under the control of the IDMC head office (Department for Water Management). Regulators in the Giua canal are operated by the Thuan Thanh enterprise upon an agreement with the head office.

Socioeconomic characteristics

The Nam Duong irrigation system supplies irrigation and drainage services for an area covering the entire 36 communes of the Gia Binh and Luong Tai Districts, the Thuan Thanh Districts of the Bac Ninh Province, six communes of the Gia Lam District of Hanoi City, six communes of the My Van District of the Hung Yen Province and communes of the Cam Binh District, the Hai Duong Province. The total area in Gia Lam irrigated by the Nam Duong irrigation system is 600–700 hectares, partly by pumps taking water from the main and secondary canals (partial irrigation) and partly by gravity from secondary canals (full irrigation). My Van takes water from G11, the Nguyet Duc pump, under contract with the Thuan Thanh Enterprise and from the Bac Van Lam canals, C1, C5, under contract with the Nhu Quynh Enterprise. The water fee is levied by the water fee norm issued by the Hanoi and Hai Duong Provinces, and not by the Bac Ninh Province.

The total population is approximately 340,000 of which agricultural population occupies 88.5 percent. There are 84,996 households of which farming households account for 72,246. The average family size is 4.2 persons/household. The average farm size is 0.28 ha/household

Economy, welfare and poverty

In the Nam Duong area, the local economy is still at a development status. Agriculture plays a main role in this area. Although handicrafts are developing in some areas, such as bending bronze instruments and knitting in Dong Cuu, agricultural activities are the main occupation while others are secondary.

The highest annual average rice yield during 1994–1998 was 4.0 tons/ha and the highest paddy converted output was 128,032 tons/year (table 4.4).

Table 4.4. Cultivation production in the area.

Assessment criteria	1994	1995	1996	1997	1998
Cultivation area	34,267	34,000	34,090	34,000	34,400
Yield (t/ha/crop)	3,572	3,605	3,779	3,844	4,001
Paddy converted output (tons/year)	109,000	118,000	119,800	120,000	128,032

In Thuan Thanh and Gia Luong Districts, households (98% and 93%, respectively) earn their primary income from agriculture (cultivation and animal husbandry). Though located in the rather well-off Red river delta, compared to the Central Coastal region, the poverty rate in Gia Luong and Thuan Thanh is 55 percent as evaluated by the World Bank poverty line in 1999 (T&T International 2000). The poverty rate data from communal consultations indicate that the poverty rate is increasing from head to tail of the main canal (table 4.5).

Table 4.5. Poverty rate along main canals (2001).

District	Bac canal communes	Poverty %	District	Nam canal communes	Poverty %
Thuan Thanh	Tri Qua	8.4	Thuan Thanh	Xuan Lam	14
	Dinh To	16.3		Ha Man	25
	Dai Dong Thanh	9.2		Hanh Phuc (Thanh Khuong)	12.8
	Song Ho	2.5		Song Lieu	23.4
	Mao Dien	8.2		Ngu Thai	26
	An Bin	9.2		Nguyet Duc	16.5
	Hoai Thuong	13.6		Gia Dong	10.9
				Ninhxa	11.9
				Nghiadao	12.8
				Tramlo	12.3
Gia Binh	(MQ.P)Lang	13.5	Luong Tai	(NQ.P) Binh Dinh	11.1
	Ngam	12.7		Quang Phu	10.0
	Dong Cuu	9.3		Pha Lang	11.0
	Dai Bai	21.4		(TT.Thua)	10.0
	Song Giang	22.4		Tan Lang	7.7
	(SG.P)	12.6		Lam Thao	9.5
	Gian Son	14.3		Phu Hoa (VD.P)	10.4
	Xuan Lai (XL.P)	17.7		Trung Chinh	11.8
	Tan Lap (Dai Lai)	11.5		(AD.P)	12.6
	Quynh Phu	11.9		Phu Luong	15.1
	Thai Bao	16.4		Trung Xa	
	Nhan	10.7		Minh Tan (MT.P)	
	Thang(NT.P)	9.6			
	Van Linh				
	Cao Duc				
	Binh Duong				
Luong Tai	An Thinh	16.8			
	(KV.P) Trung	9.0			
	Kenh	11.0			
	My Huong				

Note: Poverty is evaluated using the MOLISA poverty line of VND100.000 /capita/month.
Source: Consultation with Thuan Thanh, Gia Binh and Luong Tai District people committees and communal PCs.

Development Orientation

Gia Luong and Thuan Thanh Districts are agricultural areas and industrial development is not significant. Local people are entirely dependent on agricultural activities for their livelihoods. The orientation of the 2000–2005 Development Plan for the District is to:

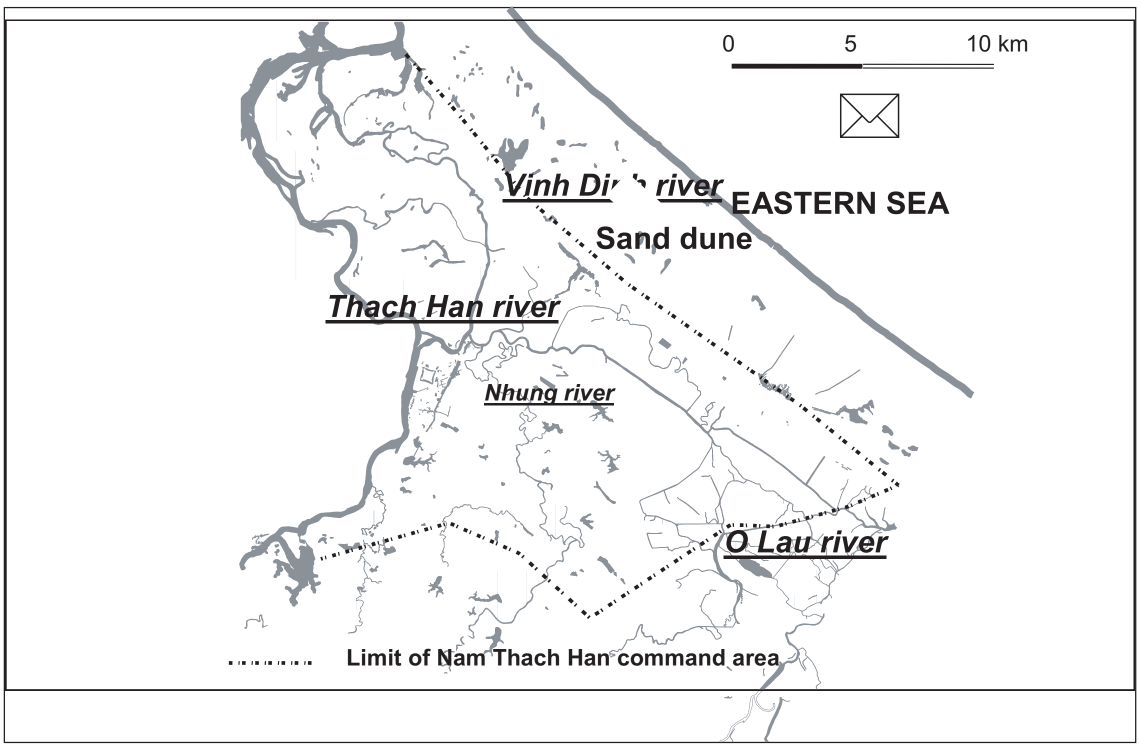
- Increase cropping intensity, apply advanced technologies to agricultural practices, and determine appropriate cropping seed to enhance yield of crops.
- Change land use pattern and form a cultivation specialization area.
- Increase land-use coefficient to raise agricultural production.

- Enlarge VAC model, create jobs contributing to improve the living standard and reduce poverty.
- Implement agricultural product processing in local production areas and balance the development of cultivation and animal husbandry.

Nam Thach Han System in the North Central Coastal Region

The Nam Thach Han irrigation system (NTHIS) serves the southern plains of Quang Tri Province located in Central Vietnam. In general, the plains have an average width of 8 km (in the east-west direction) and an average length of 20–25 km (in the north-south direction). It is bounded by coastal sandy banks to the east, hills and mountains to the west, the O Lau river to the south, and the Thach Han river to the north (figure 4.7).

Figure 4.7 NTHIS command area.



Note: The boundary of the NTHIS shown on the above map is not exact. The approximate boundary is drawn by relying on the irrigation canal system.

The irrigation command area of NTHIS generally slopes from west to east and from north to south. The cultivated land in the study area has a range of absolute elevation from -0.2 to 4.0 m. However, most of the area is at an elevation from 2.5 to 4.0 m.

The NTHIS area is affected by seasonal monsoons. From September to November, south-easterly winds originate from a barometric depression that may develop to form cyclones offshore of the Pacific Ocean, blowing in the southeast–northwest direction. These may cause strong winds with considerable force, called a tropical hurricane. From January to March the northeast winds, originating from anticyclones in the temperate zone at the Asian Central (Siberian) region, bring cold and dry conditions and blow in a northeast-southwest direction. However, the South Thach Han area is not affected by these winds due to high mountains located in the north.

In addition, the Nam Thach Han areas are affected by the sea-continent wind regime. From April to August, winds blow from the west during daytime and from the eastern sea at nighttime. Western winds are very dry due to the protection from the high mountains.

The climate of the Nam Thach Han area is divided into two distinct seasons: the rainy season (from September to December) and the dry season (from March to July). The remaining months (January, February and August) are considered as transition seasons.

The climate of the Nam Thach Han area can be illustrated by following average monthly characteristics calculated for the periods from 1910 to 1938 and from 1960 to 1988 (table 4.6). The table shows a distinct difference in rainfall, air humidity, and evaporation during the rainy and dry seasons, particularly with respect to rainfall with an average monthly rainfall of 467 mm and 93 mm in the rainy and dry seasons, respectively. Rainfall for the 4 months of the rainy season accounts for 71 percent of the total yearly rainfall. In contrast, differences in temperatures and wind velocity are not considerable.

Table 4.6. Monthly climatic characteristics of the Nam Thach Han area.

		Temperature (mm)	Rainfall (°C)	Humidity (mm)	Wind (%)	Evaporation (m/s)
Wet season	September	27.0	435	85.7	7.1	47.9
	October	25.0	623	88.5	6.8	25.1
	November	21.1	521	89.5	7.2	16.8
	December	20.8	288	89.8	6.8	34.7
	Average	23.5	467	88.4	7.0	31.1
Dry and transitory season	January	19.3	158	90.3	6.5	24.0
	February	20.6	69	90.8	6.2	15.1
	March	22.6	66	89.9	5.9	15.8
	April	25.5	59	86.3	6.4	23.5
	May	28.0	109	61.7	7.1	41.3
	June	29.4	83	76.3	9.4	77.8
	July	28.4	87	73.6	9.4	113.6
	August	28.9	111	75.5	7.4	66.0
	Average	25.3	93	80.6	7.3	47.1
Yearly	Average	24.7	217	7.2	7.1	41.8
		Total	2609			502.6

Source: Sanh 1994.

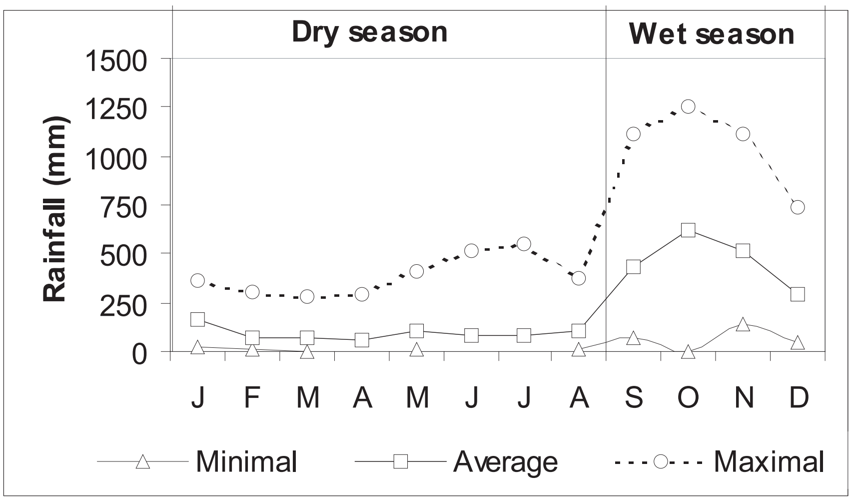
The data also show a significant interannual variation of monthly rainfall (figure 4.8). In October for example, monthly rainfall varies from a low of 3 mm to a high of 1,296 mm. It also reveals that the observed minimum monthly rainfall during the dry season is almost zero. These are important natural constraints of the system.

Hydrography and Hydrology

Figure 4.4 shows that the command area of NTHIS is bounded by Thach Han river to the North and O Lau river to the South. Additionally, there is a dense network of natural rivers and lakes in the irrigation area.

The surface water of the irrigation system could be potentially affected by the hydrological regimes of three elements: a) Thach Han river, b) O Lau river, and c) inland rivers and lakes. However, water from the O Lau river is currently not used by the NTHIS due to an absence of water reclamation structures, such as salinity prevention and water-storage structures. Topographical conditions are not favorable for utilization of this water source as land elevation gradually lowers toward the river. Hydrological characteristics of the two remaining surface water sources are described in the following sections.

Figure 4.8. Maximal, average and minimal monthly rainfall, from 1910 to 1938 and from 1960 to 1988.



Thach Han River

Like other rivers in Central Vietnam, the Thach Han river is short and steep with a small catchment area (1,460 km^2).[3] With the low forest cover rate on watersheds and variable rainfall over time, the river-flow regime varies strongly over seasons (table 4.7).

Table 4.7. Monthly discharge of the Thach Han river (75% probability, in m^3/s).

Dry season								Wet season				Average
J	F	M	A	M	J	J	A	S	O	N	D	
50.0	41.0	26.0	16.0	11.0	8.1	9.1	18.0	125.0	137.0	106.0	70.0	51.4

Source: Sanh 1994.

[3] In Central Vietnam from Thanh Hoa to Binh Thuan Provinces, only Ma, Ca, Thu Bon and Ba river basins have catchment areas larger than 10,000 km^2.

According to Sanh (1994), the required water discharges for the NTHIS are equal to 18.0 m^3/s. The following comments can be drawn about inflows to the Thach Han river:

- Despite calculations for the dry year (at 75% probability), average annual inflows of 51.4 m^3/s are higher than the estimated requirements of 18.0 m^3/s.
- In the dry season, the duration when inflows are less than requirements lasts for 4 continuous months from April to July. In particular, inflows in June represent only 45 percent of requirements (8.1 m^3/s compared to 18.0 m^3/s).
- In the wet season, peak monthly inflows can reach 137 m^3/s.

The above discussion shows that the Thach Han river is an abundant water source, but that it has a flow regime unfavorable to agricultural production, flood prevention and control. The dry season also coincides with the cropping season when inflows are usually smaller than the system water demands. On the contrary, in the rainy season, inflows are abundant even causing inundation and limiting agricultural production.

In order to clearly determine the climatic and hydrological difficulties in the NTHIS, Pham Van Ban (2002) calculated a drought coefficient ($K_{drought}$) for every 10 days for 6 years from 1995 to 2000. This coefficient resulted from combining air dryness ($K_{dryness}$) when comparing rainfall with potential evaporation and drought possibilities due to limited inflows ($K_{low\ flow}$):

$$K_{drought} \quad \sqrt{K_{dryness} * K_{low\ flow}}$$

The coefficient does not completely correspond to the real drought situation because it does not take into account water storage capacities of the system (in rivers, ponds, lakes, canals, etc) (Pham Van Ban 2002). However, the analysis results show a high degree of drought vulnerability for the system, especially in the summer-autumn cropping season when the system normally is faced with medium to serious droughts for a month or more every year (table 4.8).

Table 4.8 Drought severity of different decades during dry seasons from 1995 to 2000.

	J			F			M			A			M			J			J			A		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1995								++	++	++	+++	+++	+					+++	++	++	+++	++	++	
1996								++	++	++								++	++	+++				
1997						+		+								+++	+++	+++	+++	+++	++	++		
1998									++	++	+++	+++							++	++	+++	+++	+++	++
1999							++	++								++	++	+	+	+++	+	++		
2000							++	++		+++									++	+		+	++	

Note: +, ++ and +++ correspond to low, intermediate and high drought severity, respectively.

Natural storage

The network of rivers, streams, ponds, and lakes in the irrigation command area plays a decisive role in the utilization of return-flows. In this system, Vinh Dinh river is the largest one connecting Thach Han and O Lau rivers (refer to previous Figure 4.8). The Vinh Dinh river has a length of about 35 km and a width of about 60 m, and a water surface area of about 210 hectares. As it is separated from the lower part of Thach Han river (where fresh water is impacted by saline water intrusion) by An Tiem Siphon and Vinh Yen Dam (both structures were built in year 2000 for drainage, flood control and salinity prevention), water is suitable for agriculture.

Besides supplying water for pumping stations, Vinh Dinh river also plays an important role in flood routing. In the case when the Thach Han river water level rises to high level, An Tiem sluice is opened so that Vinh Dinh river can discharge about 25 percent of flood volumes into the Thach Han river. As a result, damage and loss caused by floods can be significantly reduced, for instance, dike sides (or the left N1 secondary canal bank, in fact) can avoid deterioration and inundation and the severity of damage outside dikes can be mitigated during the flood season.

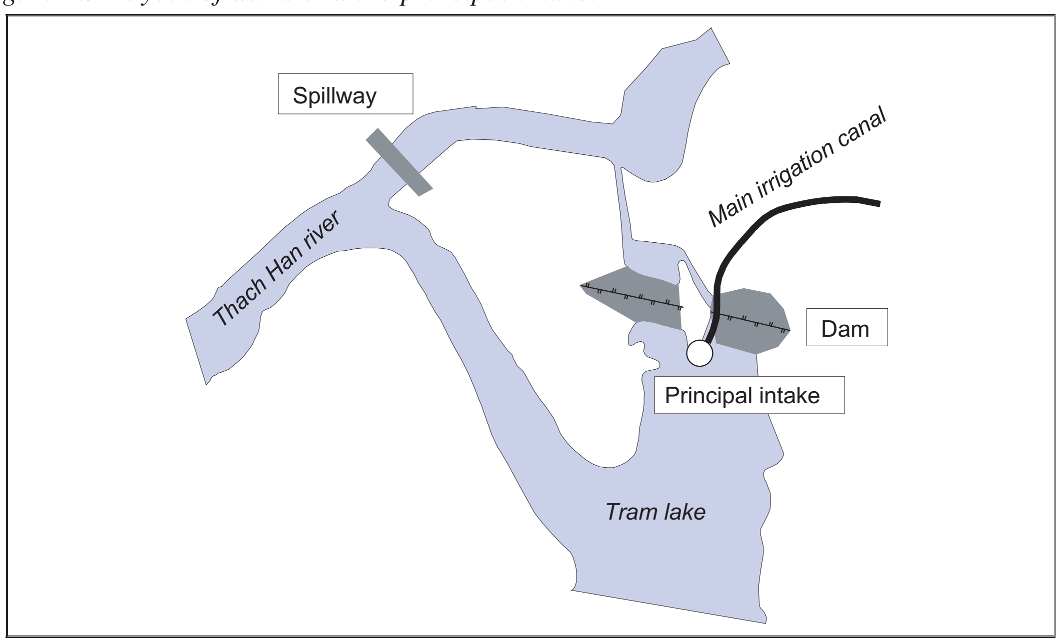
Characterization of Nam Thach Han irrigation system

There are two kinds of headworks in NTHIS: (a) dam and principal intake for gravity supply and (b) pumping stations for utilization of recycled water.

Dams and principal intake

Dams and principal intakes (figure 4.9), as well as other construction of NTHIS, have been built since 1978. Headworks, including an earth-filled dam, spillways and water intake, are located 7 km from the upstream of the irrigation area.

Figure 4.9 Layout of dams and the principal intake.



An earth-filled dam is designed to prevent water flowing downstream from the Tram lake. The absolute dam crest elevation is 21.5m and designed for a water level of 20.5m. In last 25 years, the highest observed water level was only 18.5 m on 31October 1983. This level is 3.0 m lower than the top of the dam.

The spillways are designed to keep water flowing from upstream at enough elevation for gravity diversion to the command area. These are concrete spillways of 135 m length and 8.5 m absolute height. The design water level is 7.14 m (this is the lowest water level at which the structure can supply water to the irrigation system).

The principal water intake: takes water from Tram Lake to the system. It is designed for a maximum discharge of 33.0 m^3/s.

The spillways were designed according to two contradictory criteria: a) the spillways should be low enough to be able to drain floods, but b) they should be high enough to store water and raise the water level in the upstream. In practice, at 8.5 m of crest elevation as designed, the spillways cannot store enough water to meet demand in the summer-autumn season when inflows are small. The two following solutions are applied to overcome this problem:

The first solution involves a temporary earth-filled dam. Before 2000, NTHIS used to annually build a temporary earth-filled dam at the top of the spillways at the beginning of the summer–autumn season. During the rainy season, the dam was demolished to let the floods out. The temporary dams face the following weaknesses:

- Waste of labor due to annual rebuild;
- Small storage capacity because only 1 m in height;
- Prone to be destroyed by occasional heavy rain (in 1999 for instance);
- Unable to make use of surplus water at beginning of the summer-autumn season because construction can only start late when inflows are low enough. Sometime, water levels do not reach the dam crest at 9.5m.

The second solution involves the use of a rubber dam. Since the summer-autumn crop of 2001, the NTHIS has installed a rubber dam of 2.0 m height at the top of the spillways. The dam is able to raise upstream water levels and store 9.7 million m^3 of water in addition to the storage capacity of the spillways. If the rubber dam can store the water from two heavy rains in the upstream during the summer-autumn season (at the beginning and middle as in 2002), the system would be augmented with 19.4 million m^3 of water, which is equal to 385 mm for 5,038 hectares of cultivated area or 13 percent of the system's irrigation water demand.

Operation principles of the rubber dam are as follows:

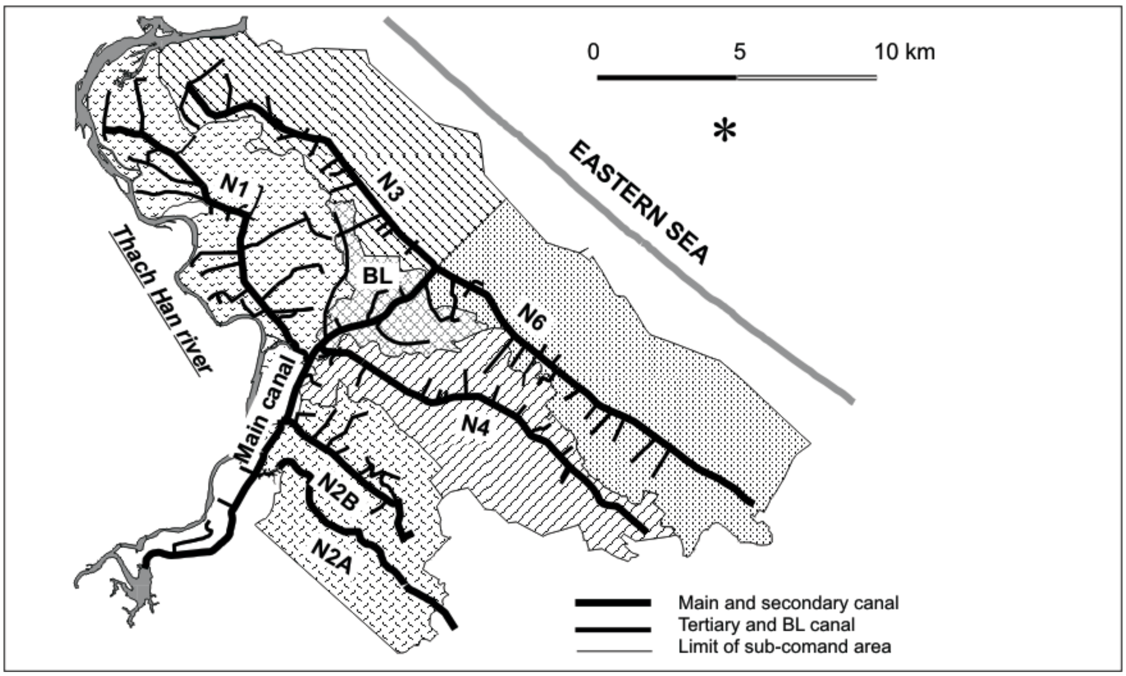
- When the water level reaches 11.20 m (0.70 m higher than the rubber overflow): water in the dam is released to increase the flood discharge capacity of the dam;
- When the water level in the upstream decreases to 9.50 m (1.00 m lower than the rubber overflow level): water is pumped into the float to store water (water from upstream will rise filling the reservoir to the 10.5 0 m water level).

According to the NTHIS' staff, however, the rubber dam cannot adequately solve the water shortage problem of the system. In the summer-autumn season, NTHIS still must apply a rotation irrigation method. Areas located at tail-ends of canals are still irrigated by pumping stations. Furthermore, the rubber dam reduces the flood drainage capacity of the spillway. Even with no water inside of the dam, there is 0.20 m height of the dam's body (current overflow level is 8.70m, not 8.50m).

Pumping station

There are three pumping stations under management of the NTHIS, which are the Phuong Le pumping station (capacity of 2,000 m^3/h) supplies water for the tail of canal N3, the Hien Luong pumping station (capacity of 3,000 m^3/h), and Quang Dien pumping station (capacity of 2,000 m^3/h), which supply water for the tail of canal N1. There are numerous electric and petrol pumping stations under management of Cooperatives but the exact number is not known. For example, Nai Cuu Cooperative possesses an electric pumping station (capacity of 540 m^3/h) and two mobile petrol pumping stations; Gia Do Cooperative has an electric pumping station (capacity of 2,000 m^3/h) and a petrol pump owned by an individual which are hired by the Cooperative. All of the above pumping stations take water from natural springs, rivers, lakes, ponds and drainage canals, especially from Vinh Dinh river. These pumping stations either provide permanent irrigation for both winter-spring and summer-autumn crops or temporary irrigation when NTHIS lacks water.

Figure 4.10 Layout of canal system and sub-command area.



Note: This map illustrates general locations of sub-command areas of the system as the boundaries are administrative limits of communes, rather than the hydrologic boundary.

The canals of the NTHIS are classified as main, secondary (namely by the letter N and one number from 1 to 6, except canals N2A and N2B), tertiary (namely by the letter N and two or three numbers) and on-farm canals. In addition, there are some canals called “Bio-level” (BL), which are directly supplied by the main canal but have a scale as small as tertiary canals.

Figure 4.10 presents the six following sub-command areas: N2 sub-command area irrigated by N2A and N2B secondary canals; N1, N3, N4 and N6 sub-command areas irrigated by correspondent secondary canals; and BL sub-command area irrigated by BL canals.

Sub-command areas and the canal system can be characterized respectively by IIDP (ratio of net irrigated area to designed command area) and irrigation intensity in terms of canal length (IICL), defined as the ratio of actual to designed canal length. These two indicators reveal that net irrigated areas are very small (43%) in comparison with the design command area although the irrigation canal system has been completed to 87 percent compared to the design (table 4.9). In particular, the N2A canal has been completed to 53 percent compared to the design but can only serve 6 percent of the designed command area. The contradiction between the designed irrigation and actual canal system can be explained by the facts that due to water shortage, the system cannot serve a large part of the cultivated areas, including those occupied by upland crops.

Table 4.9. Characterization of sub-command area and canals system.

Canal	Canal system			Sub-command area		
	Designed (km)	Actual (km)	IICL (%)	Designed (ha)	Net (ha)	IIDP (%)
N2A	13.3	7	52.6	3,473	202	6
N2B	7	5.9	84.3	800	546	68
N4	13.9	13.9	100.0	1,920	1173	61
N6	15.4	10.9	70.8	3,659	756	20
N1	14.8	14.5	98.0	3,582	2291	64
N3	12.8	13.8	107.8	2,049	971	47
BL	n.a.	41.4	n.a.	1,486	1123	75
KC	17.2	16.4	95.3	16,969	7332	43
Total	94.4	82.4	87.3	16,969	7332	43

Status of canal system

At present, some secondary canals are covered or lined by concrete or brick. In contrast, tertiary canals and on-farm canals are in poor condition. In some places, field-to-field irrigation is still practiced due to incomplete on-farm canals. This does not significantly affect agricultural production, but it does raise difficulties for water distribution between fields. For example, farmers sometimes must take water in lower fields to irrigate higher fields.

According to local authorities, canal systems do not meet production requirements (rotation irrigation) with many deficiencies in design (see box 1 on comments).

Box 1. Comments by local authorities about canals system:

- Example 1: N13 canal in Nai Cuu Cooperative

\- To irrigate fields at the tail-end of the canal (high fields), operators must close all intake gates in the upstream to create a water level high enough (locally called pressed water) at the tail-end of the canal. This method takes a long time and overflow sometimes happens at head of canal. Otherwise, water cannot flow to fields even though the water level reaches 2/3 the height of the canal (locally called suspended fields). The same phenomenon happens to the secondary and tertiary canals. In order to irrigate ten hectares at high elevation at head of secondary canal N1 for example, operators have to control flows or close many gates along the canal.

\- Lining canal in N13 canal makes it difficult for water supply. When the canal was still an earth canal, the Cooperative could take water quickly (gates at head of canal were fully open) because of very low canal bottom and large cross section. After lining, the gate can be opened to 45 cm at maximum; otherwise, there will be an overflow of water.

- Example 2: Canal N1-10

Earlier, when it was an earth canal, water flowed to all command areas. After lining, water can flow only to half the canal length because of the raised bottom elevation (locally called suspended canal).

- Example 3: Tail of N1 canal

The canal was lined, but water is never full in the canal. In fact, it is not necessary to fill the canal with water because the field elevation is low.

Characterization of regulators

In addition to the principal intakes as discussed above, there are two other kinds of regulators in the system, i.e., a) gates at head of canals and b) regulators in canal. Most canals are equipped with sluices with fixed gates (made of steel or concrete) or unfixed gates (filled with earth when needed). The unfixed gates are applied only for small canals. There are two regulators in the main canal (K7 and K12), 3 in N1 secondary canal (K6, K10 and K13), 1 in N3 secondary canal, 1 in secondary N4 canal and 1 in N6 secondary canal. In addition, there are many regulators in the tertiary canals. All regulators are in good condition allowing the management agencies to be active in distributing water.

Role of regulators

By controlling flows or closing sluice gates, operators are able to apply two rotation irrigation methods: upstream/downstream and alternative intermittent irrigation. The upstream/downstream rotation irrigation is not widely practiced, however, because of the following reasons. This method is locally concentrated irrigation (upstream or downstream). During the turn of downstream, it requires large dimensions of the upstream canal to avoid overflow. It is not suitable for complicated topographical conditions. In the same area, there are high plots as well as low ones. In a short duration of time, it is very difficult to distribute water for all plots at such different elevations.

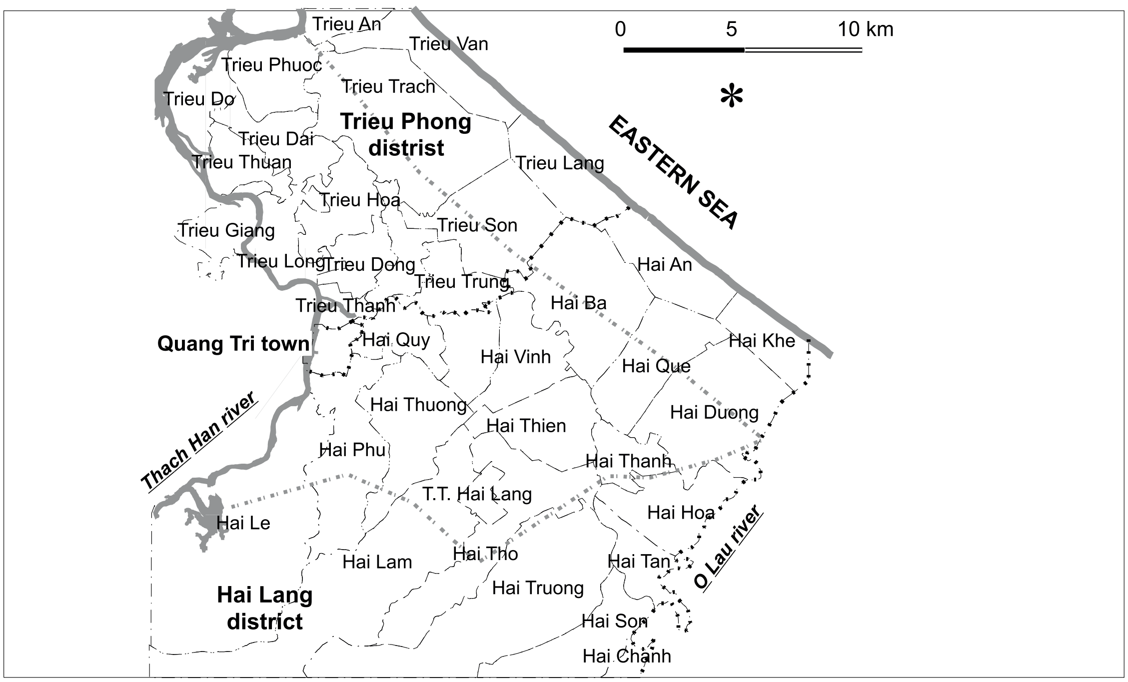
Regarding the alternative intermittent irrigation method, all regulators in the canal are not fully closed but are used for regulating water level and discharges between upstream and downstream. This method can be illustrated by the following examples regarding water regulation in three levels of the system: main, secondary and tertiary canals.[4]

Socioeconomic Characteristics

The highest administrative unit of the system is at district level, thus making the NTHIS an inter-district system. Quang Tri town, Trieu Phong and Hai Lang districts.

Each district is made up of wards and communes (Quang Tri town consists of 2 wards, while Trieu Phong and Hai Lang Districts cover 19 and 21 communes and townships). It is important to note that there are several communes belonging to these Districts that are not served by the NTHIS. They are communes situated in the north of the Thach Han river, communes in coastal areas, communes on western hills and mounds, and southern communes adjacent to the O Lau river. Each commune is divided into villages. Although villages do not constitute an official administrative unit, agricultural Cooperatives are usually established at this level.

Figure 4.11. Administration division of the Nam Thach Han command area.



[4] Water supply in terms of volume will be discussed in the next chapter. Descriptions herein have only the objective to show where and when water is supplied by using regulators.

Population

According to the Statistical Yearbook in 2000, the total population of Quang Tri town, Trieu Phong, and Hai Lang Districts was 217,000 (14,900, 107,800, and 94,300, respectively), of which more than 80 percent were farmers. The average population density in the system is 500 persons/km^2, but the population is unevenly distributed. In many communes of the Trieu Phong District, the population density is more than 760 persons/km^2. In contrast, the density in several communes of the Hai Lang District is less than 300 persons/km^2. In view of a location where agricultural production plays an important role, such a population density is considered relatively high, even higher than that of the Mekong delta (about 380 persons/km^2), but much lower than that of the Red river delta (about 1,000 persons/km^2). Given the population density, the per capita landholdings are limited, especially for communes in the plains.

Economic Welfare and Poverty

Nam Thach Han Irrigation and Drainage System is located in the Thach Han river basin, Quang Tri Province. Quang Tri has an area of 4,592 km^2 and a population of 571,019. Agriculture occupies a predominant share in the GDP. In 2000, the GDP in the Province was BVND 1,679, of which the agricultural and forestry sectors accounted for 38 percent.

Table 4.10. Quang Tri Province gross agricultural output at current prices (VND million).

Sectors	1995	1997	1998	1999	2000
Total	5,491,313	776,603	733,775	1,004,444	1,045,419
Cultivation	347,363	508,571	476,086	661,950	623,638
Livestock	132,280	170,542	157,633	212,195	263,950
Services	69,488	97,490	100,056	130,300	157,831

Poverty Rate

In the Quang Tri Province, uneven evaporation and rainfall are the main cause for losses of property and lives. The rural poverty rate is approximately 24.4 percent when calculated by MOLISA's poverty line and 66 percent according to the World Bank's overall poverty line. Based on MOLISA's definition, the poverty rate for communes in the command area of the Nam Thach Han system ranges from 12 percent to 34 percent. In 2000, for canals N1 and N3 (in the Trieu Phong District), the poverty rate was evaluated based on the old poverty line of VND 70,000/person/month. Meanwhile, for N4 and N6, in the Hai Lang District, it was based on the new poverty line of VND100,000/person/month. This explains a shift in poverty in 2000 compared to 1998 in the N2, N4 and N6 canals.

Table 4.11. Poverty rates of communes in the NTHIS (%).

Secondary canals	Village	1998 (hunger rate)	1998	2000
N2	Hai Phu	4.0	6.47	15.5
	Hai Thuong	2.4	9.17	11.8
	Hai Lam	9.3	16.26	16.4
N1	Trieu Thanh	2.0	11.9	7.92
	Trieu Dong	3.7	12.3	6.22
	Trieu Long	6.1	14.6	9.3
	Trieu Hoa	3.0	10.6	6.62
	Trieu Dai	7.0	16.8	7.99
	Trieu Thuan	9.0	9.9	7.87
	Trieu Do	10.8	12.3	8.99
N3	Trieu Son	6.0	15.1	6.14
	Trieu Trach	5.0	13.7	6.05
	Trieu Phuoc	10.1	15.9	11.39
N4	Hai Quy	3.1	16.16	16.3
	Hai Xuan	5.2	16.38	19.3
	Hai Vinh	8.8	22.91	18.8
	Hai Thien	9.9	18.17	14.1
	Hai Thanh	28	24.78	33.6
N6	Hai Ba	8.2	14.25	17.1
	Hai Que	9.7	16.51	20.3
	Hai Duong	6.9	24.78	33.6

Source: Consultation with Trieu Phong and Hai Lang People's Committees and benefited communes.

Direction for Economic Development

For the Quang Tri Province, the overall economic growth rate is forecast at 8–9 percent and 9–9.5 percent for the years 2005 and 2010, respectively. This corresponds to a per capita GDP increase from US$200 in year 2000 to US$15 and US$560 by year 2005 and 2010, respectively.

To realize such targets, the main orientation for socioeconomic development is to continue economic structural transformation in a direction to increase industrial, construction and service shares, as well as to decrease agricultural, forestry and fishery shares. By year 2010, the respective shares of a) industries, b) construction and services, and c) agriculture, forestry and fishery are targeted to be in the ranges of 25.0 to 26.3 percent; 43.0 to 43.6 percent, and 30.1 to 32.0 percent.

Nevertheless, this does not mean that agricultural, forestry and fishery stabilization and development will be ignored. The agricultural sector remains a key factor for ensuring food security and social stabilization. Targets for annual agricultural production growth rate are set within the range of 4.5 percent to 5.5 percent. One of the proposed measures aimed at realizing this target is to strengthen and improve existing water structures, including NTHIS, for the ultimate purpose of stabilizing and developing agriculture in key paddy areas such as the Trieu Phong and Hai Lang Districts.

Sampling Procedure in the Nam Duong System

Three stages stratified-cluster sampling procedures were used for undertaking household level surveys.

Stage 1- After Nam Duong system has been clearly characterized, based on homogenous conditions for soil, cropping patterns, and economic activities, the northern main canal was chosen for PRA and household survey. The canal was stratified into 3 strata – head, middle, and tail sections based on access to water and irrigation infrastructure. After detailed discussion with Nam Duong IDMC officers as well as with Thuan Thanh and Gia Binh enterprises staff four secondary canals were chosen, one located at the head (B3b) with best water assess, two canals located at the middle (B17a and B19) with average water access and one canal located at the tail-end (B49) with poorest water access, as representative for each canal section (figure 4.2).

Stage 2 - In Vietnamese rural areas, the commune is the smallest administrative unit. Ideally communes along secondary canals should be used as a cluster within which a village is chosen for sampling. However, all secondary canals in Nam Duong irrigation system are short, covering no more than one commune. The secondary canal B3b supplies water for Tri Qua commune, canal B17a supplies water for An Binh commune, B19 supplies water for Mao Dien commune and B49 supplies for Van Ninh commune. Moreover, village is smallest unit of rural society where access to resources (land and water) is rather homogenous. The village located along representative secondary canal is therefore used as a cluster. Depending on village land location along representative secondary canal, three or four villages, one at the head, one or two at middle and one at tail, were chosen as representative clusters.

Stage 3 - PRAs were conducted at chosen communes and villages to obtain information on land, population, education, agriculture, economic activities, income-expenditure, rich-poor perception, infrastructure, irrigation network and management.

Detailed household surveys were conducted in 13 villages: Tu The village, where Bac, Nam, Dong and Tay hamlets were used as survey clusters, in the Tri Qua commune; Giua, Thuong Vu, Yen Ngo and Cho villages in the An Binh commune; Nos. 4 through 8 villages in the Mao Dien commune; Xuan Duong, Cao Tho and Tho Ninh villages in the Van Ninh commune (table 4.12, figure 4.12).

In each village, a list of all villagers was requested from the village headman and a sample of households was selected through systematic random sampling from each selected village.

Figure 4.12 Nam Duong irrigation system command area and location of survey communes.

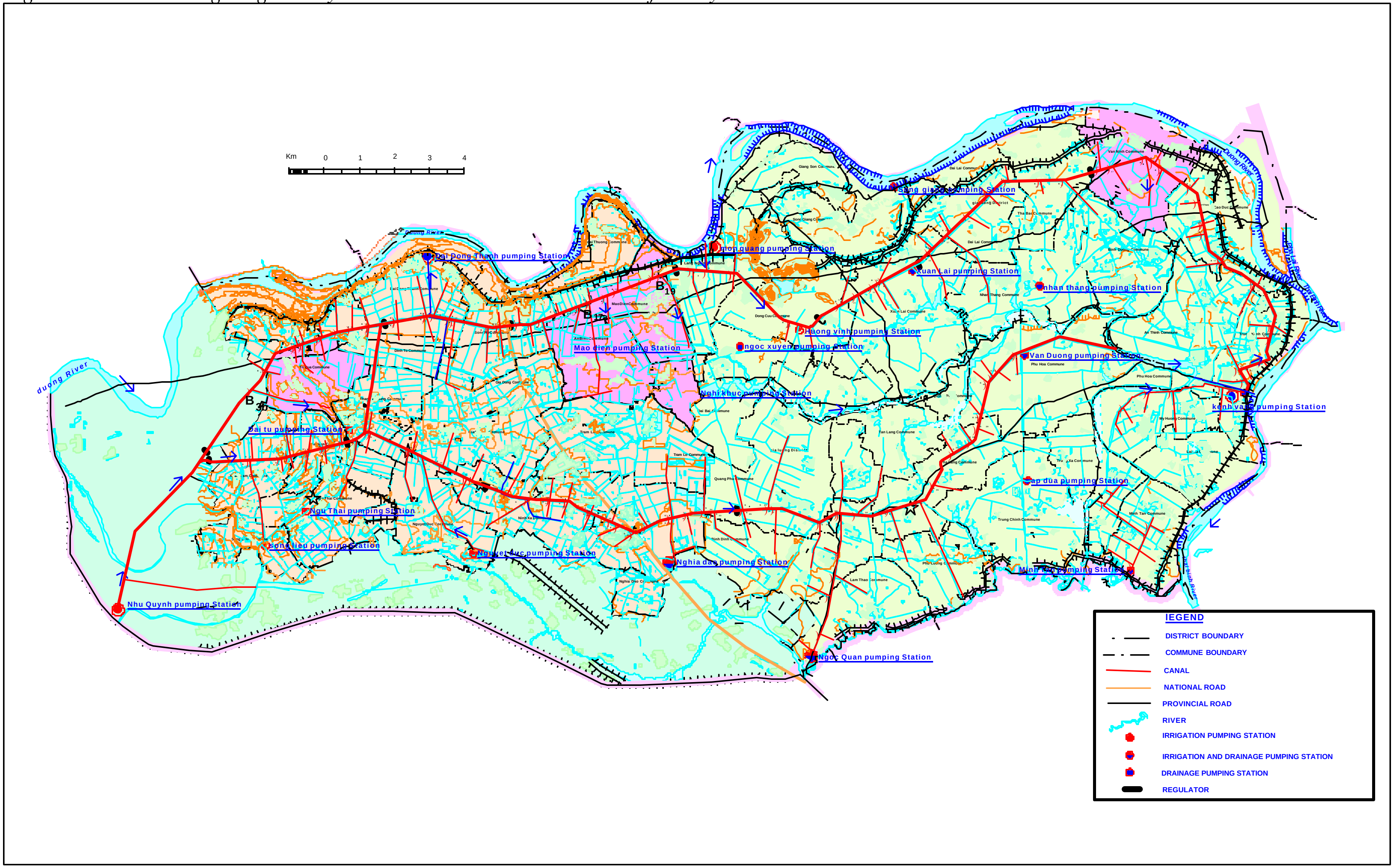


Table 4.12. Surveyed households in the Nam Duong irrigation system.

Communes/villages	Household	Location in main canal	Locations in secondary canal
Total	480		
Tri Qua commune	120	Head	
Dong village	30		Head
Nam village	30		Middle
Bac village	30		Middle
Tay village	30		Tail
An Binh commune	120	Middle	
Cho village	30		Head
Yen Ngo village	45		Middle
Giua village	15		Middle
Thuong Vu village	30		Tail
Mao Dien commune	120	Middle	
Village No. 5	30		Head
Village No. 8	30		Middle
Village No. 4	15		Middle
Village No. 6	15		Middle
Village No. 7	30		Tail
Van Ninh commune	120	Tail	
Xuan Phuong village	30		Head
Cao Tho village	62		Middle
Tho Ninh village	28		Tail

Basic Information on Survey Communes

Basic information on the communes was obtained through PRAs conducted in the survey communes to obtain comparative information on them (table 4.13).

Total land and agricultural land of Tri Qua, An Binh, Mao Dien and Van Ninh are 541, 805, 591, 765 and 396, 560, 414, 548 hectares, respectively. Land to man ratio ranges from 360 m^2/person to 650 m^2/person. Although An Binh and Mao Dien have the largest land areas, and Tri Qua and Van Ninh have the highest agricultural land per agricultural person. Mao Dien has the lowest land to man ratio, which is only half of other communes.

The total population and agricultural households are 7,541, 8,619, 12,561, 7,752 persons and 1,286, 1,780, 2,650, 1,781 households for Tri Qua, An Binh, Mao Dien and Van Ninh, respectively.

On-farm irrigation networks and patterns of land distribution of each rural community are similar. The map of the Tri Qua Commune (figure 4.13), located at the head of main canal, and Van Linh Commune (figure 4.14), located at the tail end of the main canal, are presented here to show on-farm irrigation network and land distribution patterns.

Table 4.13 Land and labor.

Indicators	Unit	Tri Qua	An Binh	Mao Dien	Van Ninh
A. Land					
1. Total land	ha	541.4	804.63	590.68	764.53
2. Agriculture land	ha	395.84	559.97	413.53	547.69
+ Planted area of paddy	ha	326.9	490.06	319.10	343.69
+ Planted area of upland crops	ha	21.8		17.10	162.49
+ Planted area of multi- year crop	ha	2.76	3.06	36.52	18.43
+ Fishery land	ha	33.91	35.13	40.50	23.46
+ Residential land	ha	-	53.70	38.20	48.27
+ Garden land	ha	10.99	31.72	35	
3. Specially used land	ha	96.83	143.98	115.98	109.82
4. Others land	ha		46.98	22.89	58.72
5. Agriculture land/agriculture person	m^2	598	586	361	650
1. Agriculture land/ agriculture householdm^2		3,078	2915	1570	3,075.2
B. Population and labor					
1. Population	Persons	7,541	8,619	12,561	7,752
2. Agriculture population	Persons	6,618	8,126	12,315	-
3. Total household	Households	1,752	1,832	2,745	2,141
4. Agriculture household	Households	1,286	1,780	2,650	1,781

Figure 4.13 Tri Qua commune, irrigation network and land distribution.

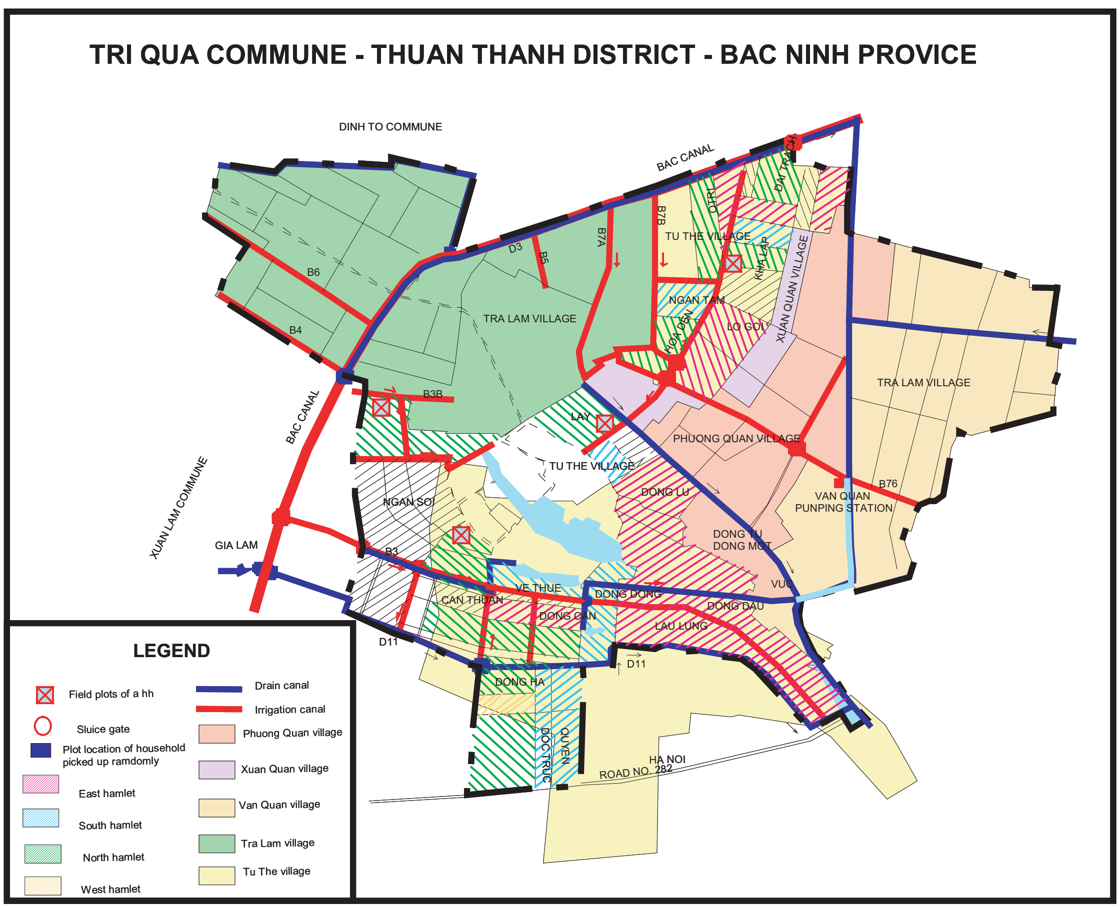
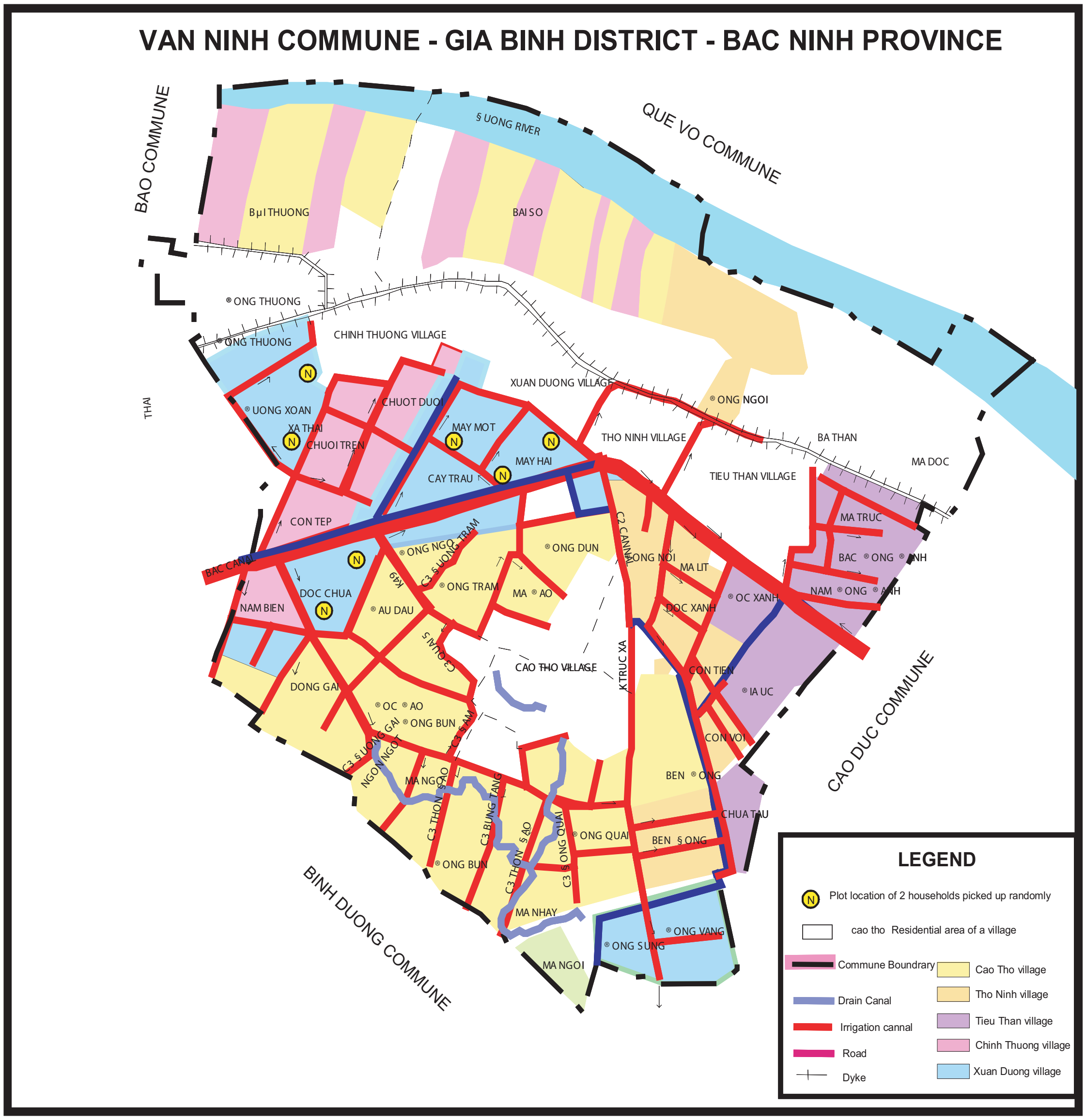


Figure 4.14. Van Linh commune, irrigation network and land distribution.



Data from the surveyed communes present a mixed picture of basic infrastructure. An Binh has the best electric conditions, with 4 electric stations, 32 km of low voltage line, while Tri Qua and Mao Dien have the best road and water supply conditions with a total road length of 21 km, 20 km and with drilled wells numbering 1,010 and 1,300 respectively. Van Ninh and An Binh have the largest number of schoolrooms.

Sampling Procedure in the Nam Thach Han System

Similar to the Nam Duong system, in Nam Thach Han three stages of stratified-cluster sampling procedures were used for undertaking household-level surveys.

Stage 1-Based on homogeneity of soil, cropping pattern, economic activities, main canal and three secondary canals were chosen for PRAs and household surveys. The canals were stratified into 3 strata: head, middle and tail sections based on access to water and irrigation infrastructure. Three secondary canals N2 located at the head, N1 located at the middle and N6 located at the tail end were chosen as strata.

Table 4.14 Infrastructure.

Indicators	Unit	Tri Qua	An Binh	Mao Dien	Van Ninh
1. Electricity					
a. Electricity station		4	4	2	2
b. Low voltage line	km	7.5	32	12	19
2. Road	km	21	16.6	22	
Inter-village	km	2.8	13.96	19.4	4
+ Pathway	km		6.6	14	4
+ Concrete way	km	18	7	5.4	
Inter- commune	km		3	2.6	
3. School					
Primary school	Room	19	20	24	25
Secondary school	Room	8	15	8	13
High school	Room	0	0	0	0
4. Health station	Unit	1	1	1	1
5. Market	Unit	1	1	1	0
6. Water supply					
Drilled well	Unit	1,209	860	1,300	96
Dug well	Unit	543	540	55	591
Others	Unit		370	1,445	1,335

Stage 2-Secondary canals in Nam Thach Han are long, covering several communes (figure 4.15). Several communes located at the head, middle and tail end of the secondary canal were chosen for the preliminary survey. These are Hai Thuong and Hai Lam along N2 (head of the main canal), Trieu Dong, Trieu Dai, Trieu Thuan, Trieu Do along N1 (middle of the main canal) and Trieu Son, Hai Ba, Hai Que along N6 (tail end of the main canal). Most Cooperatives in Nam Thach Han are at the village scale. Thus villages and Cooperatives, at the head, middle and tail of chosen secondary canals were used as clusters for sampling (figure 4.15).

Stage 3-PRAs were conducted at chosen communes and Cooperatives to obtain information on land, population, education, agriculture, economic activities, income-expenditure, rich-poor perception, infrastructure, irrigation network and management.

Four PRA tools were used: Focus Group Discussion (FGD), Mapping, Household Survey and Semi-Structured Interview. FGD was conducted in all communes with the participation of commune leaders (People's Committee Chairman and Party's Secretary) and representative of organizations (Cooperatives, Women Union, Farmer Association...) and specialized and responsible cadres (transportation-irrigation cadre, land cadre...) and village leaders. The content of discussion focused on commune's institutions and organizations, the socioeconomic situation of the commune, commune's policy, agricultural development, and irrigation and poverty issues. FGD was also conducted in villages of the target communes. The mapping method was used to define administrative boundary of villages, land-distribution pattern, location of household plots and on-farm irrigation network.

A detailed household survey was conducted in 10 villages: Dai An Khe, Thuong Xa and Mai Dan along N2, Nai Cuu, Dai Hao, Trieu Thuan and Gia Do along N1 and Dong Bao, Co Luy, Don Que along N6 canals (table 4.15, figure 4.15). In each commune, a list of all farmers was obtained and a sample of households was selected through systematic random sampling from each selected village.

Figure 4.15. Nam Thach Han command area and location of survey communes.

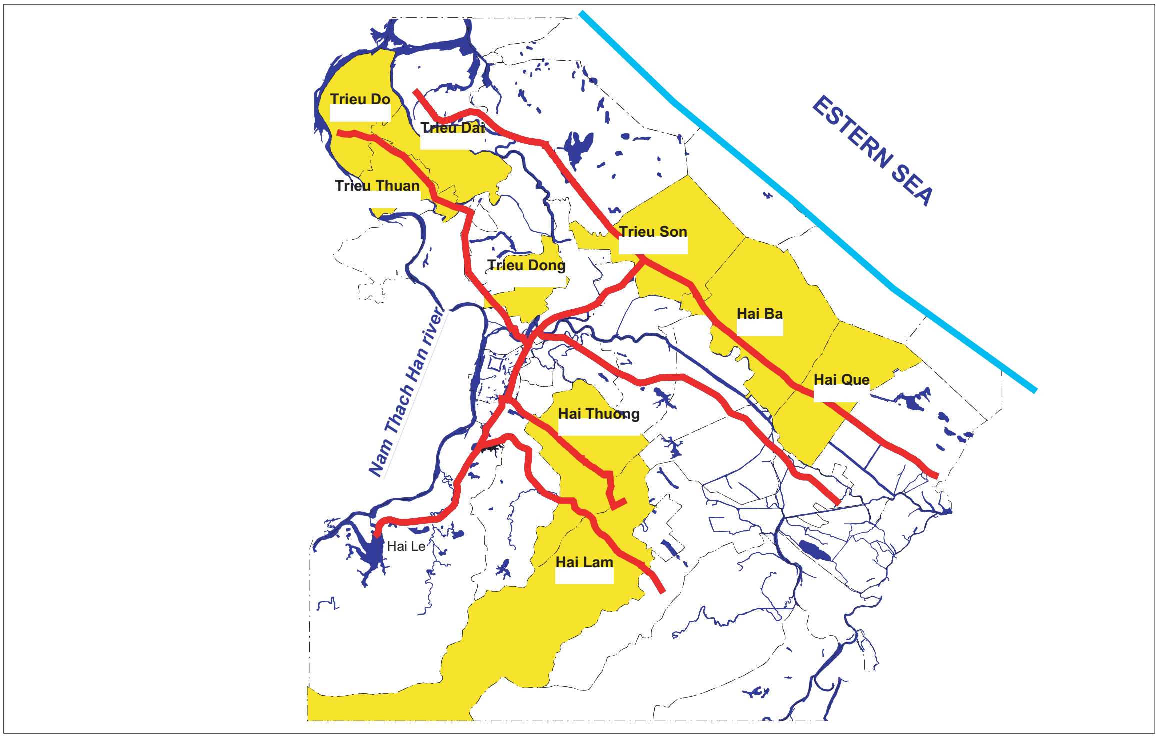


Table 4.15. Surveyed households in the Nam Thach Han system.

Canal/village	Household	Location in main canal	Location in secondary canal
Overall	480		
Canal N2	120	Head	
Dai An Khe	30		Head
Th-uong Xa	60		Middle
Mai Dan	30		End
Canal N1	240	Middle	
Nai Cuu	60		Head
Dai Hao	60		Middle
Trieu Thuan	60		Middle
Gia Do	60		End
Canal N6	120	End	
Dong Bao	30		Head
Co Luy	60		Middle
Don Que	30		End

Basic information on survey communes

A commune covers several villages, upon which a Cooperative is established. The communal population ranges from 2,500 in Trieu Dai to 6,100 in Hai Que. The land of the communes varies substantially from 200 hectares in Trieu Dai to more than 2,200 hectares in Hai Que. The land-to-man ratios vary accordingly (table 4.16).

Table 4.16. Basic information on the survey commune (land and labor).

Indicators	Unit	Trieu Dong	Trieu Thuan	Trieu Dai	Trieu Do	Hai Thuong	Hai Lam	Trieu Son	Hai Ba	Hai Que
A. Land										
1. Total land	ha	587.8	684.89	205	979.33	1,661.19	8,205.5	1,612.1	2,223.11	1,536
2. Agriculture land	ha	421.7	489.63	146	575.63	635.54	469.4	440.4	567.73	570
+ Planted area of paddy	ha	285.2	308.47	-	363.68	399.54	261.8	319.9	401.31	417
+ Planted area of upland crops	ha	27.6	122.01	-	90.36	47.91	237	55.7	77.26	110
+ Planted area of multi-year crop	ha	109	0	24	91.64	0.86	0.3	-	-	43
+ Fishery land	ha	0	2.46	2	27.93	10.56	10.8	-	50.047	0
+ Residential land	ha	133.8	85.55	40	23.67	26.19	133.6	849	22.46	17.5
+ Garden land	ha	109	66.68	-	-	0	115.3	64.8	841.557	15
3. Specially used land	ha	84.19	98.99	32	153.17	129.59	110.7	161.2	138.8	124.9
4. Others land	ha	52.33	77.39	27	226.13	25.06	-	-	1,494.12	841.1
5. Average of agriculture land/ agriculture person	m^2	-	750	-	1097	625	1,084	900	1035.17	1,300
6. Average of agriculture land/ agriculture household	m^2	-	5,250	-	5699	4,649	5,181	4,000	4746.76	6,500
B. Population and labor										
1. Population	Persons	5,980	5,935	2474	6,320	5,438	4,321	4,423	6,121	4,369
2. Agriculture population	Persons	-	5,353	2414	5,781	5,075	4,221	-	5,788	4,287
3. Total household	Persons	1,280	1,110	478	1,251	1,375	906	1031	1,227	860
4. Agriculture household	Persons	-	933	468	1,040	1,087	896	767	1,187	828

The pattern of irrigation network and land distribution is similar for each commune. Maps of Nai Cuu (figure 4.16) and Dong Bao (figure 4.17) villages are presented below to show on-farm the irrigation network and land-distribution pattern in the rural community in Nam Thach Han.

Figure 4.16. Nai Cuu Village, Trieu Dong commune irrigation network and land distribution.

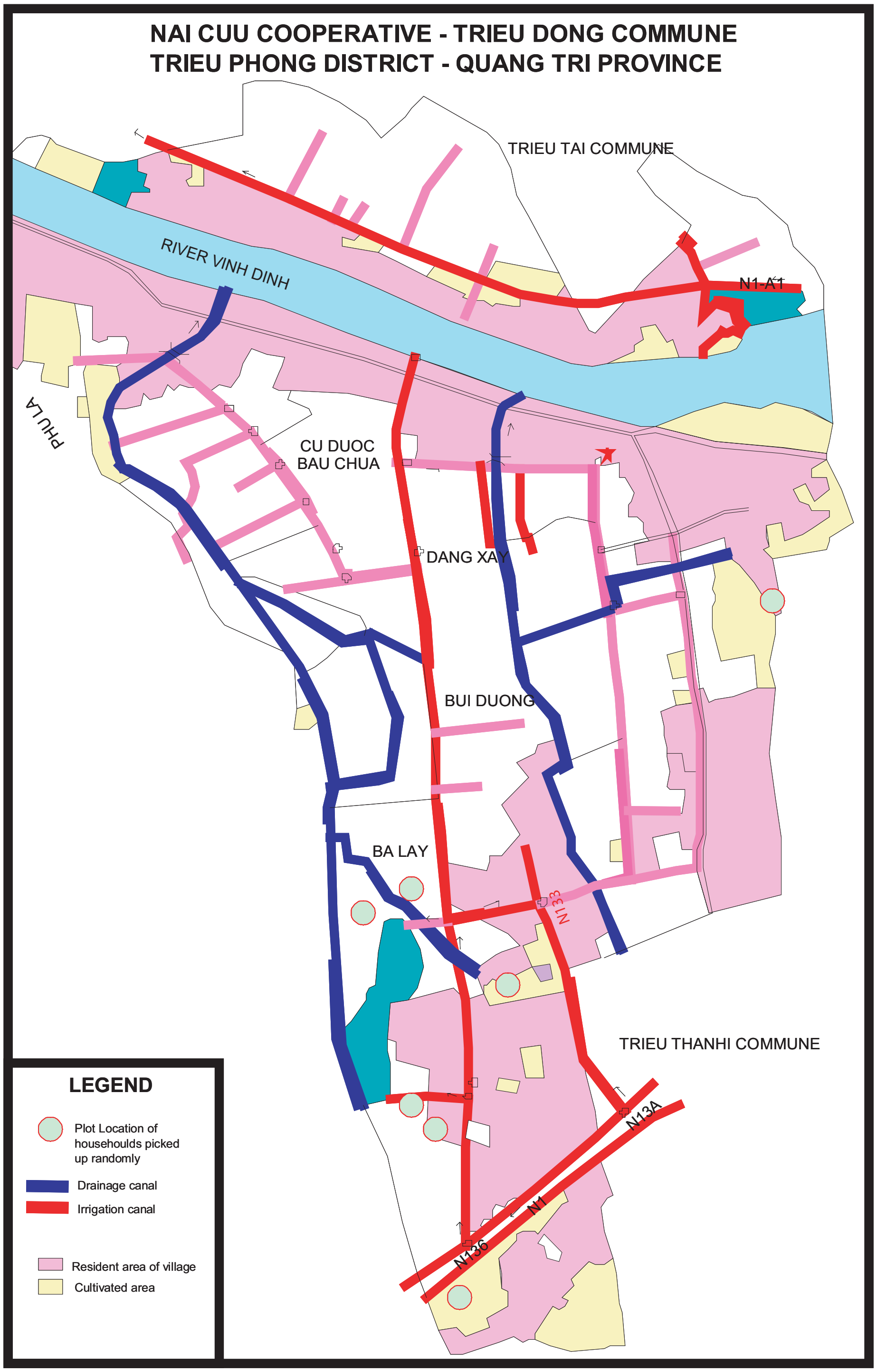
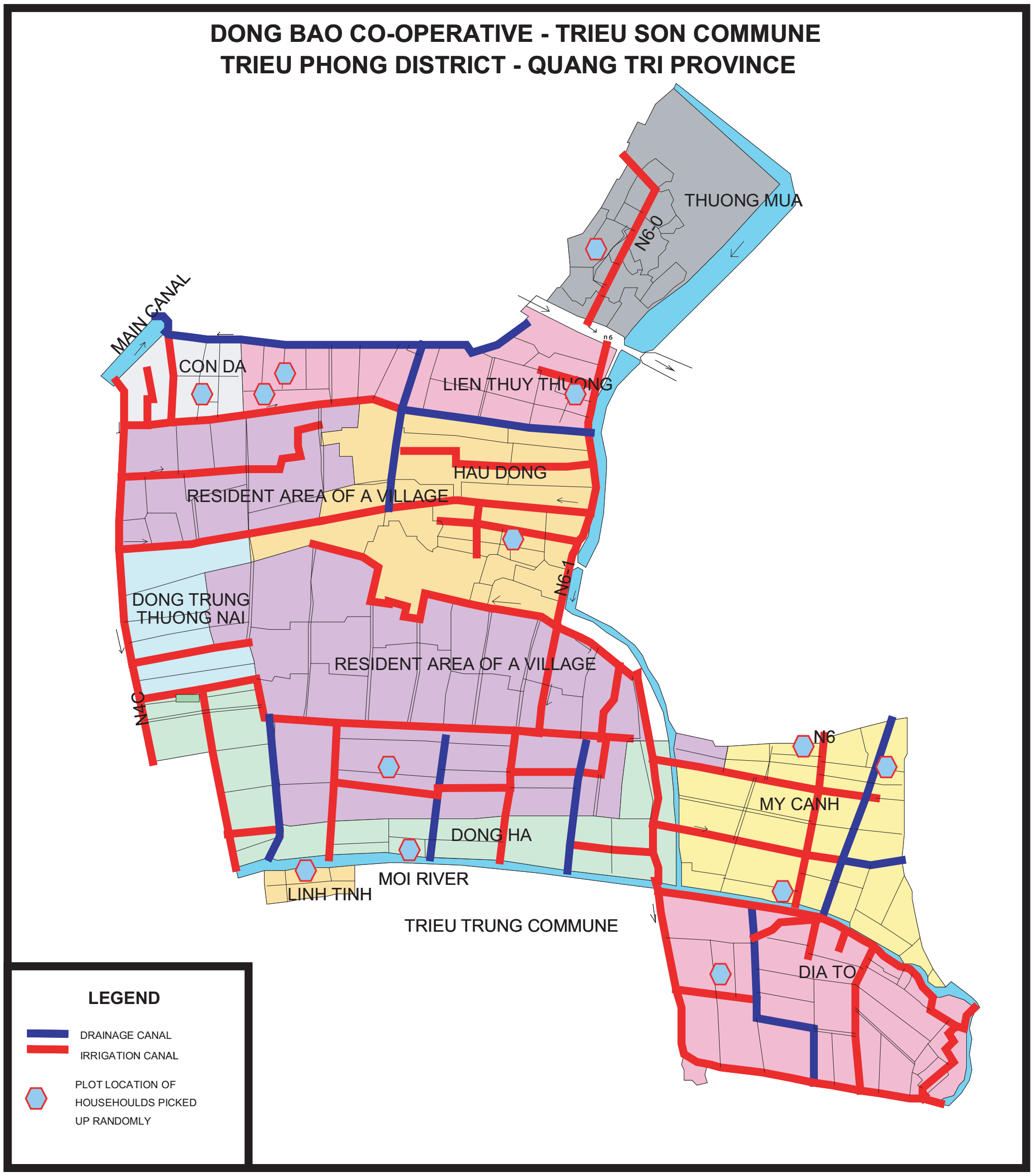


Figure 4.17. Dong Bao Village, Trieu Son Commune, irrigation network and land distribution.



Questionnaire, data entry, editing, cleaning and organization of primary data

For survey requirements, a set of parameters, specific questions, and a format for the questionnaire were determined and designed. Prior to the formal survey, a trial survey was conducted to test survey contents as well as the structure of questionnaire (see questionnaire sample in annex). The questionnaire consisted of four sections as described below.

In general, there were three basic groups of data. The first group described the basic household characteristics such as age, education, family size, etc. A second group of data contained information on agricultural practices. The third group contained information on the irrigation indicators. The descriptive statistics for the farm-level and plot-level data are included in the annex.

Household characteristics included the number of years that the household head had been engaged in agricultural practices. Household data also included whether the head of the household was male or female. A dependency ratio was calculated for each house, which was defined as the number of agricultural laborers per household member. Information was obtained on household assets. This variable was simplified to only include the following assets: house, wardrobe, tables, chairs, and motorbike. Finally, information was obtained on non-farm employment activities. To compensate for the fact that actual income generated from these activities is often underreported, a variable was created to account for the number of non-farm income sources rather than stated income.

Information on agricultural practices included household cultivated land area per laborer, the number of plots, and the total cultivated land area. Other information gathered included the total value of a household's agricultural production tools. Information on livestock and poultry production was obtained from the surveys and the weight of production was included for the sale of piggy, porker and poultry. Finally, the gross value product per hectare was calculated for each household, based on crop production.

The survey contained several questions to elicit indicators of irrigation-management performance from farm households. The first question asked the farmer his perception on whether irrigation water quantity was considered sufficient for the spring crop and the summer crop. Responses were combined to create a variable capturing perception of water sufficiency. A second question was asked concerning the farmer's perception of whether irrigation deliveries were timely. Finally, two questions were asked to record the number of times each plot suffered from either inundation or a lack of water over the last 5 years. These four variables were considered to best capture irrigation performance in the two systems at the farm level.

In Vietnam, farm households typically have a large number of plots spread across a wide area. This makes it difficult to pinpoint whether a farm is located at the head, middle, or tail of an irrigation system, especially at the secondary and tertiary levels. Data were gathered on each plot including area, crop, yield, plot location along a canal, land quality and cropping intensity. In relation to irrigation, data were gathered for each plot on whether it was fed by gravity, semi-gravity or pump irrigation. Information was also obtained on the depth, duration and number of days for each irrigation turn. A proxy for irrigation service was gathered pertaining to the number of times over the last 5 years that each plot had suffered from inundation or lack of water. Average rates of application for different inputs were assigned to each plot based on farm ownership.

Section 1. Basic information and general production results of households. Basic information of households.

Table 1. Population and labor of households. This table contains information about the householder, her/his relatives, population, agricultural and nonagricultural labor and income per person in the household, etc.

Table 2. Land and current situation of irrigation and drainage. This table illustrates land size, land types and location of plots along tertiary canal, current irrigation and drainage at these plots. For research requirements on irrigation and drainage, data should be collected by each plot. Following this table, many parameters or indicators such as cultivated land, planted area, plots of household, land classification by soil types (including 7 types from 1-7), or by production crops (1-3 crops), plots of household along the tertiary canal, gravity and nongravity irrigation and drainage, etc. Also, table 2 together with table 1 is used to calculate parameters such as land per person, cultivated land per person, cropping intensity, percentage of gravity irrigation and drainage, etc.

Table 3. Production results of cultivation in 2001. Parameters in this table are calculated by each plot mentioned in table 2. This table consists of 2 contents. The first comprises seasonal area cultivation and crop output. The second presents the current irrigation and drainage situation for each plot, such as drought and inundation frequencies, irrigation costs, etc.

Table 4. Production results of cultivation in 2001. This table is to summarize production results in table 3 and to estimate them in cash. Therefore, this concludes consumption, sale and price indicators. According to this table, we can estimate the total value of household production output, structural income of various crops and product prices.

Section II. Result of household's production. This section is to calculate household income

Table 5. Average production cost per hectare of different crops in 2001. (following crops in table 3). Production cost for each crop includes both material input and labor (quantity and price). By this table, it is possible to calculate inputs (materials and labors) for each crop, and together with table 4 the income of each crop can be estimated.

Table 6. Livestock value in 2001. This table presents the calculation of livestock income and cost. By this table, household's livestock capacity can be seen and it is possible to estimate output value and livestock income of household.

Table 7. Household incomes from other nonagricultural activities. This table calculates other incomes outside cultivation and livestock. Thereby, we can find out nonagricultural activities carried out by households. Based on tables 5, 6 and 7 the total household income can be estimated (household income = cultivation income + livestock income + nonagricultural incomes). A person's income can be estimated by household income together with table 1. Using this income to compare with criteria on poor households regulated by MOLISA, the poor and nonpoor households in the study areas are classified.

Section III. Living expenditures and gender issues

Table 8. Purchase and expenditures of household. This table includes 2 parts. Part 1 is for statistics of household's annual expenditures. Part 2 presents the current status of household's living standard. This table shows essential requirements of different households. Together with table 5, it reveals the household economic capacity.

Table 9. Gender issues in production. The requirement of this table is statistics of work done by men or women in order to clarify gender roles in production. By combining this table and household classification in table 4, it is possible to point out who carries out and holds decisive roles in production in different households (this issue is not mentioned in the report).

Table 10. **Assets and main equipment of households.** This table shows the statistic of household assets and cash at the time of survey. By this table, household production capacity can be assessed.

Section IV. Questions on irrigation and drainage issues and household participation.

Collect qualitative information about irrigation and drainage issues in the locality by interviewing. By doing so, we can assess strengths and weaknesses of irrigation aspects as well as current policies in the local area. However, this information should be considered as reference sources for the project repot because it is a subjective viewpoint of households. The questionnaire is used to collect primary information and data. These are raw data. There is no requirement for calculation in the questionnaire that aims to reduce the survey quantity and ensure objectiveness of the survey. The tables in the questionnaire are related. According to the data survey, it is possible to calculate various parameters or indicators as required by the research.

Organization of field survey

Researchers working in the Center for Irrigation and Water Supply Research and staffs in Hanoi Agricultural University and Vietnam Agricultural Scientific Institute were designated as survey enumerators. They worked together with staff from irrigation companies and district agricultural divisions. Additionally, local staff with expertise in the actual situation of irrigation, agricultural production and households in local areas assisted survey staff during the survey. Prior to the survey, a training course was conducted on the content and method of the survey.

The project selected two study areas. One is Nam Duong Irrigation System including Thuan Thanh, Luong Tai and Gia Binh Districts, Bac Ninh Province and the other study area is Nam Thach Han irrigation consisting of Hai Lang and Trieu Son Districts, Quang Tri Province.

Surveyed households were selected as follows: 25 percent at the head of main canal, 50 percent in the middle and 25 percent at tail end. Along the secondary canal, in the selection of surveyed households this rule was followed.

Surveyed households were selected randomly; however, along the tertiary canals, households did not follow the distribution rule mentioned above. That is because farmer's plots are scattered under the principle of "with good and bad, with near and far." Thus, their plot's location along tertiary canals was determined by themselves. Before analysis, the collected data were verified and cleaned to ensure reliability of the data.

Data input

After designing tables in worksheets, it is necessary to input data into worksheets under the principle *"as correct and sufficient as in questionnaire."* During this process, if mistakes and illogical data occur, the person responsible for this work should take note and inform the checking group of this for processing. The computer file which contains the input data is considered an original file (table 4.17) and no calculations are allowed in this file. In original files, worksheet name is the same as the name of tables in the questionnaire.

Data Processing

Surveyed data can be considered as input data while calculated indicators and report preparation are output of data processing. From the original worksheet, many parameters can be calculated as required by the project. To carry out this work, it is necessary to create a number of calculated files and worksheets in these files.

Table 4.17. Worksheets in original file of 2 systems.

Nam Duong	Nam Thach Han	Name of table
B1	B1	Basic information of household
B2.dat dai	B2.dd (1–9)	Soil type and irrigation situation of plot 1 to plot 9
	B2.dd (10–18)	Soil type and irrigation situation of plot 10 to plot 18
B3.Kqlua	B3.1.KQlua (1–9)	Paddy production results from plot 1 to plot 9
	B3.1.KQlua(10–18)	Paddy production results from plot 10 to plot 18
B3.Kqvu3	B3.2.KQ rau	Upland crop production
B4.ThuTT	B4.ThuTT	Cultivation results
B5.ChiTT	B5.ChiTT	Average production cost
B6.CN	B6.CN	Livestock production results
B7	B7	Other incomes
B8	B8	Purchase and expenditures by household
B9	B9	Gender issues
B10	B10	Assets and equipment
Section 4	Section 4	Other questions for interviewing

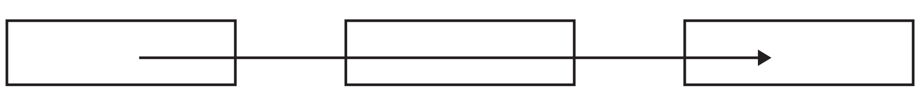
Table 4.18. File name in Excel worksheet.

Nam Duong		Nam Thach Han	
Name	Data sources	Name	Data sources
Goc.XLS		B goc.XLS	
B1,2D.XLS	Goc.XLS/B2dd	B1. ho Th.XLS	B goc.XLS
B2VTTL.XLS	Goc.XLS/B2dd	B2. dat th.XLS	
B3D.XLS	Goc.XLS/B3.KQlua	B3. DT luaTh.XLS	
B4D.XLS		B4. Thu TT. XLS	
B5D.XLS	….	B5. CF lua…XLS	
B8D.XLS		B6. CN Th. XLS	
Cay mau.XLS		Co cau DTGT. XLS	
Gia thoc.XLS		Han ung.XLS	
		Mau Than.XLS	

In the calculation file, worksheets are created to calculate other parameters. The calculation file B1,2D.XLS creates some worksheets such as B1.1XLS co ban, B2.2.2 hang dat, B2.2 vu sx, B2.3 Chan dat and B2.4 tuoi tieu, to calculate the required parameters. Thus, calculation tables are organized as shown in figure 4.17.

After parameters are calculated, required results for the project report are combined in “File Bao cao chung.”

In “File Bao cao chung” we can find sources of data by the tool bar. Data in any cell in the worksheets have their source address. By the toolbar, we can find the source address for any data cell. For data in a worksheet we can use toolbar auditing to find its source; arrows of this toolbar show its sources.

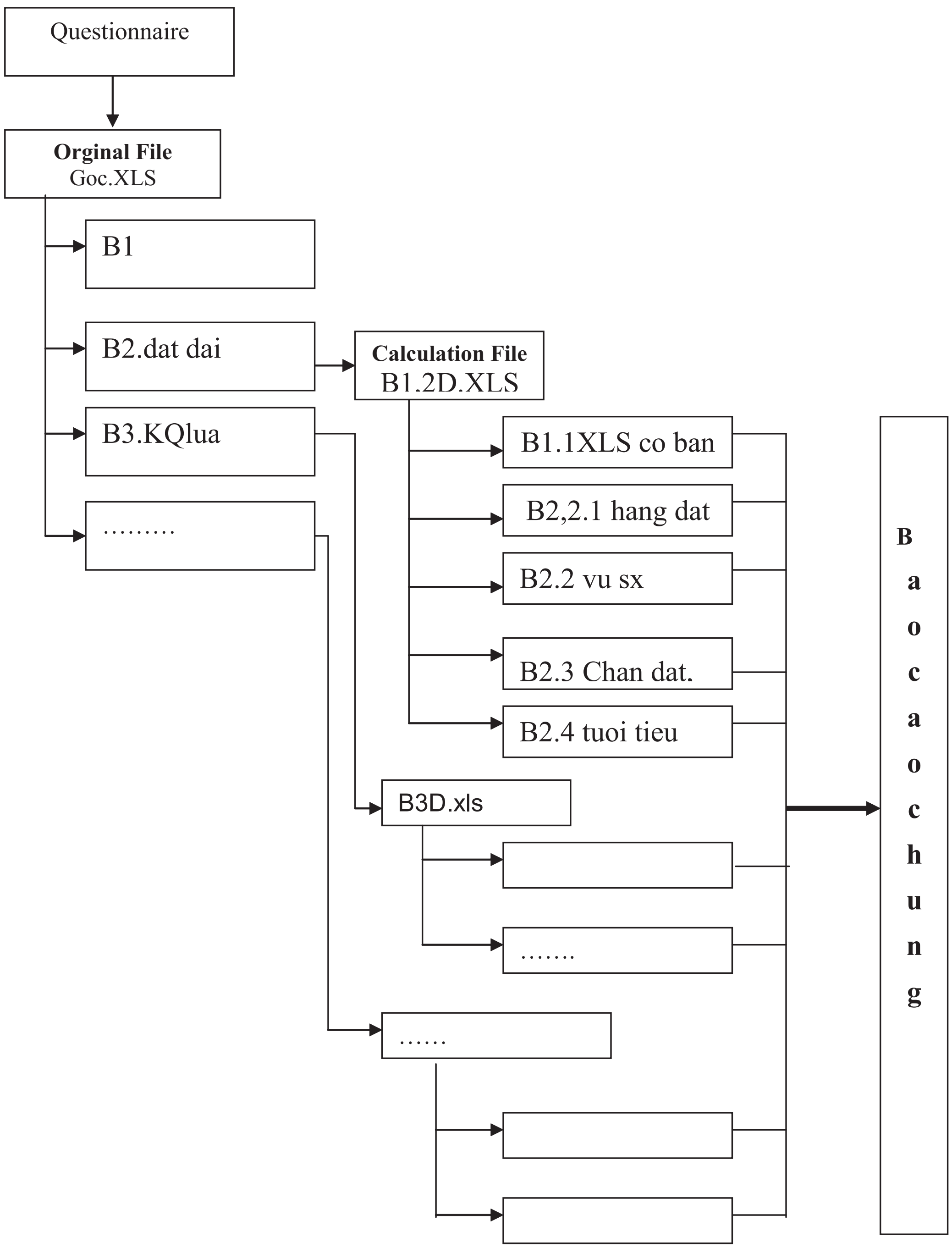


When a new worksheet is created, we must take data to this worksheet from an original file or from previously related files by copying formula other than copying value. This method is applied consistently from the beginning to the end of data processing. Thus, when data in the original file change, then data in related worksheets also change.

Worksheet consists of 2 major parts:

1. Surveyed data or calculated data, often from row 1 to row 486
2. Checked and result part is from row 487

Figure 4.18 Diagram of data organization of the project in Excel.



Definitions of Poverty

There are three definitions of poverty that could be used for the quantitative analysis of this study. The first definition of poverty is based on a household's self-perception. The data for this classification were obtained during the surveys undertaken for the study. The second definition of poverty is based on per capita monthly income levels as defined by the Government of Vietnam. The monthly income poverty level for rural areas has been set at VND 100,000 per person. The final definition of poverty is based on annual per capita expenditure levels. The poverty level is based on an annual per capita expenditure level of VND 1,790,00 (US$128) in 1998, which is a level of expenditures necessary to purchase a nutritionally adequate diet of 2,100 calories as well as some essential basic living items (World Bank 1999). The three definitions are included in the dataset as a binary variable equal to 1 if the household is classified as in poverty and 0 if it is not. Calculated poverty rates for the three definitions are 9 percent for household self-perception, 23 percent for income poverty, and 31 percent for expenditure poverty.

This study utilizes the income poverty line for the quantitative analysis. This is used for two main reasons. First, a major goal of this project is to increase rural farm incomes through better irrigation management, especially in terms of values of crop production, which are relatively easy to calculate. Second, the emphasis is on low incomes, which can be fairly accurately assessed from crop production figures. While actual expenditures better reflect a household's welfare status, it is the income level that dictates the potential to reach the desired expenditure level.

Chapter 5

Poverty in Irrigated Agriculture: Spatial Dimensions

This chapter examines the spatial dimensions of poverty in the studied irrigation systems. Data from the surveys are presented that detail the differences between the non-poor and poor within the two systems. Emphasized here are the differences as they occur across the different sections of the irrigations system's main canal: head, middle and tail.

Spatial Dimensions of Poverty: Nam Duong Irrigation System

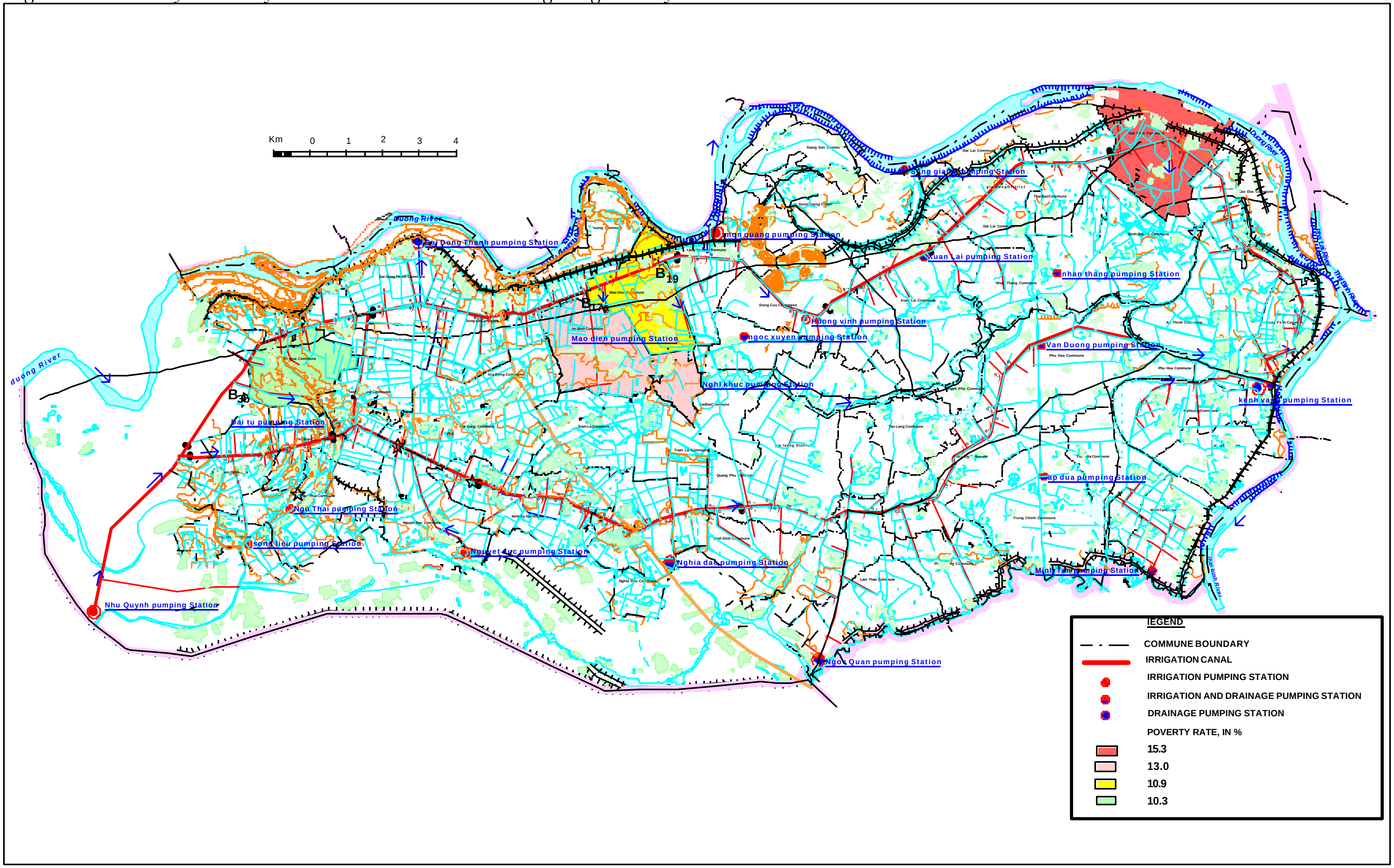
In the Nam Duong irrigation system, out of 480 households surveyed, there are 49 poor households. There are 284 poor persons occupying 12.4 percent of the total sample population. The poverty rates in Tri Qua, An Binh, Mao Dien and Van Ninh are 10.3, 12.98, 10.93 and 15.29 percent, respectively (table 5.1).

Table 5.1. Poverty and location of the poor along the Nam Duong irrigation system.

	Number of persons			Share (%)		
Communes/villages	Poor	Non-poor	Total	Poor	Non-poor	Total
Overall	284	2008	2292	12.4	87.6	100
Tri Qua commune	58	505	563	10.3	89.7	100
Dong Village	-	145	145	-	100	100
2 Middle villages	57	237	294	19.4	80.6	100
Tay village	1	123	124	0.8	99.2	100
An Binh commune	81	543	624	13.0	87.0	100
Cho village	26	121	147	17.7	82.3	100
2 Middle villages	41	273	314	13.1	86.9	100
Thuong vu village	14	149	163	8.6	91.4	100
Mao Dien commune	60	489	549	10.9	89.1	100
Village 5	34	126	160	21.3	78.8	100
3 Middle villages	11	259	270	4.1	95.9	100
Village7	15	104	119	12.6	87.4	100
Van Ninh commune	85	471	556	15.3	84.7	100
Xuan Phung village	18	129	147	12.2	87.8	100
Cao Tho village	47	240	287	16.4	83.6	100
Tho Ninh village	20	102	122	16.4	83.6	100

The poverty rate along the main canal of the Nam Duong irrigation system shows no definite increasing trend from head to tail, although the poverty rate at the tail end is higher than at the head. The two middle communes present a different picture, which is examined at the end of this chapter. The trend of poverty is especially confusing when examined at the village level. Therefore, it is not possible to conclude from the data that the poor are concentrated at the tail ends (figure 5.1).

Figure 5.1. Poverty in survey communes in the Nam Duong irrigation system.



Land Productivity across the irrigation system and in the rain-fed area

Land productivity across the Nam Duong irrigation system and the associated rain-fed areas are presented in table 5.2. In the Nam Duong irrigation system, land productivity in the rain-fed area is about half that in the irrigated areas. Across the irrigation command area, the land productivity in both study areas does not change as hypothesized (similar to the poverty rate). In Nam Duong, land productivity at the head is highest followed by the tail end. This may indicate that farmers are somewhat successful in adapting to their conditions.

Table 5.2. Land productivity in irrigation system and rain-fed area (MVND/ha).

Main canal sections	Nam Duong	
	Secondary canal	Land productivity
Head	B3b	21.2
Middle	B17a	18.4
	B19	19.5
Tail end	B49	20.9
Rain-fed	Rain-fed	11.2

Irrigation, Drainage, Paddy Yield and Poverty along the Irrigation Canal

Gravity irrigation can be considered an indicator of irrigation quality. The main benefits for gravity irrigation are reduced cost due to the absence of a need to use a pump and reduced need to use own labor if manual transport is necessary. In Nam Duong, gravity irrigation coverage is given as follows: in Tri Qua it is 77 percent, in An Binh 58 percent, in Mao Dien 62 percent, and in Van Ninh only 3 percent. In the Red river delta, drainage services are as important, if not more important, than irrigation. Looking at the drainage service, the same tendency is found for gravity drainage, which is 89 percent, 86 percent, 82 percent and 51 percent, respectively, for Tri qua, An Binh, Mao Ddien and Van Ninh (see table 5.3).

Table 5.3. Irrigation, drainage, paddy yield and poverty in Nam Duong.

Communes	Poverty (%)	Spring				Summer			
		Inn. (%)	Dro (%)	Gi (%)	Yield (kg/500 m^2)	Inn. (%)	Dro. (%)	Gd (%)	Yield (kg/500 m^2)
Tri Qua	10.3	1.9	5.8	78.7	242	4.1	3.1	88.8	225
An Binh	12.98	3.6	14.6	57.9	230	2.9	9.2	85.7	214
Mao Dien	10.93	1.2	6.9	61.7	232	5.4	6.6	81.9	215
Van Ninh	15.3	0.7	18.2	2.9	201	9.9	7.2	51.2	200
Poor		1.61	14.6	44.5	215	6.58	8.3	80.5	200
Non-poor		1.89	10.97	50.9	227	5.46	6.32	76.5	215

Note: Inn: inundation frequency (%); Dro: Drought frequency (%); Gi: Gravity irrigation (%); Gd: Gravity drainage (%).

The frequency of drought is also considered an indicator of irrigation quality. Here, the analysis considers the reported 5-year drought frequencies. As drought and inundation are strongly influenced by seasonal changes, these are examined seasonally. The trend in drought frequency for the spring season is similar to that in gravity irrigation. Tri Qua suffers 6 percent, An Binh 15 percent, Mao Dien 62 percent, and Van Ninh 18 percent. Inundation frequency for summer is 4 percent, 3 percent, 5 percent and 10 percent for Tri Qua, An Binh, Mao Dien and Van Ninh, respectively.

For both spring and summer, paddy yield decreases from head to tail end. Tri Qua has the highest yield: 242 kg/500 m^2 for spring and 225 kg/500 m^2 for summer, followed by Mao Dien, 232 kg/500 m^2 and 215 kg/500 m^2 and An Binh, 230 kg/500 m^2 and 214 kg/500m^2. Van Ninh has the lowest yields, 215 kg/500 m^2 and 200 kg/500 m^2 (table 5.3).

Both irrigation and drainage quality, in terms of inundation frequency, drought frequency, gravity irrigation coverage, and gravity drainage coverage, have a decreasing tendency from the head to the tail end of the main canal. There is also a correlation between irrigation and drainage quality and crop yield as well as poverty rates. The better the irrigation and drainage quality the higher the crop yields and the lower the poverty rate.

Comparisons of irrigation and drainage qualities and crop yields among poor and non-poor also confirm the conclusion that the better the irrigation and drainage quality the higher the crop yields and the lower the poverty rates.

Nam Thach Han Irrigation System

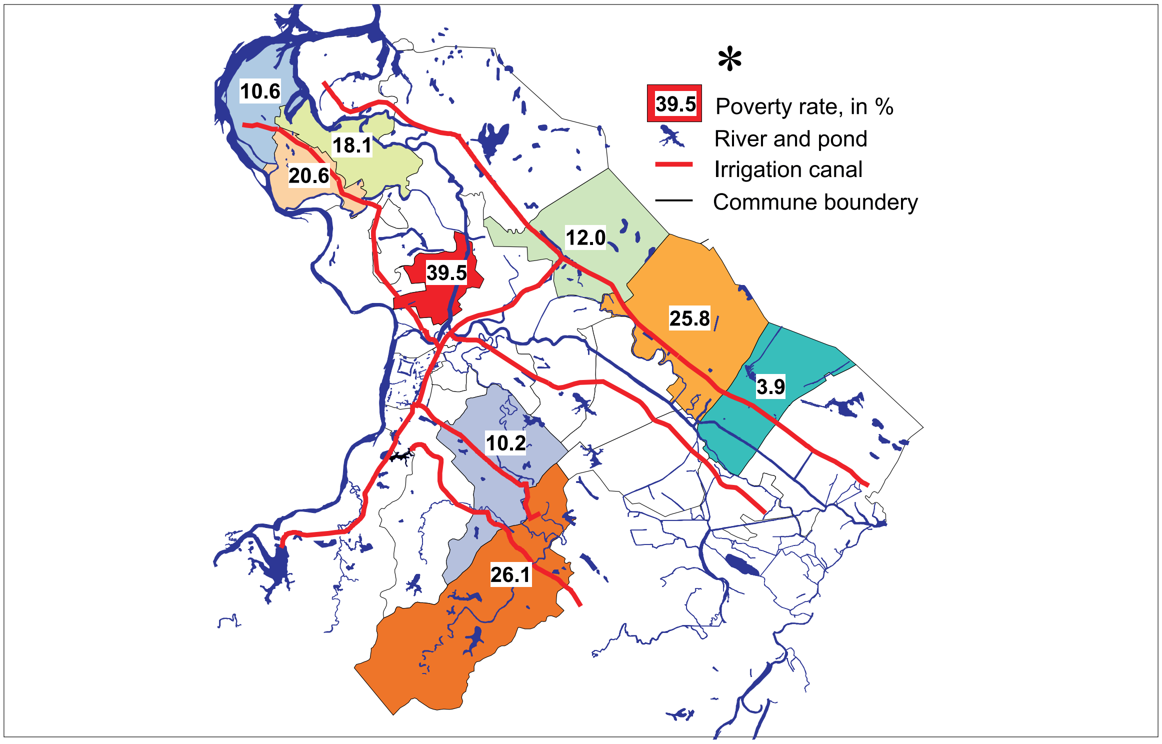
In the Nam Thach Han irrigation system, out of 480 households surveyed, there are 88 poor households. There are 511 poor persons, which account for 19.16 percent of the population. The poverty rates in N2, N1 and N6 are 15.19 percent, 21.92 percent and 16.93 percent, respectively (table 5.4).

Table 5.4. Poverty and location of the poor along the Nam Thach Han irrigation system.

Communes/villages	Number of persons			Share (%)		
	Poor	Non-poor	Total	Poor	Non-poor	Total
Overall	88	392	480	18	82	100
N2	18	102	120	15	85	100
Dai An Khe	2	28	30	7	93	100
Thuong xa	9	51	60	15	85	100
Mai Da	7	23	30	23	77	100
N1	52	188	240	22	78	100
Nai Cuu	23	37	60	38	62	100
Dai Hao	12	48	60	20	80	100
Trieu Thuan	11	49	60	18	82	100
Gia Do	6	54	60	10	90	100
N6	18	102	120	15	85	100
Dong Bao	3	27	30	10	90	100
Co Luy	14	46	60	23	77	100
Don Que	1	29	30	3	97	100

Canal N1 has the highest poverty rate at 22 percent, canal N2 the lowest poverty rate at 15.19 percent and canal N6 a rate of 16.93 percent. Among Cooperatives, Nai Cuu at the head of N1 has the highest poverty rate at 39.46 percent and Don Que Cooperative at the tail of N6 has the lowest rate at 3.87 percent. The poverty rate increases from head to tail in N2, but decreases from head to tail in N1 and N6 (figure 5.2).

Figure 5.2. Poverty in survey communes in the Nam Thach Han irrigation system.



At the head of the system, canal N2, the poor account for 15.19 percent. For this secondary canal, Dai An Khe Cooperative has the lowest poverty rate at 5 percent, whereas the Mai Dan Cooperative has the highest rate of the poor at 26.06 percent. In the middle of the system, canal N1, the rate of poverty reduces from the head to the tail end. At the tail end of the system, canal N6, poor households are mainly concentrated in the middle reach, which is Co Luy, accounting for 25.78 percent.

Land Productivity across the Irrigation System and in the Rain-Fed Area

Land productivity across the Nam Thach Han irrigation system and its rain-fed area is presented in table 5.5. Land productivity in the rain-fed area is half that in the irrigated areas. In Nam Thach Han the productivity is highest at the tail end followed by middle and head sections.

In the Nam Thach Han irrigation system, irrigation and drainage quality at the head and middle of the main canal are better than at the tail end (table 5.6). Along secondary canals, irrigation and

Table 5.5. Land productivity across the irrigation system and in the rain-fed area (MVND/ha).

Main canal sections	Nam Thach Han	
	Secondary canal	Land Productivity
Head	N2	14.6
Middle	N1	15.9
Tail end	N6	17.6
Rain-fed	Rain-fed	7.6

drainage quality vary among secondary canals. Along N2 and N6, irrigation and drainage quality at the tail and middle is better than at the head. Along N1, irrigation and drainage at the middle is better than at the head and tail ends. The yield along the main canal is not significantly different in the head, middle and tail sections. Yields at the tail along N2 and N6 secondary canals are higher than in the head and middle sections. Along N1, the yield at the middle and tail end is higher than at the head.

Table 5.6 Irrigation, drainage, paddy yield and poverty along canals in Nam Thach Han.

Canals	village		Spring				Summer			
		poverty (%)	Inn (%)	Dro (%)	Gd (%)	Yield (kg/500m2)	Inn (%)	Dro (%)	Gi (%)	Yield (kg/ 500m2)
N2	Daiankhe	5,10	2.5	2.8	83.3	232	1.6	23.8	70.3	227
	Thuongxa	15,33	3.2	0.8	88.2	222	0.1	32.5	84.7	216
	Maidan	26,06	1.1	-	91.9	251	-	38	71.8	240
	poor	15,19	-	1.44	91.4	222	-	31.5	82.2	216
	Non-poor	-	2.9	1.81	86.7	233	0.5	31.7	76.5	225
N1	Naicuu	39,46	1.0	4.3	89.7	226	0.2	21.1	82.8	219
	Daihao	18,13	1.4	0.2	91.4	240	0.4	18.6	86.0	235
	Tthuan	20,64	1.2	0.7	95.9	240	1.0	22.9	91.2	227
	Giado	10,56	3.1	0.1	88.3	247	0.3	19.4	82.4	233
	poor	21,92	1.2	1.3	87.5	226	0.2	20.3	82.6	217
	Non-poor	-	1.8	2.0	86.1	242	0.5	20.5	78.8	232
N6	Dongbao	11,92	10.4	1.8	56.9	234	8.8	16.2	67.3	222
	Coluy	25,78	9.4	4.0	72.7	224	7.6	20.6	99.4	212
	Donque	3,87	22.1	3.1	61.8	252	13.1	18.1	70.8	237
	poor	16.93	11.5	0.7	67.0	213	8.8	15.9	78.6	197
	Nonpoor	-	13.1	3.65	55.5	239	9.4	19.4	65.7	226
System	N2									
Overall		15.19	2.5	1.1	77.2	231	0.5	31.7	87.2	224
	N1	21.92	1.7	1.3	79.5	239	0.5	20.5	86.4	229
	N6	16.93	12.8	3.2	66.8	235	9.3	19	76	223
	poor	19.16	3.05	1.4	81.5	222	1.9	21.7	82.7	211
	Non-poor	-	5.03	1.8	73.7	239	2.9	23.2	75.4	228

The data on irrigation and drainage quality and yield do not show any specific spatial pattern in Nam Thach Han. A comparison of paddy yields and irrigation and drainage quality of poor households to non-poor households shows that the poor have lower yields, but better irrigation and drainage quality. The smaller land area may be a reason leading to better irrigation quality of the poor, while other factors that the non-poor have (e.g., skill, capital) are factors for the higher yields in the non-poor households.

An Aggregate Approach to the Analysis of the Spatial Dimensions of Poverty

This section documents the analysis of the irrigation water and poverty linkage as based on the aggregated data set for both the Nam Duong and Nam Thach Han irrigation systems. Some basic descriptors are given in table 5.7 below concerning the overall irrigation situation. It can be seen that irrigation infrastructure coverage tends to drop off at the tail ends of the irrigation systems. This pattern is much more pronounced in the Nam Duong irrigation system. However, it does not follow from these average statistics that GVP/ha follows the same trend. This tends to indicate that it is the performance of the irrigation systems rather than the existence of infrastructure that is most influential on yields, and thus on poverty.

Table 5.7. Some basic characteristics of the two irrigation systems in Vietnam.

	GVP/ha (VND 1,000)	Percent gravity	Percent Irrigated irrigation	Percent Gravity Drainage
Head	11,395	79%	93%	88%
Middle	10,542	70%	93%	85%
Tail	11,873	33%	72%	47%

Both irrigation systems were divided into head, middle and tail sections. The average values were calculated for three different irrigation performance variables including dry-season water sufficiency, wet-season water sufficiency, and timeliness of irrigation as perceived by a household. A household would either answer “yes (=1)” if the service was satisfactory or “no (=0)” if the service was unsatisfactory. The average of all three of these measures was calculated to estimate a “water satisfaction index.” The results are shown below in figure 5.3.

The figure shows that timeliness of irrigation tends to fail more toward the end of the irrigation systems. However, dry-season water sufficiency tends to rise moving from head to tail. The rainy season sufficiency is rather consistent throughout. The calculated irrigation satisfaction index is essentially equal for the three sections. Given the wide variety of local conditions between and within irrigation systems, this result is not unexpected.

Table 5.8 lists both irrigation satisfaction and dry-season water sufficiency along with 5-year occurrences of drought and inundation. The figure indicates that tail ends tend to suffer more from drought per land area. The increased occurrence of drought per irrigated area in the tail end indicates that drought incidence is more likely a case of lack of infrastructure rather than a case of poor performance. That is, there is greater dissatisfaction with dry-season water sufficiency at the head section than at the tail end, even though there is a greater incidence of drought at the tail end. These data are presented graphically in figure 5.4.

Figure 5.3. Average values of irrigation performance indicators for head, middle, and tail sections of both irrigation systems.

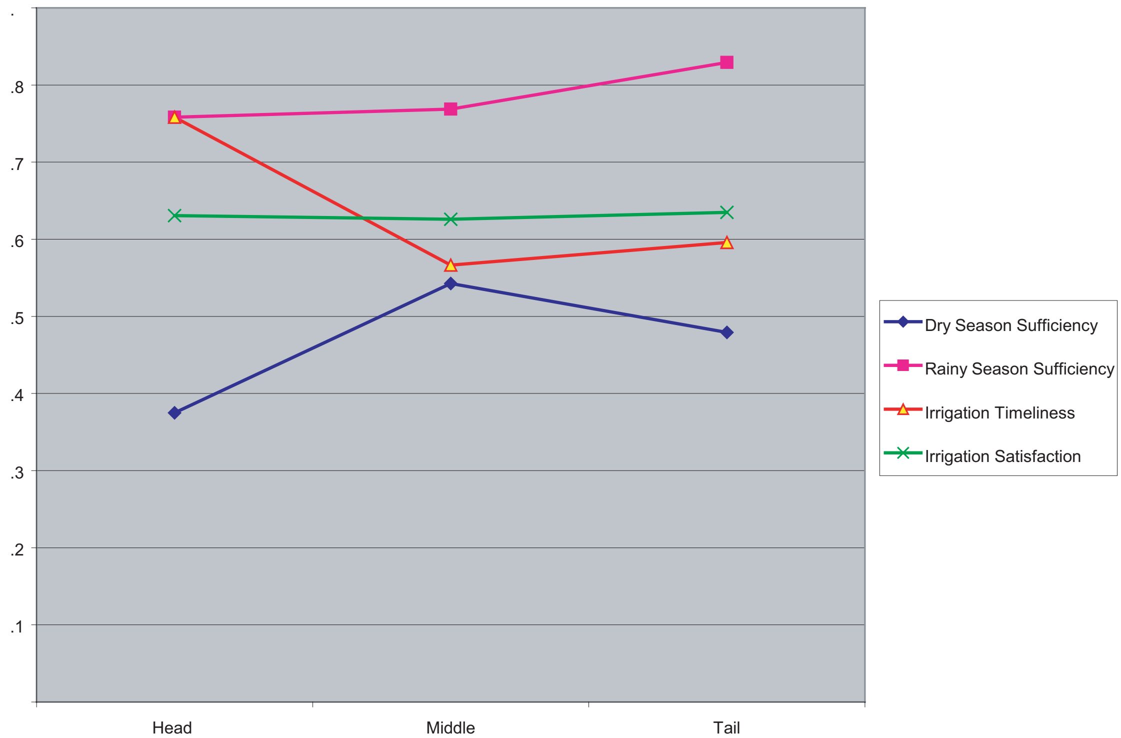


Table 5.8. Irrigation performance indicators for the head, middle and tail sections of the two irrigation systems.

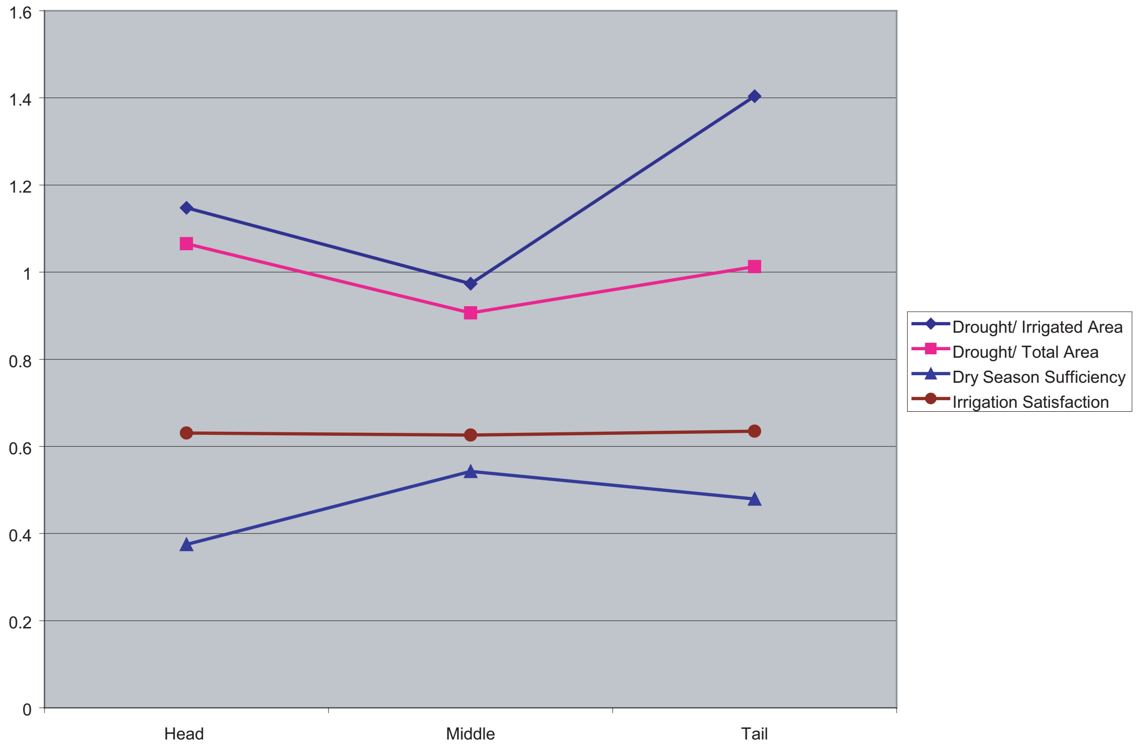
	5-year drought area/ irrigated area	5-year drought area/ total area	Average dry season sufficiency [0=no, 1=yes]	Average rainy season sufficiency [0=no, 1=yes]	Average irrigation timeliness [0=no, 1=yes]	Average irrigation satisfaction [0=no, 1=yes]
Head	1.15	1.07	0.38	0.76	0.76	0.63
Middle	0.97	0.91	0.54	0.77	0.57	0.63
Tail	1.40	1.01	0.48	0.83	0.60	0.63

The aggregate analysis does not reveal much in the way of useful patterns in variations in irrigation performance. This is caused by the different patterns in performance of the two systems. To overcome this shortcoming, a spatial analysis was conducted on a single selected system, i.e., the Nam Duong irrigation system.

Spatial Analysis: Nam Duong Irrigation System

An aggregated spatial analysis of the Vietnam irrigation systems diminishes the complexity of Vietnamese irrigation systems. The Nam Duong irrigation system was analyzed more rigorously

Figure 5.4. Five-year incidence of drought measures and irrigation performance indicators for both irrigation systems.



to gain a better understanding of the spatial implications of irrigation and poverty. The portion of the Nam Duong system studied was shown to have a very uneven spatial pattern of poverty. This is contradictory to the hypothesis that the poverty rate will increase from head to tail.

The sample population as analyzed was drawn from the head, middle and tail sections. A unique feature of the Nam Duong irrigation system is the presence of the Mon Quang pumping station located in the middle section of the main canal. Specifically, this pumping station splits the two communes surveyed as “the middle section.” That is, one village was upstream of the Mon Quang pumping station, while the other was downstream and thus received water from it. In this light, the main canal of Nam Duong can, in a sense, be considered as two irrigation systems: one located from the main pumping station to the first middle village and the second located from Mon Quang to the tail end.

In this case, an analysis that accounts for this fact will yield richer information than the overall analysis. Two Logit regression models were run to test this situation. One model of the Nam Duong irrigation system maintained the original head, middle, tail dummy variables. The second model created two new dummy variables: one for the “head” middle location and one for the “tail” middle location. The hypothesis was that the two separate middle locations would have a stronger predictive ability for poverty than the aggregate variable. Further, the two “tail” variables would have a stronger predictive ability for poverty, supporting the original hypothesis that poverty rates will increase from head to tail of an irrigation canal.

The model was almost identical to the previous regression models; except that a variable for the area receiving gravity irrigation was substituted for the irrigation availability dummy. This is necessary for Nam Duong as the head and middle sections have 100 percent irrigation coverage, while the tail is only slightly lower (i.e., no variability). The regression is run with the farm-level data. Only the results for the location variables are discussed here.

The results for the first regression using only head, middle, and tail (head is the omitted dummy) are statistically significant with a Nagelkerke R-Square of .524 and a -2 Log likelihood of 351.5. The model's overall predictive ability is 82.3 percent and 60 percent for the poverty classification. For the location variable, the middle section has a stronger predictive ability for poverty than the tail end. This does not support the supposition that poverty will increase from head to tail in an irrigation system. The results are given in table 5.9.

Table 5.9. Regression results for Logit model of Nam Duong with head, middle, and tail location variables.

	B	S.E.	Wald	Sig.	Exp(B)
Area with gravity irrigation (ha)	.0003	.000	.740	.390	1.000
Middle location dummy	1.830	.468	15.315	.000	6.237
Tail location dummy	1.117	.733	2.324	.127	3.055
Years in agriculture	-.011	.013	.734	.392	.989
Gender of household head (1=female)	-.009	.478	.000	.984	.991
Household head education level	-.062	.057	1.163	.281	.940
Land area per laborer	-.003	.001	30.431	.000	.997
Dependency ratio	-6.239	1.110	31.596	.000	.002
Assets	-.00001	.000	2.336	.126	1.000
Total number of nonagricultural sources of income	-1.081	.179	36.560	.000	.339
Number of plots	-.045	.109	.168	.682	.956
Total area of all plots	.001	.000	15.612	.000	1.001
Weight of sale piggy	-.004	.001	7.869	.005	.996
Weight of porker	-.005	.001	19.158	.000	.995
Weight of poultry	-.008	.003	5.555	.018	.992
GVP/	-.0002	.000	19.788	.000	1.000
Value of agricultural production tools	-.0001	.000	.322	.570	1.000
Constant	9.650	1.850	27.216	.000	15514.056

The second model which considered the two middle locations separately had a similarly significant result. For this model the -2 Log likelihood was 349.8 and the Nagelkerek R-Square was .527, slightly higher than the first model. The overall predictive ability increased to 83.5 percent. The model's predictive ability is 62.7 percent for poverty, an increase of 2.7 percent over the first model. Interestingly, the "head" middle dummy now has a very strong predictive ability, stronger than the other two location variables (table 5.10). However, the tail-end location dummy still has the lowest predictive ability of the three location variables. This may be due to the presence of a pumping/drainage station at the tail of the irrigation system that serves the tail end.

The pattern of predictive ability of the location variable conforms better with the data on poverty, which showed that the "head" middle section had a higher poverty rate than the "tail" middle section (13% and 10.9%, respectively). However, the tail end of the main canal experiences a significantly higher poverty rate than either of the other two sections at 15.3 percent. This may be due to the negligible coverage of gravity irrigation at the tail end. If farmers respond to the availability of access to irrigation regardless of actual performance, then poor performance has a great negative impact on poverty than lack of access to irrigation altogether. This would be the case if people in areas where access is scarce chose other occupations or chose to grow less risky, cheaper crops.

Table 5.10. Regression results for disaggregated middle location dummy variable.

	B	S.E.	Wald	Sig.	Exp(B)
Area with gravity irrigation (ha)	.0002	.000	.453	.501	1.000
"Head" middle location dummy	2.196	.549	16.024	.000	8.987
"Tail" middle location dummy	1.464	.543	7.285	.007	4.325
Tail location dummy	1.098	.730	2.261	.133	2.997
Years in agriculture	-.008	.014	.317	.574	.992
Gender of household head (1=female)	-.130	.487	.072	.789	.878
Household head education level	-.065	.058	1.276	.259	.937
Land area per laborer	-.003	.001	31.181	.000	.997
Dependency ratio	-6.510	1.146	32.268	.000	.001
Assets	-.00001	.000	2.250	.134	1.000
Total number of nonagricultural sources of income	-1.099	.180	37.238	.000	.333
Number of plots	-.076	.113	.455	.500	.927
Total area of all plots	.001	.000	12.153	.000	1.001
Weight of sale piggy	-.004	.001	8.679	.003	.996
Weight of porker	-.005	.001	17.265	.000	.995
Weight of poultry	-.008	.003	5.369	.020	.992
GVP/ha	-.0002	.000	20.728	.000	1.000
Value of agricultural production tools	-.0001	.000	.327	.567	1.000
Constant	10.542	1.986	28.174	.000	37855.966

Overall, the implication is that location in the "head" middle section receives a much stronger impact. This helps focus where possible assistance might be placed. The more important implication is that a simple head-middle-tail approach will not yield useful results if they do not match the hydrologic realities of the system.

Conclusion

The results of the analysis show high benefits from irrigation. The land productivity in irrigated areas is more than twice as a high as in rain-fed areas. In Nam Duong, the pattern is better irrigation and drainage quality at the head and lower quality at the tail end; and there is a high correlation between the quality of irrigation and drainage and the rate of productivity and poverty. There is, however, no pattern of higher irrigation benefit at the head and lower at the tail end. In Nam Thach Han there is no pattern of head-tail irrigation and drainage quality and, due to a mismatch of information, no correlation between irrigation and poverty could be found.

Irrigation positively influences farmer income and production. However, cropping patterns, decided by soil type, also have a high impact on farmer income and production. Though the irrigation and drainage quality varies from head to the tail end, the quality of the soil does not change from head to the tail end.

The aggregate approach to the spatial analysis of poverty in the irrigation systems helped isolate the most significant factors. Both gravity irrigation and gravity drainage coverage tended to drop off at the tail ends. However, this pattern did no correspond to a similar drop in GVP/ha or irrigated area. In fact, the tail ends tended to have higher irrigated areas.

In examining several irrigation performance indicators, no clear conclusion could be drawn from the aggregate analysis. These indicators were based on farmers' perception and memory of seasonal irrigation sufficiency and irrigation timeliness. An "irrigation satisfaction index," which was the average of the three indicators suggested that overall, irrigation satisfaction is uniform throughout the system. However, it appears that the head has a much higher timeliness rating than the middle or tail end. This could be the case if head-end farmers take water from the canal whenever it is present and when they need it. If these are illegal abstractions, then this is a major constraint to implementing a more equitable rotational distribution schedule.

Examining the inundation and drought frequencies (which are taken as proxies for irrigation performance), a similarly constructed "irrigation satisfaction index" shows a similar smoothing out over the irrigation system. The data, however, indicate that the tail end suffers more occurrences of drought per total irrigated area than the middle or head sections. This indicates that irrigation is performing worse at the tail ends for dry-season irrigation.

The regression analysis run for the Nam Duong shows that location is important in predicting poverty. The location is even more important when it is based on hydraulic conditions rather than on a simple head-middle-tail classification. For Nam Duong, the "head" middle section is the most significant predictor of poverty. Regression results indicated that being located here increases a household's chance of being classified as in poverty by a factor of 8.99. Other important household factors include the dependency ratio, the number of nonagricultural sources of income, and the gender of the head of household.

The spatial analysis has determined where the poor are located and identified many reasons why they are poor. Quantitative investigations have shown that poverty is linked to irrigation, but not always in a clear way. Some pockets of poverty exist where there is poor irrigation coverage, while other pockets exist where irrigation simply performs poorly. The regression analysis has shown that there are other important factors in determining poverty. However, irrigation, with especially poor performance, is a strong indicator of where poverty will occur. The next chapter examines the issues of determinants of poverty in irrigated agriculture.

Chapter 6

Determinants of Poverty in Irrigated Agriculture

This study utilizes the income poverty line for the quantitative analysis. This is used for two main reasons. First, a major goal of this project is to increase rural farm incomes through better irrigation management, especially in terms of values of crop production, which are relatively easy to calculate. Second, the emphasis is on low incomes, which can be fairly accurately assessed from crop production figures. While actual expenditures better reflect a household's welfare status, it is the income level that dictates the potential to reach the desired expenditure level.

Table 6.1 presents the correlations between three poverty classifications and four different performance indicators. The three definitions of poverty are income poverty (PTINC), expenditure poverty (POVEX), and a self-identified poverty index (HCLASS). The expected signs are negative for water-quantity sufficiency (WSUFF) and timeliness of irrigation (IRRTIME) and positive for occurrences of drought and inundation. However, this relationship holds only for income poverty. For housing class (self-perceived by the household), the expected relationships hold for all but timeliness of irrigation. For expenditure poverty, the relationships are negative for all. This result could be because as drought or inundation occurs with greater frequency, a household increasingly seeks nonagricultural sources of income. Overall, the strongest relationships are between timeless of irrigation and 5-year occurrences of drought.

Table 6.1. Correlation table of poverty classifications and irrigation performance indicators.

	Housing class (HCLASS) [0=non-poor, 1=poor]	Income poverty (PTINC) [0=non-poor, 1=poor]	Expenditure poverty (POVEX) [0=non-poor, 1=poor]	Overall water quantity sufficiency (WSUFF) [1=yes]	Timeliness of irrigation deliveries (IRRTIME) [1=yes]	5-year occurrences of plot inundation
HCLASS	1.00					
PTINC	0.16	1.00				
POVEX	0.12	0.28	1.00			
WSUFF	0.03	-0.04	-0.03	1.00		
IRRTIME	-0.02	-0.16	-0.16	0.32	1.00	
Inundation	0.02	0.00	-0.05	0.02	-0.02	1.00
Drought	0.15	0.13	-0.03	-0.15	-0.17	0.23

The Nam Duong and Nam Thach Han irrigation systems experience somewhat similar weather patterns, but at different times of the year. To better capture the seasonal influences, it was decided to link data from the two systems based on dry and rainy seasons rather than on spring and summer seasons. For Nam Duong, the spring crop is typically the dry season crop when irrigation is most important. For Nam Thach Han, it is the summer crop that is normally the dry season.

Farmer rationality and performance

The next important aspect of linking irrigation with poverty is to assess whether farmers are responding rationally to the availability of irrigation water. Table 6.2 presents data depicting cropping patterns relative to irrigation coverage and performance. The data in table 6.2 show that there is very little change in the cropping area for paddy between the dry and the rainy seasons. Furthermore, the paddy cropping pattern does not follow either the pattern of drought incidence or the pattern of inundation incidence. The area planted with paddy is most closely related to the area of irrigated land; dropping off in percentage terms at the tail end where irrigation coverage is lower. Besides indicating a high dependency on paddy crops, it also demonstrates that farmers respond to the availability of irrigation water. In regard to paddy, it is the availability of irrigation water, rather than the frequency of drought or inundation occurrence, that is the key factor in deciding whether to plant paddy.

Table 6.2. Cropping patterns, irrigation coverage, and irrigation performance.

	Area (ha)	Dry-season paddy (ha)	Rainy-season paddy (ha)	Percent change in paddy area	Percentage of area cropped with paddy on average	Irrigation coverage of total land `	5-year dry-season drought incidence	5-year rainy-season inundation incidence
Head	62.9	57.3	58.1	1.46%	92%	95%	995	212
Middle	132.5	122.4	122.4	0.05%	92%	95%	2124	410
Tail	99.5	83.0	83.1	0.10%	84%	73%	1484	877.5

The importance of different income sources for poverty alleviation

This study holds that income-earning activities are among the most crucial in alleviating poverty. Increased incomes can increase access to resources important for alleviating other dimensions of poverty. Therefore, it is important to examine the impact that different economic activities have on income in the study areas. There are two components to this analysis. First, per capita income is examined as this is the basis for defining income poverty lines. Positive influences on this aspect are important for moving out of poverty and up the income earning ladder. Second, income vulnerability is a key characteristic of the poor. Minimizing negative deviations in income earning can have a significant impact on poverty alleviation. To assess the importance of different income-earning sources on these two factors, two regression models were constructed.

The first model uses several income-earning activities to explain per capita income figures. Income earning activities included production levels in tons for both the rainy season and the dry season, the total number of reported sources of nonagricultural income, and three livestock/poultry production activities. The null hypothesis is that seasonal production figures will not be a significant factor in explaining per capita income levels. The maintained hypothesis is that seasonal crop-production levels will play a significant role in determining per capita income levels. Results for the two regressions are shown in table 6.3.

The model for the per capita income regression had an adjusted R-square of 0.238. All sources of income were significant and positive, except for dry-season crop production. It is a straightforward conclusion that increased production will lead to higher gross income (in monetary

Table 6.3. Impact of difference income sources on per capita income and on negative income deviations from the poverty line.

Variable	Per capita income	Negative income deviations
Rainy-season production	62.22696	10.11161
	(2.33)**	(3.01)***
Dry-season production	-58.0543	-8.357
	(-2.01)**	(-2.30)**
Number of nonagricultural income sources	25.42165	4.210485
	(6.51)***	(8.56)***
Weight of sale piggy	0.163369	0.006032
	(9.84)***	(2.89)***
Weight of porker	0.129592	0.005257
	(10.36)***	(3.34)***
Weight of poultry	0.193947	0.009566
	(4.34)***	(1.70)*
Constant	86.1095	-17.1836
	(9.24)***	(-14.64)***
Adjusted R-squared	0.238	0.119

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

or in-kind terms); therefore, this result must be interpreted as an occurrence of correlation rather than as one of causation. However, it is interesting that dry-season crop production has a negative relationship. This rather counterintuitive result could be caused if poorer dry-season growing conditions lead nonpoor families that are not reliant on crop production to concentrate more on nonagricultural income-earning activities. Thus, the non-poor farmers are responding with less input into the dry-season crops due to their expected poorer returns.

Similar results are obtained from the second model which examined the impact that different sources of income had on the negative deviations in income below the poverty line. This model yielded a rather poor adjusted R-square of 0.119. However, the significance for the two crops is improved over the per capita income model. For the second model, the dry-season crop again displays a negative relationship with negative deviations. This is taken as an important indication of the importance the dry season crop has for poorer farmers. Since, dry-season crops are most susceptible to drought conditions this points to an important area where pro-poor interventions can be formulated. Overall, for both models the null hypothesis is rejected.

Importance of Irrigation in Relation to Poverty

The next step in the analysis is to examine the impact that irrigation has on poverty. To undertake this analysis a Logit model was constructed. The model consisted of irrigation variables, household characteristics, and non-crop production activities. The model utilized the binary income poverty variable as the dependent variable. Irrigation variables included a dummy for farms located in the middle section and the tail end of the main canal. The total irrigated land area is included as an explanatory variable. The dependent variable for the model is poverty, which is a binary variable equal to 1 if the household is poor, and 0 if not.

It is maintained that a poverty classification for a household is a function of household characteristics including age, education, dependency ratio, etc., agricultural practices including land area, land per laborer, gross value product per hectare, and livestock choices, and irrigation performance. Irrigation performance mainly refers to farmer perceptions of irrigation performance such as timeliness, sufficiency of water and number of times drought or inundation was experienced per plot over 5 years. Additionally, the location along the main canal is also deemed important due to the common occurrence of poor performance increasing at the tail ends of a canal. The null hypothesis is that irrigation area, middle location, and tail-end location are not significant predictors of poverty.

Table 6.4 presents the results of the regression. The model correctly predicted 81.3 percent of all classifications and 44.5 percent of poverty classifications. The model with no variables (constant only) predicted 77 percent of cases correctly, but 0 percent of poverty cases correctly, which indicates a significant improvement by the model. The Nagelkerke R-square for the model was 0.426. The model yielded a -2 Log Likelihood of 716.387 and a chi-square of 316.045 [17 d.f.].

Household characteristics that are significant are education level of the household head, the land area per agricultural laborer, assets, number of nonagricultural income sources and the dependency ratio. Farm-related variables that are significant include pig and poultry raising activities and the total number of plots. These significant variables are all of the expected sign.

Table 6.4. Estimation results of Logit model on income poverty.

	B	S.E.	Wald	Sig.	Exp(B)
Irrigation area	.001	.000	8.557	.003	1.001
Middle location	1.944	.299	42.324	.000	6.987
Tail end	1.430	.375	14.526	.000	4.180
Years in agriculture	.004	.009	.230	.631	1.004
Household head gender (1=female)	-.214	.322	.442	.506	.807
Education level of household head	-.084	.036	5.393	.020	.919
Land area/labor	-.002	.000	39.938	.000	.998
Labor/household size	-4.187	.669	39.213	.000	.015
Assets	-.017	.006	7.487	.006	.983
Total nonagricultural sources of income	-1.176	.135	75.533	.000	.308
Number of plots	.162	.044	13.293	.000	1.176
Total area of all plots	-.383	2.862	1.789	.181	.022
Sale piggy weight	-.003	.001	12.617	.000	.997
Porker weight	-.005	.001	37.388	.000	.995
Poultry weight	-.004	.002	4.359	.037	.996
GVP/ha	.001	.013	.005	.945	1.001
Value of agricultural production tools	-.0001	.000	2.185	.139	1.000
Constant	3.038	.718	17.900	.000	20.874

Note: B = Beta coefficient; S.E. = Standard error.

The irrigation-related variables are all significant at the 1 percent level; thus the null hypothesis is rejected. Interestingly, the middle section location variable has a bigger influence on the chance of a household being in poverty than the tail end. This is probably due to the poor performance of irrigation in the Nam Duong middle section. Irrigated area is also significant at the 1 percent level, but positive in sign. Preliminary data analysis for the Nam Thach Han system shows that the poor generally have better irrigation coverage than the non-poor. This condition probably slightly outweighs the situation in Nam Duong where the opposite is true as well as farmers in Nam Duong having smaller farms.

Basic differences between the poor and the non-poor

This section assesses some basic household characteristics of the two systems. In particular, differences in the characteristics between poor and non-poor households are examined. Table 6.5 presents the comparative data for poor and non-poor households in the Nam Duong and Nam Thach Han irrigation systems (IS).

Table 6.5. Basic differences between the poor and the non-poor.

HH conditions	Unit	Nam Duong			Nam Thach Han		
		Average	Poor	Non- poor	Average	Poor	Non- poor
Family size	Persons/hh	4.8	5.8	4.7	5.6	5.8	5.5
Dependency ratio		1.71	1.75	1.74	2.2	2.3	2.1
Education	Grade	8.4	7.2	8.5	7.5	6.5	7.7
Planted land	m^2/labor	1,668	1,549	1,685	3,367	2,683	3,528
Paddy plot size	m^2/plot	290	276	292	644	590	653
Total asset and capital	VND 1,000/person	8,259	5,362	8,593	7,021	4785	7,553
Gravity irrigated	%	50.3	44.5	50.9	74.9	81.5	73.7
Gravity drainage	%	76.9	80.5	76.5	76.5	82.7	75.4
Spring drought	%	8.7	11.5	8.4	1.7	1.4	1.8
Spring inundation	%	2.4	1.9	2.5	4.7	3.1	5.0
Summer drought	%	5.1	6.8	4.9	22.9	21.7	23.2
Summer inundation	%	5.5	5.3	5.5	2.7	2	2.8
Paddy yield	kg/500 m^2	219	207	231	231	217	234
Land productivity	VND 1,000/500 m^2	996	876	1013	772	628	804
Income	VND 1,000/hh	10,579	5,429	11,164	12,243	5,022	13,864
Structure of income							
Cultivation	%	24	41.8	23	29	50	28
Livestock	%	23	20.5	24	29	28	29
Nonagricultural	%	53	37.8	53	42	22	43

Dependency ratio

The average household size in Nam Duong is 4.8. An average poor household in Nam Duong has 5.8 persons and an average non-poor household has 4.7 persons. In Nam Thach Han the family size is 5.6. A poor household has 5.8 persons and a non-poor 5.5 persons.

On the system average, a family in Nam Duong has 2.8 laborers and in Nam Thach Han a family has 2.6 laborers. In both systems, the family size/labor ratio of the poor is slightly higher than that of the non-poor. A laborer from a poor household has to earn a living for a greater number of family members.

Education

In the Nam Duong irrigation system, the average educational level of the household head is 8.6. The average educational level for the head of the household for the poor is 7.4 and for the non-poor it is 8.7. In Nam Thach Han, average educational level of the householder is 7.5. The average educational level of the poor is 6.5 and for the non-poor it is 7.7. Thus for both systems the non-poor have a higher education level.

Land

On average, the areas of land that households in the Nam Duong irrigation system and the Nam Thach Han irrigation system have are 2,537 m^2 and 5,250 m^2, respectively. On a per capita basis, each person in Nam Duong has 531 m^2 of land, a poor person has 503 m^2 and a non-poor person has 559 m^2. An average person in Nam Thach Han has 945 m^2 of and. On average, in the Nam Thach Han irrigation system, a poor person has 770 m^2, while a non-poor person has 1,029 m^2. For both Nam Duong and Nam Thach Han, the non-poor have a larger land area.

Asset value and Capital

In the Nam Duong irrigation system, the average value of assets and capital of each household is nearly VND 39.5 million. The corresponding value for the poor and the non-poor are VND 31 million and VND 40 million, respectively. Each person has a total average asset value and capital of VND 8.259 million.

In the Nam Thach Han system, the average value of household assets is nearly VND 39 million. Asset value of poor households is lower than that of the non-poor households (VND 27.8 million and VND 41.5 million, respectively). On average, each person has a total asset value of VND 7.021 million.

With more assets and capital, the non-poor households can more easily gain access to advanced technologies or invest in agricultural production whereas poor households are faced with obstacles because of fund constraints and limited economic capability.

Structure of household income

In Nam Duong, nonagricultural income accounts for 53 percent and agricultural income for 47 percent of the total income. For a poor family in Nam Duong, nonagricultural income accounts for 38 percent and agricultural income for 62 percent.

In Nam Thach Han, nonagricultural income accounts for 42 percent and agricultural income for 58 percent of the total income. In Nam Thach Han, for a poor family, nonagricultural income accounts for 23 percent and agricultural income for 77 percent.

The above statistics indicate that the non-poor depend on both agricultural and nonagricultural income, while the poor depend largely on agricultural income.

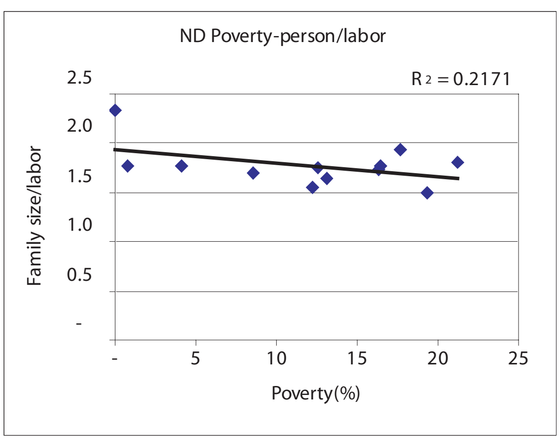
Irrigation and drainage quality and cultivation production

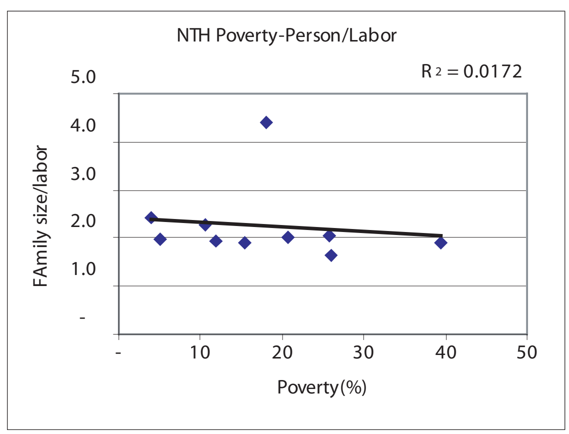
In Nam Duong, a non-poor household has better irrigation and drainage quality, a higher percentage of gravity irrigation and drainage, and lower drought and inundation frequencies. In Nam Thach Han, however, the poor seem to have better irrigation and drainage quality. In both systems, the paddy yield of the non-poor is higher than that of the poor.

Causes of Poverty within the Study Areas Using Simple Correlations

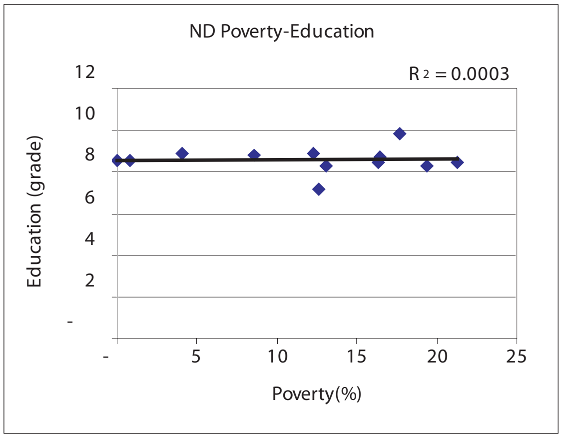
This section analyzes different trends within the study areas. The analysis is based on village-level data. The purpose is to identify significant factors that have a negative or positive impact on poverty.

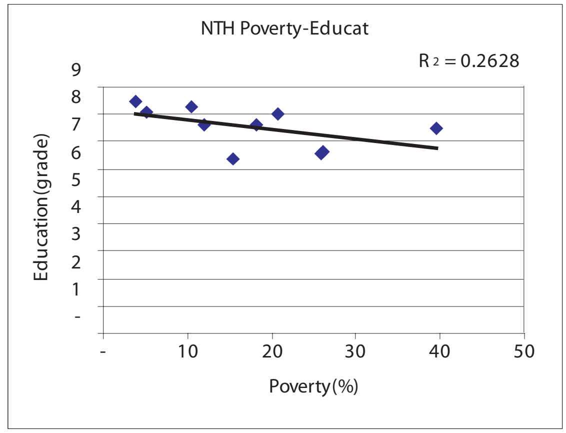
Poverty and dependency ratio. In both systems, more poverty in a cluster is associated with a less dependency ratio. It is likely that labor in a non-poor family can support a larger number of persons.



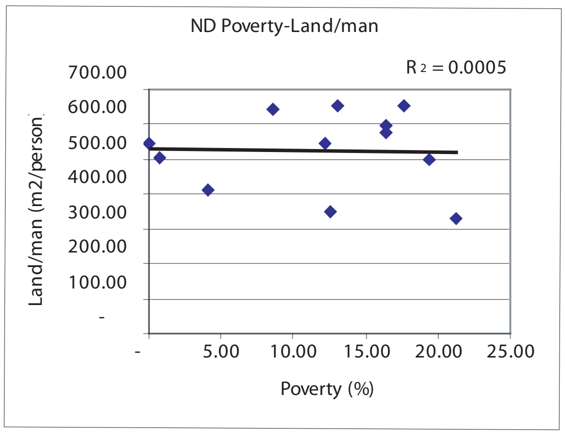


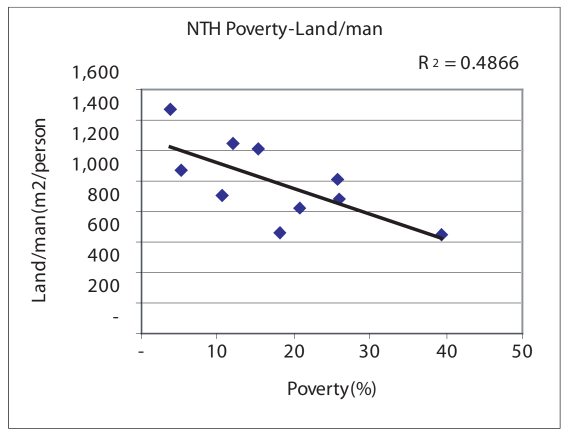
The *education* level of household heads in Nam Duong shows no correlation to the poverty rate. In Nam Thach Han the higher the education level the lesser the poverty.



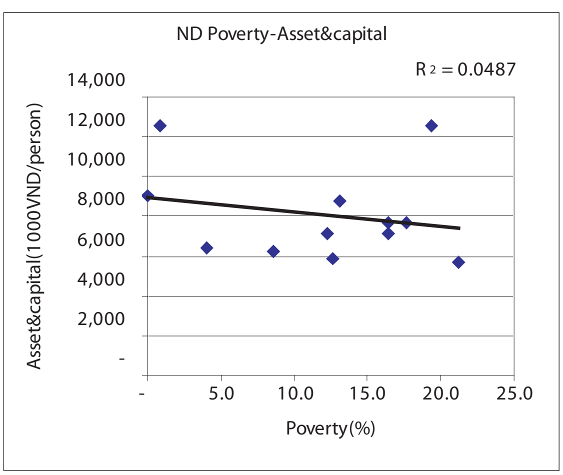


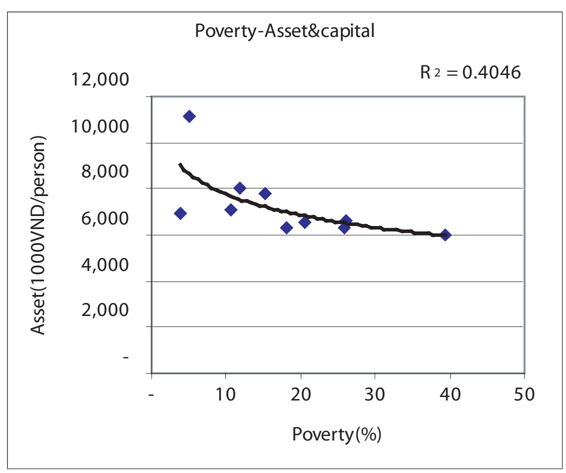
Land-man ratio: Similar to the education level, the land-man ratio in Nam Duong shows no correlation to the poverty rate. But in Nam Thach Han, the land-man ratio strongly correlates to poverty.





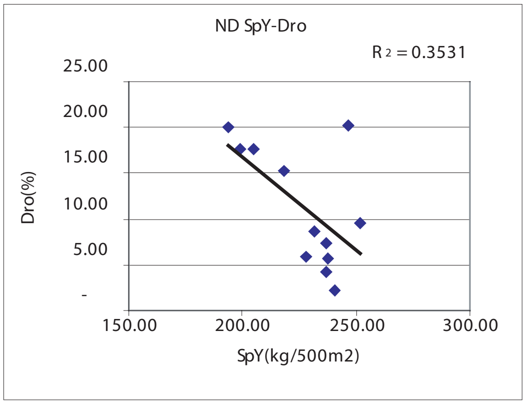
Total asset and capital: In both systems, poverty decreases as the total asset and capital increase. In Nam Duong, the trend is not clear but in Nam Thach Han the correlation is significant and the trend is obvious.

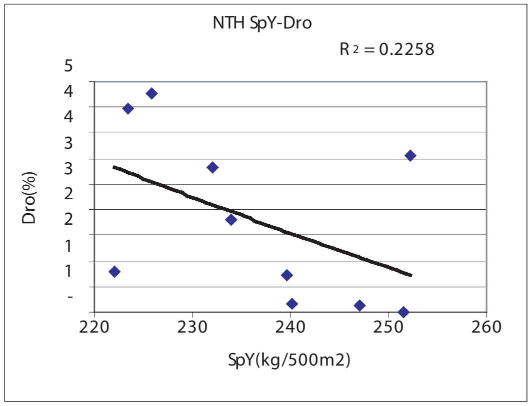


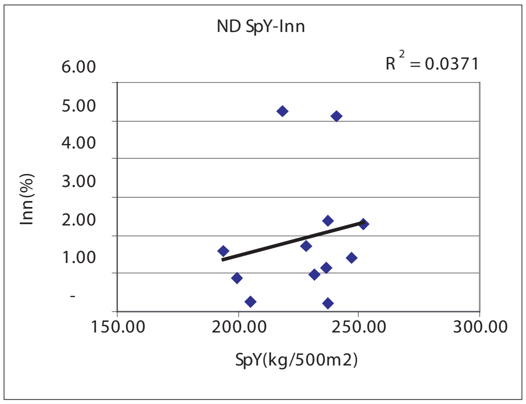


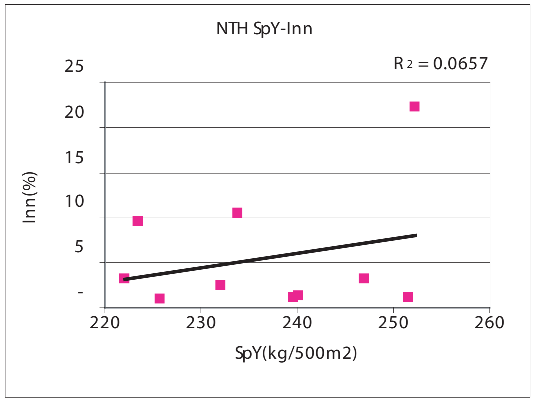
As mentioned previously, the 5-year reported occurrences of drought or inundation are used as proxies for irrigation quality. Here, reported frequencies for village averages are plotted against poverty to show trends.

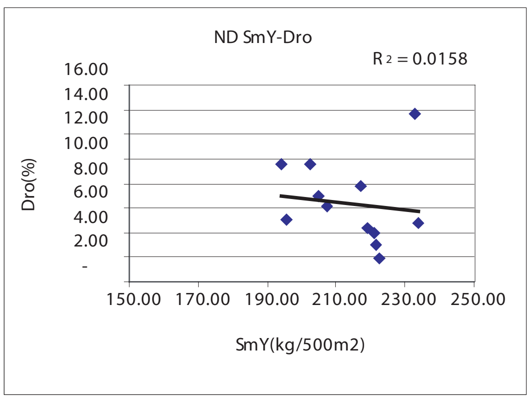
Inundation, drought and rice yield: In Nam Duong, the rice yield is negatively affected by drought in spring and by inundation in summer. In Nam Thach Han, the impact of inundation and drought is not clear.

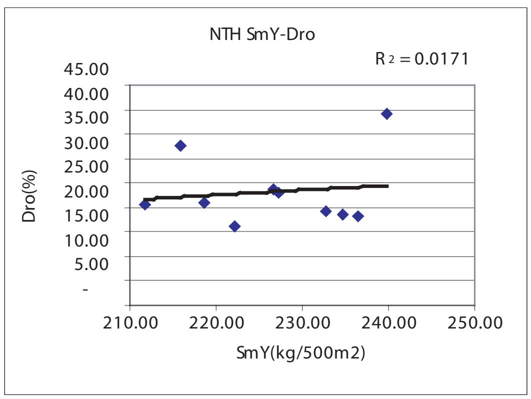


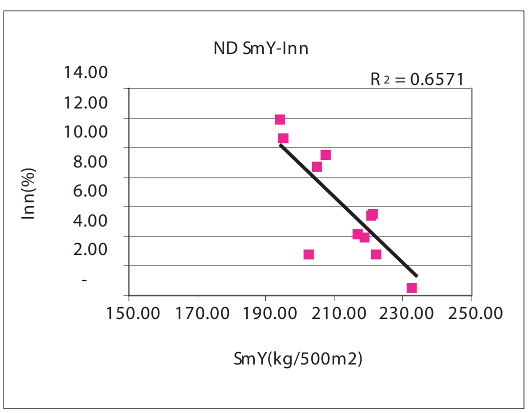


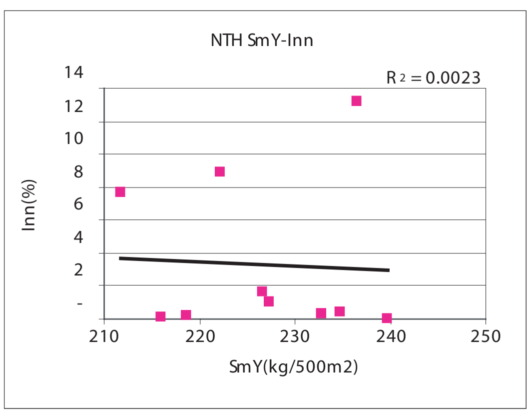




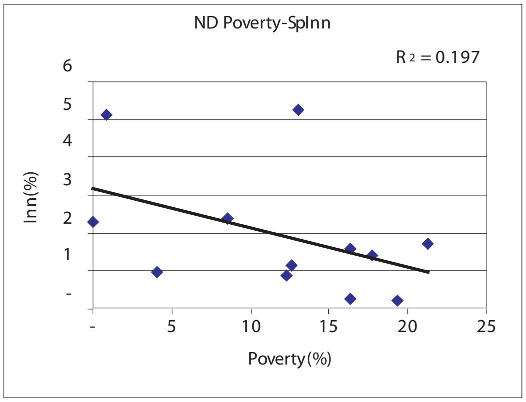


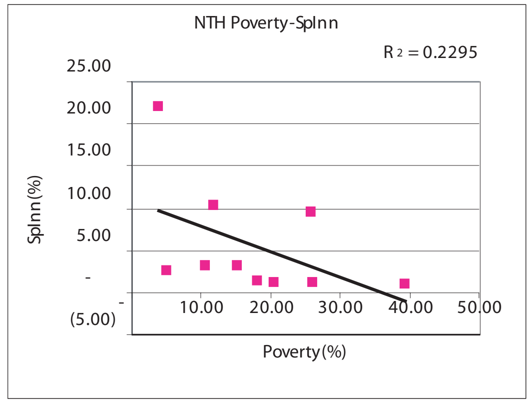


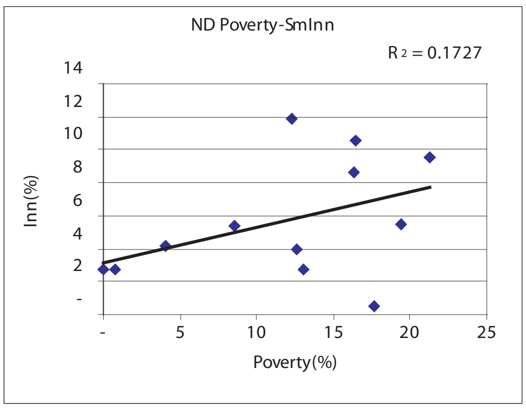


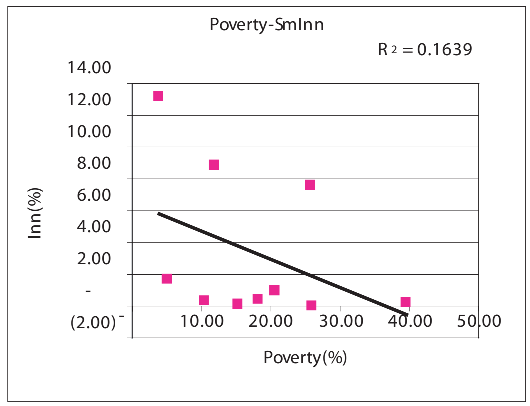


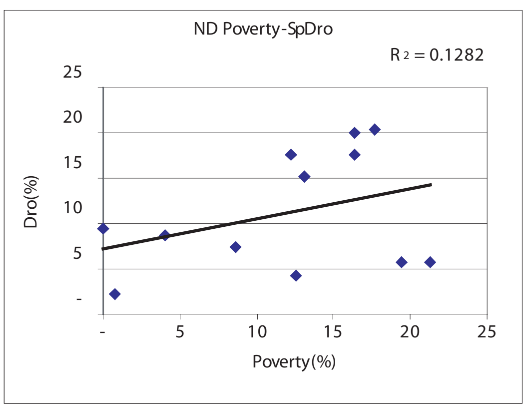
Inundation, drought and poverty: In both Nam Duong and Nam Thach Han, drought seems to be positively related to poverty. However, the tendency is not clear and the simple regression yields a poor fit. Moreover, inundation in Nam Thach Han seems to be associated with a lower poverty level.

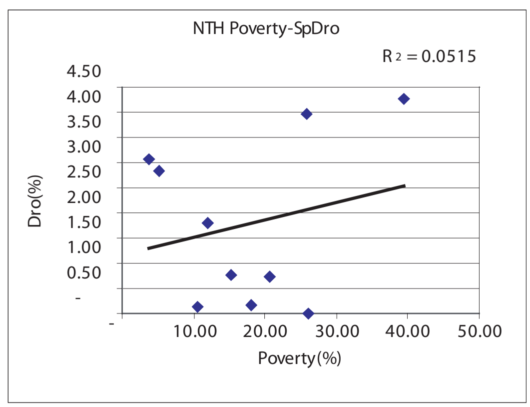


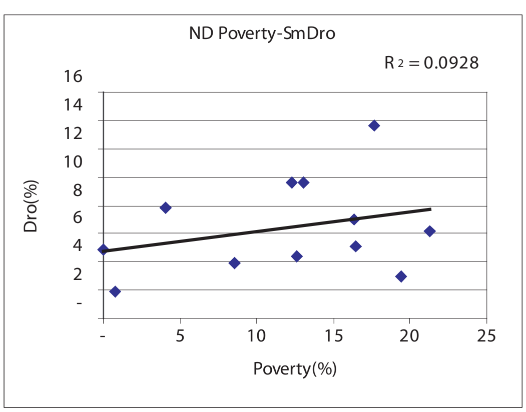


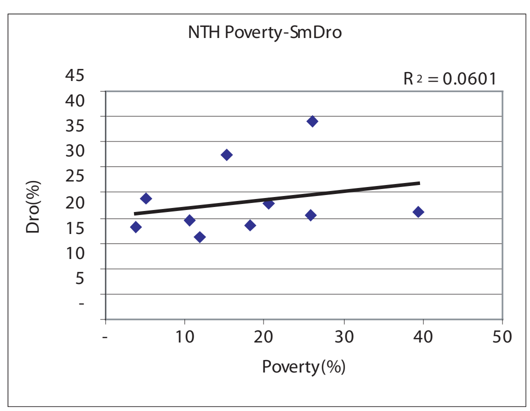












The trend analysis shows only a strong negative correlation of poverty and the land-man ratio (R^2=0.49), poverty, total asset and capital (R^2=0.4) in Nam Thach Han and yield of paddy rice and spring drought (R^2=0.35) and yield and summer inundation (R^2=0.66) in Nam Duong. The village-level analysis does not show any other significant correlation.

The next section makes a detailed review of the development of certain indicators regarding irrigation performance.

Analysis of Agricultural Income Factors Using Multivariate Analysis

Multivariable regression, using household survey data, has been applied to test the significance of various factors in explaining household income/expenditure and poverty. This section first examines the Nam Duong irrigation system followed by the Nam Thach Han irrigation system. All major inputs to the model have been tried to have the best fit models. Only the models with the best fits (highest R-squares) are discussed here.

Nam Duong: Annual Income

The first model examined the impact that different household resources had on income levels. The variables included in the model are total assets and capital (production tool and money resource), dependency ratio (labor resource), education, land to man ratio (land resource) and nonagricultural income. Nonagricultural income is not a household resource by itself. However it is a special kind of farm household income thus it is being included into the model to take a full consideration of all variable associates with farm household income. The model has R2-adjusted of 0.53. Results for the *Income regression* show that income is positively associated with total asset and capital, education level, land-man ratio, and nonagricultural income (table 6.6). Increasing total asset value by 1,000,000VND/person, education level by one, land/man ratio by 100m^2/person, nonagricultural income by 100,000 VND/person/year would increase farmer income by 17,000 VND/person/year, 31,300 VND/person/year, 120,000 VND/person/year and 100,000 VND/person/year, respectively.

Table 6.6 Results of regression analysis for income in Nam Duong.

Variable	Coefficient	t-Statistic
Assets (1,000VND/person)	0.017	2.8***
Dependent(person/labor)	74.5	1.2
Education (grade)	31.3	1.7*
Land/man (m^2/person)	1.2	5.5***
Nonagricultural income (1,000VND/person)	1.0	21.4***
C	-114.6	-0.6
Adjusted R-squared	0.6	

* significant at 10%; ** significant at 5%; *** significant at 1%.

Nam Thach Han: Annual Income

Regression of *Income* and various inputs (table 6.7) gives a rather good fit with adjusted R^2 equal to 0.75. The income is positively influenced by total asset and capital, land-man ratio and nonagricultural income.

Table 6.7 Regression Results for Income in Nam Thach Han.

Variable	Coefficient	t-Statistic
Assets (1,000VND/person)	0.055	5.7***
Dependent(person/labor)	-33.4	-1.0
Education (grade)	14.9	1.24
Land/man (m^2/person)	0.2	3.9***
Nonagricultural Income (1,000VND/person)	0.94	30.***
C 726.0	5.1***	
Adjusted R-squared	0.8	
* significant at 10%; ** significant at 5%; *** significant at 1%		

An increase by 1,000,000 VND/person, in total capital and asset would increase income by approximately 55,000 VND/person/year. Increasing nonagricultural income by 100,000 VND/person/year would increase income by 100,000 VND/person/year. Increasing land/man ratio by 100m2/person would increase income by 21000 VND/person/year.

Conclusion

A key element to any examination of poverty is the definition of poverty chosen for analysis. This study had previously decided to focus on income-defined poverty for this analysis. This is because increased income can increase access to many resources that are considered elements of poverty in other decisions. Additionally, irrigation is primarily an input into a productive economic activity. It was still felt worthwhile to do a preliminary investigation of the importance of this factor. Three definitions of poverty (income, expenditure, and self-perception) were examined for correlation. The three definitions were closely correlated indicating that an income only approach to devising interventions may miss important factors. However, in examining the correlations with different irrigation performance variables, it was found that income demonstrated the expected correlations. Therefore, irrigation interventions are an appropriate focus if raising incomes is the primary goal.

Analysis showed that farmers react in a rational way to irrigation and irrigation infrastructure. When infrastructure is present then farmers will typically plant paddy, a water-intensive crop. This occurs regardless of the performance history. Therefore, if irrigation infrastructure is present, it is quite important to make sure it performs adequately to help ensure successful farmer crops. Where irrigation infrastructure is not in place, then farmers plant less-water-intensive crops. An important point from the analysis is the need to increase crop diversification in irrigated areas. This is a good opportunity to help increase the productivity of farmers. Another important point is to improve performance in existing irrigated areas to help ensure farmers' crops. Finally, expanding irrigation to nonirrigated areas will increase the options farmers have in their cropping decisions.

Regression analysis confirmed that crop production is a significant source of income for the farmers. An interesting result from the regression analysis is the important role of dry-season crop production. Results indicate that dry-season crops are significant, but in a negative way. It is assumed that this result is caused by the higher dependency of poor households on crop production. This indicates that dry-season crop production, where poor irrigation performance is the critical factor in crop failure, is an important area to focus management interventions.

Results from another regression model confirmed that irrigation is an important factor regarding poverty. However, the aggregated analysis covered opposite situations in the two systems resulting in only slightly significant results. The most important factor in determining poverty was location. Other factors included laborers—household dependency ratio and total area of all plots.

For both systems, the main cause of poverty is the lack of access of households to inputs for production such as labor, land, capital, agricultural management knowledge, irrigation and drainage. This lack of access to inputs, including management knowledge, affects cropping patterns in a way that keeps the poor from rising out of poverty.

In Nam Duong, income is positively influenced by total asset and capital, land-man ratio, and nonagricultural income and summer rice yield. The income is significantly and negatively influenced by summer rice-production cost. The income is also negatively influenced by inundation and drought, though not significantly, in both spring and summer. The rice yield is significantly and positively impacted by total assets, educational level, spring production cost, while it is negatively impacted by drought in spring and inundation in summer.

In Nam Thach Han an increase, by VND1 million/person, in *total capital and asset* would increase income by approximately VND60,000/person/month. Increasing land/man ratio by 100 m^2/person would increase income by VND18,000/person/year. The level of input use in both spring and summer are ineffective, leading to reduction of yield and income as production costs increase.

Unexpected inundation in summer also positively influences the income. This is caused by a mismatch between the past experiences, by farmers, and abrupt changes in water environment, brought about by implementation of the rubber dam, at the head work to increase water-storage capacity, and the An Tiem siphon and the Viet Yen sluice gate to prevent drainage, flood and saltwater intrusion. A more detailed explanation is provided later.

In Nam Duong, income is positively associated with total asset and capital, education level, land-man ratio, and nonagricultural income. In Nam Thach Han income is positively influenced by total asset and capital, land-man ratio and non-agricultural income.

For both systems, the main cause of poverty is households lacking access to inputs for production such as labor, land, capital, agricultural management knowledge, irrigation and drainage. This lack of access to inputs, including management knowledge, affects cropping patterns in such a way as to keep the poor from rising out of poverty.

Chapter 7

Irrigation System Performance and Its Impacts on Poverty

Assessing Performance of Irrigation Systems

For the purpose of this study, irrigation-performance assessment comprises two subcomponents:

- Characterizing irrigation systems
- Assessing performance using indicators

Methods for Characterizing the Irrigation Systems

After selection of the irrigation systems, the first essential step in this project was to undertake a detailed description and characterization of the selected irrigation systems. This helped in understanding the context and the present situation of the systems, including their resources base. In addition, system characterization helps in refining the research questions, hypotheses and assessment methods, and more importantly provides a consistent basis for within and cross-country system comparisons.

Irrigation system characteristics were classified as:

- Physical characteristics
- Technical/hydrological characteristics
- Agricultural characteristics
- Socioeconomic characteristics
- Institutional/Management characteristics

Characterization of the Nam Duong and Nam Thach Han irrigation systems were detailed in chapter 4.

Assessing Performance-Using Indicators

Water balance survey and data for the Nam Duong irrigation system

Ideally, for the water balance study in Nam Duong, inflows and outflows of Dinh Du and Trang Ky rivers are measured. However, many difficulties have to be faced in determining water losses at system level by measuring the water quantity in drainage canals released out of the system. This is because of the complexity of the operational diagram of the system. Moreover, some technical issues have to be encountered in this determination, as given below:

- Flow velocity at the outlet of the system is very low because the cross- section of the drainage canal is quite large while the flow is very small. For example, in the Trang Ky river, the area of the wet-section reaches 100 m^2 while the discharge is several cubic meters per second.

- The flow at outlets of the system is not stable because marginal conditions (discharge of pumping stations along drainage canals, water losses, water level downstream or in the main canal of the North Hung Hai system) vary a great deal over time. To determine the exact water quantity released out of the system, discharges at many different times have to be measured.

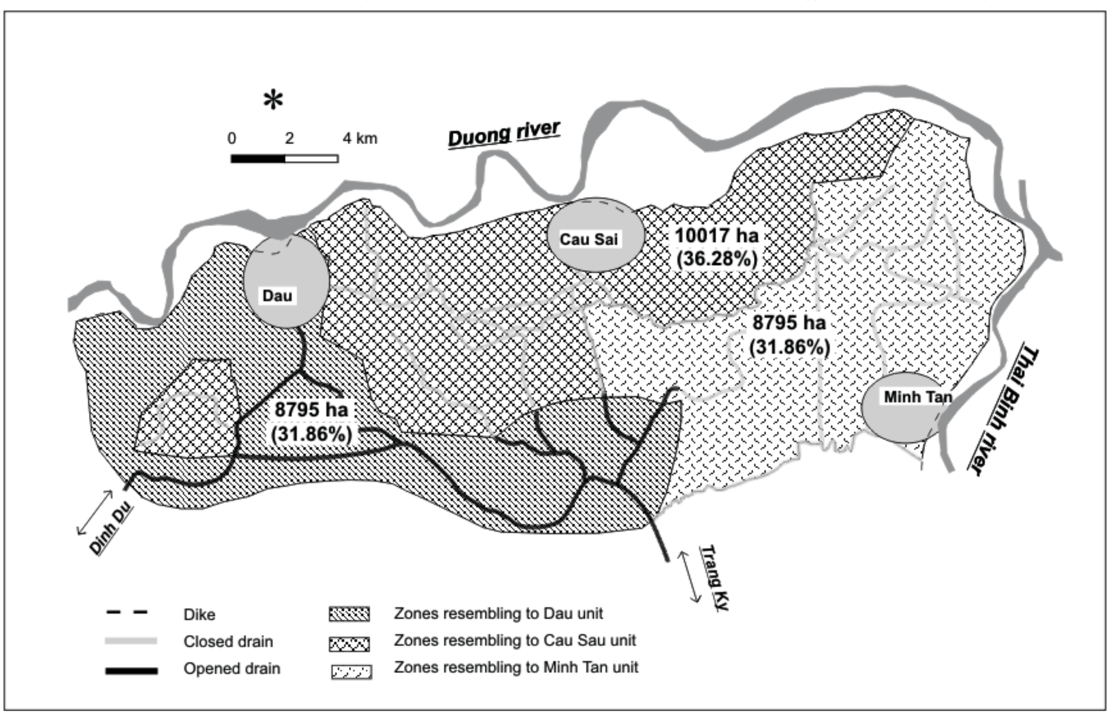
- Water losses released out of the system at the outlet of the drainage canal may become water sources for the pumping station such as that at the Trang Ky river. When pumping stations do not operate, water discharges measured at these places are positive values (water is lost to the drainage canal and is the outflow of the system). When pumping stations operate, these discharges are negative because of this inflow of the system (see notes of Minh Tan irrigation unit above).

Nam Duong is a complex irrigation system, which comprises many small subsystems during irrigation and drainage periods. For the water-balance study, three irrigation units (Dau, Cau Sai and Minh Tan) were studied in-depth.

The method used in this research allows one to review and assess this complex system. This method includes three main steps as given below:

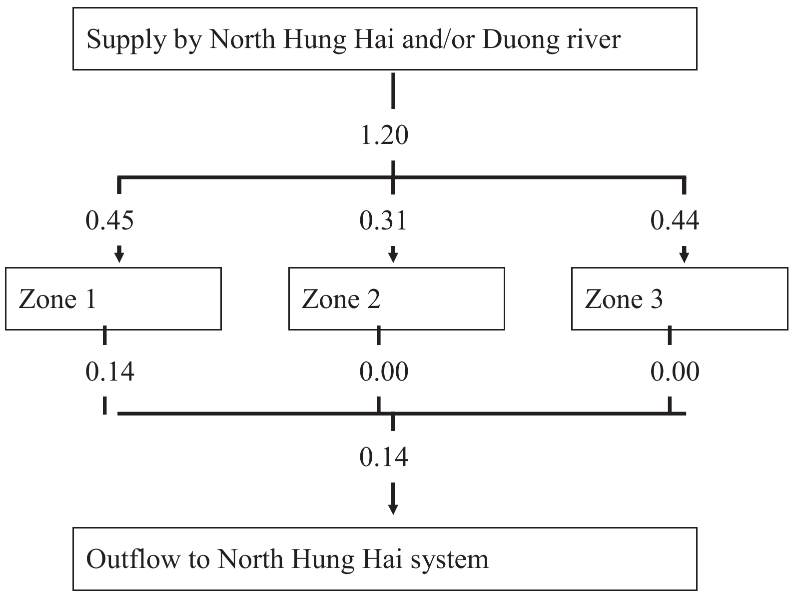
- Classification of the irrigation unit: by field surveys, we classified irrigation units of the system into three types based on its operational principles. The entire command area is then divided into three typical areas (figure 7.1).

Figure 7.1. The Nam Duong irrigation system with three areas, with different hydrological regimes.



- Calculation of the water balance for typical units: by selecting typical units for each type and with specific characteristics, water discharges at necessary locations are measured. We also develop water circles and water accounting for these units. In other words, technical difficulties in measuring discharges at observed points are overcome.
- Integration of results for the whole system: by extrapolation, water balances for each zone and the whole system are estimated (figure 7.2).

Figure 7.2. Surface water flow in the Nam Duong irrigation system (10^6 m^3/day).



Calculated results show that water losses (from irrigation canal and fields) to the drainage canal and releasing the water out of the system are relatively large. For only zone 1 (accounting for 31.9% of the total system area) the rate of Outflow/Inflow reaches 11.7 percent (10*0.14/1.20=11.7%). Water losses depend much on planning of structures. While water losses of zone 1 are very large because there is no regulator, there are no water losses in zones 2 and 3.

- There is a great requirement to upgrade irrigation canals and field banks as well as invest to complete the system (e.g., construction of regulators to store water in drainage canal at zones with large water losses). Of course, water losses to the Bac Hung Hai system are not lost because it becomes a water source for other systems in the Bac Hung Hai polder. However, if water losses are reduced, then the electric cost for irrigation will decrease.

Water balance/accounting survey and data for the Nam Thach Han irrigation system

For the water balance/accounting study, primary data were measured at the system. Some data that could not be measured due to the work load, which was beyond the capacity of the project framework, secondary data were used. Rainfall data were obtained from data recorded by the Nam

Thach Han IDMC. There are five rainfall stations within the command area of the system. These are located at headworks K9, N6, N3 and K12.

The Nam Thach Han IDMC has recorded annual water delivery at the headwork, K7, K12, and at intake gates N2, N1, N4, N3 and N6. The past data were used as secondary data. Water delivery in 2001 was recorded and measurements were conducted to check the preciseness of the data. Data on water requirement for rice and potential evapotranspiration were obtained from Dao Xua Hoc et al. 2001.

Performance Indicators

Information from both primary and secondary sources is used to estimate irrigation-system performance indicators. The results are presented in table 7.1.

In the Nam Thach Han irrigation system, the net irrigated area is approximately 7,500 hectares and the design command area of Nam Thach Han is 17,000 hectares, and thus the irrigation density is approximately 44 percent. In the winter-spring rainy season when water is abundant upstream of the Nam Thach Han dam, the tail-end area of secondary canals, especially N2, N4 and N6, suffer from inundation and thus do not require much water supply, and a substantial water quantity is released to the sea. During summer when water is scarce upstream of the dam, tail-end canals also suffer from water shortage. Increasing the water storage upstream of the dam and inside the command area by effective management of water storage in the Vinh Dinh internal river, which serves as drainage courses, would increase water storage for summer and increase irrigation intensity of the Nam Thach Han system.

In Nam Duong, the irrigation intensity of 100 percent is mainly due to additional implementation of various pumps, such as Mon Quang, Ngoc Quan, Kenh Vang, at a latter stage. The cropping intensity in Nam Thach Han is less than 2 because of unplanted areas due to water shortage during summer and inundation in winter-spring. The cropping intensity of 2.1 in Nam Thach Han is due to the winter crop.

Output per unit of command area in Nam Thach Han of VND 15 million is much less than in Nam Duong of VND 20 million due to more valuable crops, such as vegetables. A greater part of water diverted into the Nam Thach Han system is lost to downstream and to the sea. Water used in Nam Duong is more effective than in Nam Thach Han. From 1 m^3, Nam Duong can produce as much as VND4,800, while Nam Thach Han can produce only VND700.

Because of higher percolation and evapotranspiration, output per unit of water consumed in Nam Thach Han is less than in Nam Duong. The relative water supply and relative irrigation supply in Nam Duong are better to meet crop and irrigation demand. The high ratio of relative irrigation supply in Nam Thach Han is due to high effective rainfall compared to irrigation demand.

Water delivery of Nam Thach Han is twice higher than what is required for the existing net irrigated area, while water delivery of Nam Duong is only 60 percent of that required by net irrigated area. Other pumps developed at later stages (see above) can meet 40 percent of the water requirement.

Head-tail equity in terms of water delivery shows better water availability at the tail end of the Nam Thach Han system. Much of the water supply is from return flow and drainage course storage. In Nam Duong, however, the water quality in terms of gravity-irrigated and -drained area at the tail end of the Van Ling commune, is thrice less than that at the head of the Tri Qua commune.

Output value per unit of labor in Nam Thach Han is higher than in Nam Duong. This is due to less labor spent on agricultural production there. In both systems, the head end has better yield

Table 7.1 Irrigation system performance indicators.

Performance indicators (2001)	Nam Thach Han			Nam Duong		
	Spring	Summer	Annual average	Spring	Summer	Annual average
Design command area, DCA (ha)	17,000			16,500	16,500	16,500
Net irrigated area, NIA (ha)	,,7,657	7,332		16,775	16,662	
Irrigation intensity		44				101
Existing command area, ECA (ha)	,,7,657	7,332		16,775	16 662	
Main system MCA,	,,5,362	5,038				12,240
Return flow RCA	,,2,294	2,294				4,460
Gross cultivated area, GCA			13,939.77			34,941.665
Crop intensity			1.86			2.09
Rice yield (kg/ha)	,4,726.6	4,514.2		4,504.8	4,261.6	
Total rice product in command area (1,000 tons)			69.3			146.6
Output per unit CA (MVND/ha)	,,,,,,,8.09	8.1	15.45	9.07	8.7	19.9
Total production in CA (MVND)			215,369.4			695,339.1
Diverted irrigation water, DIW (MCM)	167.9	129.9	297.9	96.2	47.8	144.0
Rice output/unit of DIW (kg/m^3)			0.2			1.0
Output per unit of DIW (VND/m^3)			723.1			4,827.2
Total water supply, TWS (MCM)	187.4	138.6	326.0	128.0	145.6	273.6
Total consumed water, WET (MCM)	35.8	47.8	83.7	119.1	104.1	223.2
Output/unit of water consumed (VND/m^3)			2,573.8			3,114.9
CD (MCM)	102.9	73.2		122.4	104.1	226.5
Effective rainfall (MCM)	19.4	8.7		31.7	97.8	
Relative water supply, RWS	1.8	1.9		1.0	1.4	
Relative irrigation supply, RIS	2.0	2.0		1.1	7.6	
Capacity to deliver at the head, CCD (1,000^ m^3/d)		1,684.8		836.0		
Peak CD (1,000^ m^3/d)		726		1347.6		

Performance indicators (2001)	Nam Thach Han			Nam Duong		
	Spring	Summer	Annual average	Spring	Summer	Annual average
Water delivery capacity, WDC		2.3	0.6			
Water delivery performance, WDP	2.0	2.0		1.1	7.6	
Overall system efficiency, OPE	0.5	0.5		1.0	0.7	
Upstream actual delivery	1,524.0			84		
Upstream target delivery (CD),	2,315.0			100		
Downstream actual delivery,	1,667.0			27		
Downstream target delivery (CD),	2,221.0			100		
Head-tail equity in water-delivery performance	0.9			3.1		
Labor day (md/ha)	182.4	188.4	359.352	279.3	273.5	582.065
Output/unit of labor (VND1,000/md)	44.4	43.0	43.0	32.5	31.8	34.2
Upstream rice yield (kg/ha)	4,782	4,575	4,742	4842	4504	4,725
Downstream rice yield (kg/ha)	4,713	4,454	4,645	4024	4009	4,025
Upstream output/ha	7.97	7.94	16.3	10.3	10.1	21.2
Downstream output/ha	8.83	8.77	15.7	7.4	7.3	18.3
Head-tail equity in output			1.04			1.16
Gross value of farm production (MVND/ha)			15.45			19.9
Net value production/ha			9.5			12
Net value of farm production as % of total hh income			29			24
NVP in irrigated area (MVND/ha)			9.8			14.1
NVP in rain-fed area (MVND/ha)			6.4			9.1
Irrigation benefit(MVND/ha)			3.4			5
Irrigation benefit(VND/m^3 of DIW)			87.4			582.3
Total irrigation expenses at system (MVND)			4,500			11,587
Total irrigation expenses/ha at system level (MVND)			0.6			0.7
Total irrigation expenses/ha at farm level(MVND)			0.4			0.2
Total irrigation expenses/ha (MVND/ha)			1.0			0.9

Performance indicators (2001)	Nam Thach Han			Nam Duong		
	Spring	Summer	Annual average	Spring	Summer	Annual average
System-level profitability			3.5			5.5
Water charge collection performance			99			90
Total actual O&M			na			na
Required O&M			na			na
Number of infrastructure at main canal			74			263
Number of infrastructure at secondary canal			459			0
Number of infrastructure at tertiary canal			0			0
Number of control structures/1,000 ha in CA			69.6			15.7
Number of IDMC staff/1,000 ha			13.1			18.5
Number of on-farm irrigation staff/1,000 ha			68			36
Users' participation			1			1

than the tail end, but the difference is not very large: only 4 percent in Nam Thach Han and 16 percent in Nam Duong.

Nam Duong experiences a higher irrigation benefit, especially per unit of diverted irrigation water than Nam Thach Han. The same is true for system-level profitability.

The collection rate of water charges are 99 percent and 90 percent in Nam Thach Han in Nam Duong, respectively. This is brought about by higher relative irrigation and water supply.

The infrastructure in Nam Thach Han is better than in Nam Duong. The proportion of IMDC staff in Nam Duong, at 18.5 percent, required by the nature of pump system, is higher than that in Nam Thach Han, at 13.1 percent. The number of on-farm irrigation staff in Nam Thach Han is almost twice higher than in Nam Duong. This is due to the nature of different on-farm management structure. In Nam Thach Han, farmers are not permitted to deal with water intake into their field plots, while in Nam Thach Han farmers have to take water into their plots.

Performance indicators show that the Nam Duong irrigation system has better performance than the Nam Thach Han system.

Impact of irrigation on poverty: Regression analysis

The above performance indicators are useful for comparison among irrigation systems but do not tell much about within-irrigation-system comparisons (equity indicators and irrigation-poverty linkage). There are two other indicators, location relative to irrigation sources and drought and inundation frequencies, that can be used for cross- system comparisons. While the spatial analysis shows an unclear spatial poverty pattern, this study utilizes drought-inundation indicators in a regression analysis to analyze the impact of irrigation performance on poverty.

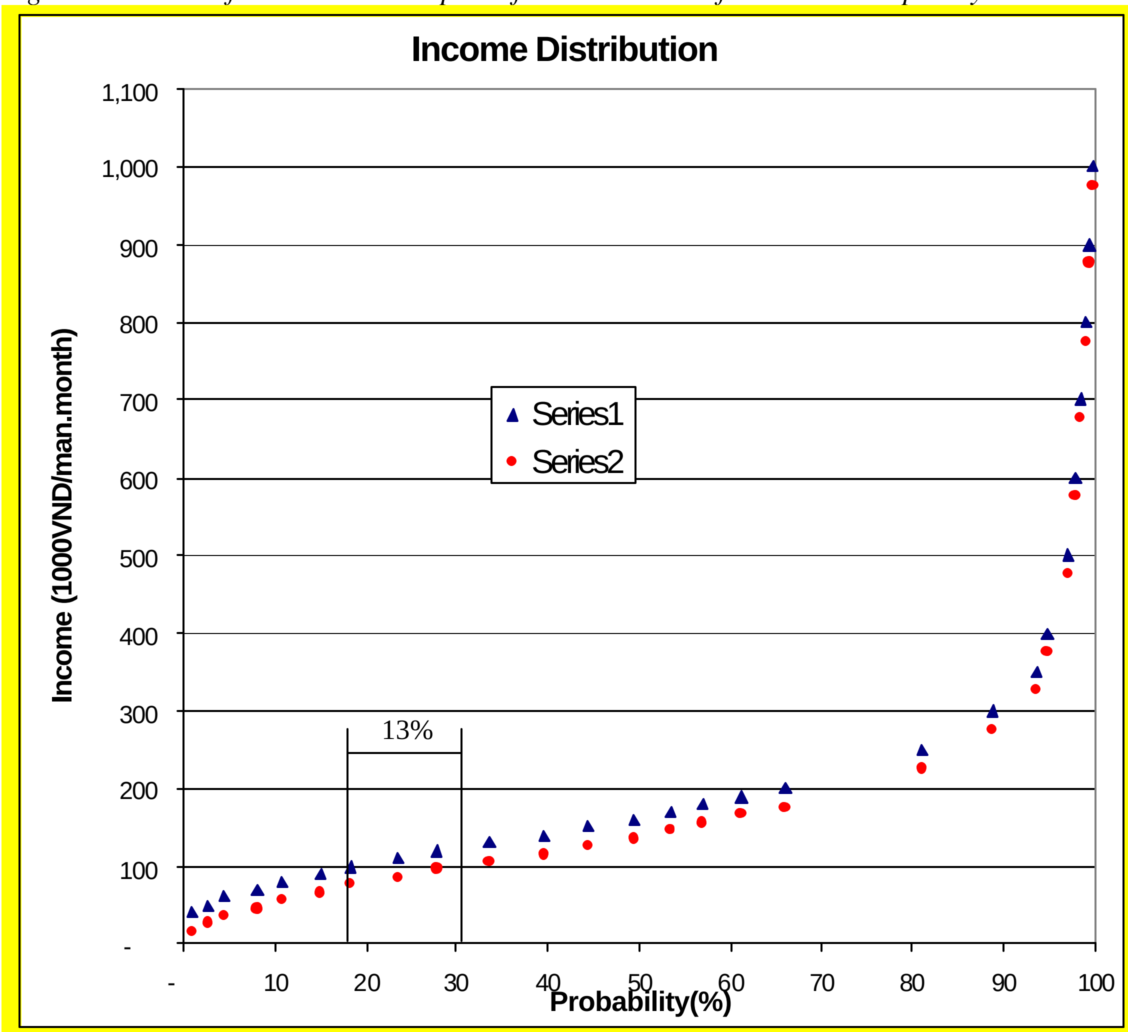
The drought and inundation frequencies here are the number of times that a household and household plot suffered from drought or inundation over the last 5 years as irrigation performance indicators for regression analysis.

In Nam Duong, inundation in summer negatively impacts summer rice yield and drought in spring negatively impacts spring rice yield. Although irrigation and drainage in the Nam Duong irrigation system still does not meet rice-yield potential the gap is not big. Spring drought occurs once in 10 years and inundation once in 20 years.

The regression analysis shows that rice yield is significantly and positively impacted by total assets, education level, spring production cost, while it is negatively impacted by drought in spring and inundation in summer.

In Nam Thach Han, land productivity is negatively influenced by summer drought and spring inundation. Before the system upgrade in 2000-2001, spring inundation occurred one in 20 years and summer drought occurred one in three years. Three major hydraulic structures were implemented in Nam Thach Han irrigation system to increase irrigation water supply, drain excess water, and prevent flood and salt water intrusion. These are: a) Rubber dam, implemented during March, 2000-September, over previous concrete head work dam, raising water level by 2 m and water storage by approximately 20 MCM; b) An Tiem siphon, implemented from May 2000-July 2001, replaced formally open N1 canal earthen section crossing flood water way, returning the water way to its former function; c) Viet Yen sluice gate, implemented from.

Figure 7.3 Result of simulation on impact of water control infrastructure on povery reduction.



Note: Series1: With irrigation and drainage improvements in 2000–2001; Series2: Without irrigation and drainage improvements in 2000–2001.

Impact of Irrigation Performance on Poverty: Logit Model

This section analyzes irrigation performance and its impact on poverty. A Logit model was again constructed similar to the one mentioned in the last section. However, irrigated area is replaced by four irrigation performance variables including sufficiency of irrigation water quantities, timeliness of irrigation deliveries, 5-year occurrences of drought, and 5-year occurrences of inundation at the household level. This analysis will yield an indication as to which performance criteria are the most important for impacting poverty, as well as being a likely target for a pro-poor intervention. The null hypothesis is that the four performance variables are insignificant predictors of poverty.

A summary of the income poverty Logit model results is given in table 7.2. The model performed well with a chi-square statistic of 316.247 [20 d.f.]. The model improved the overall predictive rate 5 percentage points to 82 percent. The model was able to correctly predict 45.9 percent of poverty cases under the income poverty classification. Estimation results for the model are shown in table 7.3.

There are six theoretically important variables related to irrigation performance included in the model: L12, L13, WSUFF, IRRTIME, INUNDATION, and DROUGHT. The location variables

Table 7.2 Model summary.

Statistic	Value
-2 Log likelihood	716.184
Cox & Snell R square	.281
Nagelkerke R square	.426

Table 7.3 Income poverty regression results for both systems.

	B	S.E.	Wald	Sig.	Exp(B)
5-year incidence of inundation (INUNDATION)	.015	.030	.250	.617	1.015
5-year incidence of drought (DROUGHT)	.038	.017	4.887	.027	1.039
Water sufficiency (WSUFF)	-.026	.130	.041	.840	.974
Timeliness of irrigation (IRRTIME)	-.374	.248	2.287	.130	.688
Middle location (L12)	1.958	.309	40.071	.000	7.084
Tail-end location (L13)	.847	.361	5.519	.019	2.333
Years in agriculture	.005	.009	.234	.629	1.005
Gender of household head	-.391	.325	1.448	.229	.677
Household head education level	-.092	.037	6.351	.012	.912
Land area/laborer	-.002	.000	38.914	.000	.998
Dependency ratio	-4.155	.667	38.764	.000	.016
Number of plots	.086	.047	3.286	.070	1.090
Total land area	.0004	.000	12.233	.000	1.000
Assets	-.016	.006	6.173	.013	.984
Total number of nonagricultural income sources	-1.181	.137	74.498	.000	.307
Sale piggy weight	-.003	.001	11.325	.001	.997
Porker weight	-.005	.001	32.806	.000	.995
Poultry	-.004	.002	4.185	.041	.996
GVP/ha	-.004	.014	.087	.769	.996
Value of production tools	-.0001	.000	2.198	.138	1.000
Constant	3.777	.764	24.428	.000	43.669

are both positive and significant. However, the middle location variable coefficient is larger than the tail-end dummy indicating that the impact of location on poverty does not grow stronger from head to tail of the main canal. This is consistent with the data, especially for the Nam Duong irrigation system which presents an unclear pattern of poverty along the canal. The model indicates that being located at the middle of the main canal, ceteris paribus, increases a household's chance of being poor by a factor of 7.1, the same. Being located at the tail end of the main canal increases a household's chances of being poor by a factor of 2.3.

Two dummy variables for perception of irrigation service related to timeliness (IRRTIME) and sufficiency (WSUFF) of irrigation service are both negative, but not significant. The variable for the number of incidences of inundation for the last 5 years is positive as expected, but insignificant. The variable for the number of times experiencing drought over the last 5 years (DROUGHT) is an indicator of irrigation performance in which each reported incident is an occurrence where the irrigation system was unable to deliver water to a plot as needed. DROUGHT is positive and significant at the 5 percent significance level; thus the null hypothesis is rejected only for this variable. The model predicts that ceteris paribus, the odds of a household being classified as income-poor increases by a factor of 1.04 for each additional incidence of drought experienced.

Other factors are also important predictors of a household's poverty classification. The results of the income-poverty model show that the education level of the household head is significantly related to poverty, with increases in the education level reducing the chance of a household being in poverty.

Regarding household characteristics, the model indicates that agricultural land per agricultural laborer is significantly related to poverty. As the area per laborer is increased and, ceteris paribus, a household's chance of being classified as "in poverty" is reduced. A household's dependency ratio is also significantly related to poverty. As a household's dependency ratio rises, that is, as there are more laborers per family member, the household's chance of being classified as income poor is reduced. The model results show a strong reduction in the chance of being in poverty for increases in the dependency ratio.

Land, in terms of the number of plots, is related to a household's poverty classification. As the number of plots increases, so does the chance of a household being classified as in poverty. The results show that for each additional plot that a household possesses the chance of being classified as in poverty increases by a factor of 1.09. Additionally, the total land area is significant in positively predicting poverty. The Government of Vietnam has maintained a policy of trying to achieve equality in land distribution, so it is not entirely unexpected that this variable would have a positive relationship with poverty. Finally, a household's assets are strongly positively related to poverty.

The number of nonagricultural income sources is significantly related to poverty. For each additional nonagricultural income source, a household's chance of being classified as poor is reduced by a factor of 0.31. The production of livestock, especially pigs, is shown to be significantly related to poverty. As more livestock is produced for sale, the chances of a household being classified as poor are reduced.

Implications for the poor

The main cause of poverty of the poor is associated with a lack of basic production inputs. Compared to non-poor households, poor households have larger family sizes, but they have lower major important assets including education, land, total assets and capital, and irrigation and drainage quality. While the non-poor depend on both agricultural and nonagricultural sources for their living the poor families rely largely on agricultural income.

Irrigation can raise farm incomes by increasing the cultivable land area, enhancing crop choice, cropping intensity, land productivity. Main crop in irrigated area is rice; meanwhile main crop in rain-fed area is maize, cassava and potato. Land productivity in irrigated land is two times higher than that in rain-fed land.

In Nam Thach Han, the improvement of irrigation and drainage infrastructure, during 2000-2001, has greatly improved household status and prevent farmers falling back into poverty. The functioning of some major irrigation and flood control structures since 2001 makes the analysis of the impact of inundation and drought on rice yield and income as well as poverty rates unclear. A simulation shows that if there is not implemented new rubber dam at the headwork, An Tiem siphon and Viet Yen sluice for flood control and salt intrusion prevention and there happen a drought similar to 1998, there would be 13% of household falling back again under poverty line.

An aggregate regression analysis to examine the importance of various irrigation- performance factors on predicting poverty indicated that only the occurrence of a drought was a significant factor. Timeless of irrigation was only significant at the 13 percent level, but had a good impact on poverty. Again, the location variables were the most significant factors in determining poverty. This strongly indicates that poverty is a multi-faceted condition and a proper approach to fighting poverty must look at the many factors. Another highly significant factor is the number of nonagricultural income sources. This indicates that diversification of income generation will be an important component in the fight against poverty.

Chapter 8

Analysis of Water Management Institutions: Implications for the Poor

This chapter analyzes water-management institutions in Vietnam. The first part of the chapter examines national-level agencies and the legal framework for water management in Vietnam.[1] The second half of the chapter, using information from Nam Thach Han and Nam Duong irrigation systems, takes an in-depth look at institutional arrangements at the system level. Finally, the concluding portion of the chapter will assess the various implications for the poor.

Background

Vietnam's laws are drafted by the relevant Ministries, debated by the National Assembly and passed by a majority of its members. The ordinances are enacted by the National Assembly's Standing Committee. An ordinance most often represents the highest level of the legal texts governing a law's implementation but may also constitute a quasi-law flowing directly from the Constitution.

Resolutions are issued by the National Assembly, its Standing Committee, the Central Government and Provincial Councils. They present the legislative and administrative decisions of these bodies. Decrees, the highest-level bylaws, are issued by the ministerial bodies. The President, Prime Minister, Ministers and People's Committees provide guidelines for the application of laws and implementation of decrees within the ministries and by lower-level State authorities.

The policy, practice and legislative framework, which established responsibility for the management of water resources and the operation of IDMCs during recent years, includes the following;

The law on Water Resources of 20th May, 1998 provides a comprehensive foundation for the agencies managing the nation's water and irrigation sectors. The law regulates the management, protection, exploitation and use of the water resources; and the prevention, combat against, and overcoming, the harmful effect caused by water.

Decree No.179/1999/ND-CP of 30 Dec 1999 is a regulation for Implementing the Law on Water Resources. It outlines the responsibilities of MARD, Provinces and on-farm water user organizations and outlines the mandate and legal status of IDMCs. This decree defines management, measure for protection, exploitation and use of water resources.

The Land Law, issued in 1993, guarantees the right to use the land for a fixed period of time (20 years for annual crop, 50 years for perennial crop) and clarified the right of handover of land, inheritance and lease of land.

[6]Much of the material on national-level agencies and the legal framework is taken from Sector Study for Agriculture and Rural Development Sector in the Socialist Republic of Vietnam, Sanyu Consultants Inc. for JBIC.

The Environmental Law, issued in 1993, provides broad guidelines for assigning responsibilities among ministries, provinces and communities, for conducting environmental impact assessments and carrying out inspection and enforcing standards. The law contains regulations, but they are vague and difficult to be implemented.

Decree 112-HDBT (1984) sets the framework for the Provinces to determine the water fee. A draft Ordinance presently under discussion is intended to align with the Law on Water Resources by consolidating the intent of Decree 112 with the Ordinance on Exploitation & Protection of Irrigation Systems, 31 Aug. 1994, and Decree 98/CP, on the Use and Maintenance of Irrigation System, 27 Dec. 1995.

Circular 860-CT/VN, Guidelines for Restructuring IDMCs, 7 May 1992 provided management guidance for the IDMCs to: (1) manage the canal network, based on the irrigation systems boundaries and not on geographic administrative boundaries; (2) contract directly with water user households or water user Cooperatives; and (3) collect water fees directly from them. This Circular has initiated a departure from local-level irrigation management from one that is based on the commune's administrative boundaries to an alternative hydraulic organization of farmers for local-level water management. The subsequent affirmations, which set out the directions and legal basis of the policy on O&M transfer, are made explicitly in the following legal documents.

Ordinance on the exploitation and protection of irrigation systems, 31 Aug. 1994 empowers the IDMC to recommend the organization of a System Steering Board in order to mobilize water users to contribute labor to repair and maintain irrigation facilities according to the law's regulations.

Decree 73/CP defines the function, obligations, rights and organization of the Ministry of Agriculture and Rural Development (MARD) and the decision 40/1998 QD-BNN/VP, 2 March 1998 defines the working regulations of MARD. The Agriculture and Rural Development Sector involves the Department of International Cooperation, Department of Planning and Projection, Department of Capital Investment and Construction, Department of Water Resources Management and Irrigation Project, and the Department of Flood, Storms, Controlling and Dikes Management. The Department of Water Resources Management and Irrigation Project has responsibility for water resources development and management and the Department of Flood, Storms, Controlling and Dikes Management is responsible for flood control and the dike system.

Decree 98/CP, on the Use and Maintenance of Irrigation System, 27 Dec. 1995 to regulate the execution of the Ordinance on Exploitation and Protection of Irrigation Systems dated 31 August 1994. This Decree (Article 9) further elaborates the provisions on the obligation of the water users.

Circular 90/1997/TTLT-TC-NN of 19 Dec. 1997 is a joint policy agreed by the Ministers of MARD and Finance to facilitate financial autonomy of IDMCs. Circular 90/1997/TTLT-TC-NN of 19 Dec. 1997 is a joint policy agreed by the Ministers of MARD and Finance to facilitate the financial autonomy and management of IDMCs. It determines the arrangement and sources of income and expenditure and prescribes items on which expenditure can be made and income distributed by the IDMCs.

Circular 6/1998/TT-BNN-TCCB, Guideline on the organization and operation of IDMCs. The Circular was issued to guide the organization and operation of IDMCs in order to strengthen management and protection of the irrigation systems to serve production, society and people's life. The Circular provides the guiding principles that IDMCs follow in their organization and operation.

Decision 1959/BNN-QLN, issued by MARD on the Strengthening, Consolidating and Reforming organizations of irrigation management at lower levels to the level of the Chairman of People's Committee of Province.

System-Level Irrigation-Management Institutional Arrangements

So far, Vietnam has 75 large- and medium-scale irrigation systems with a total designated area of 2.2 million hectares. The O&M of these schemes are directly managed by the 172 Irrigation Management Companies (IDMC) or the Department of Agricultural and Rural Development (DARD) of the Provincial People's Committee in each province. Also, there are numerous small irrigation systems constructed by the farmers and managed by the communes with assistance from the Service of Agriculture and Rural Development (SARD) of the District People's Committee in every administrative district. The O&M of all small, medium and large-scale irrigation systems are generally under the central policy guidance of the Ministry of Agriculture and Rural Development.

The management of irrigation and drainage systems is traditionally divided into two levels. The system level is managed by state companies (IDMC). The farm level is managed by the Cooperative. For the management of an entire irrigation and drainage system, the traditional organizational structure is from the principal IDMC to the subsidiary IDMC to the O&M sections and finally to the communal Cooperatives.

Analysis of Irrigation and Drainage Management Companies and Cooperatives in Vietnam

Introduction

Water management institutions in Vietnam can be difficult to understand due to difficulties in translation, blurring of official and unofficial administrative boundaries, and overlaps or gaps between administrative and operational responsibilities. This difficulty is made more difficult due to the rapid pace of change in Vietnam. Reports documenting the structure of water management can quickly become outdated.

This analysis examines the general overall structure of irrigation management in Vietnam. However, the focus is on the Irrigation Management and Drainage Companies (IDMCs) and the Cooperatives, as these are the two most important irrigation management institutions in Vietnam. Traditionally, the IDMCs are responsible for system-wide management and the Cooperatives are responsible for on-farm water management. Other institutions are briefly examined where it is necessary to clarify the linkage (especially the variety of linkages) between the IDMC and the Cooperatives.

General Structure of Irrigation Management in Vietnam

The general structure of irrigation management can be divided into administrative and technical categories (see figure 8.1). The administrative institutions are formed at the central level and duplicated at the provincial, district and commune levels. The People's Committees are the top administrative bodies for a given administrative level. The commune is the lowest level at which an official administrative division is made. However, below the commune is the village which is led by a village head and then the hamlet, led by the hamlet head. The village is an extremely important component of rural life and agricultural production.[5]

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[5] The village is an important social organization, despite the fact that there is no official village representation in the government system. The village in Vietnam has a long history of Cooperation based on realized interdependencies for dyke construction and irrigation and drainage needs (Tuan et al. 1996). Due to mutual needs and a tradition of mutual help, the villages are the basic rural units. A basic task of the village members has been to perform water management.

The technical component related to irrigation management can be subdivided into the planning and management institutions and the O&M institutions. The technical planning and management institutions are led by the Ministries. The Ministry of Agriculture and Rural Development (MARD) is the ministry responsible for the management of irrigation and drainage services and infrastructure. Under MARD are the Provincial Agricultural and Rural Development Services (PARDS) and the District Agricultural and Rural Development Services (DARDS). These institutions are established at the administrative level.

The O&M institutions are established at the system level, but within the corresponding administrative level. The traditional system-level management institution is the IDMC. While the most common portrayal is to link the IDMC with the PARDS and the Irrigation Station with DARDS, these linkages are not always true. Each irrigation system is unique and should be analyzed separately to determine its specific institutional structure. For example, if an irrigation system covers several districts, then the highest irrigation O&M institution is established at the Provincial level with further subdivisions in the management structure made at the appropriate level. The specific organization, roles, and functions of the various irrigation institutions for the Nam Duong and Nam Thach Han irrigation systems are described in detail in this chapter and in chapter 10.

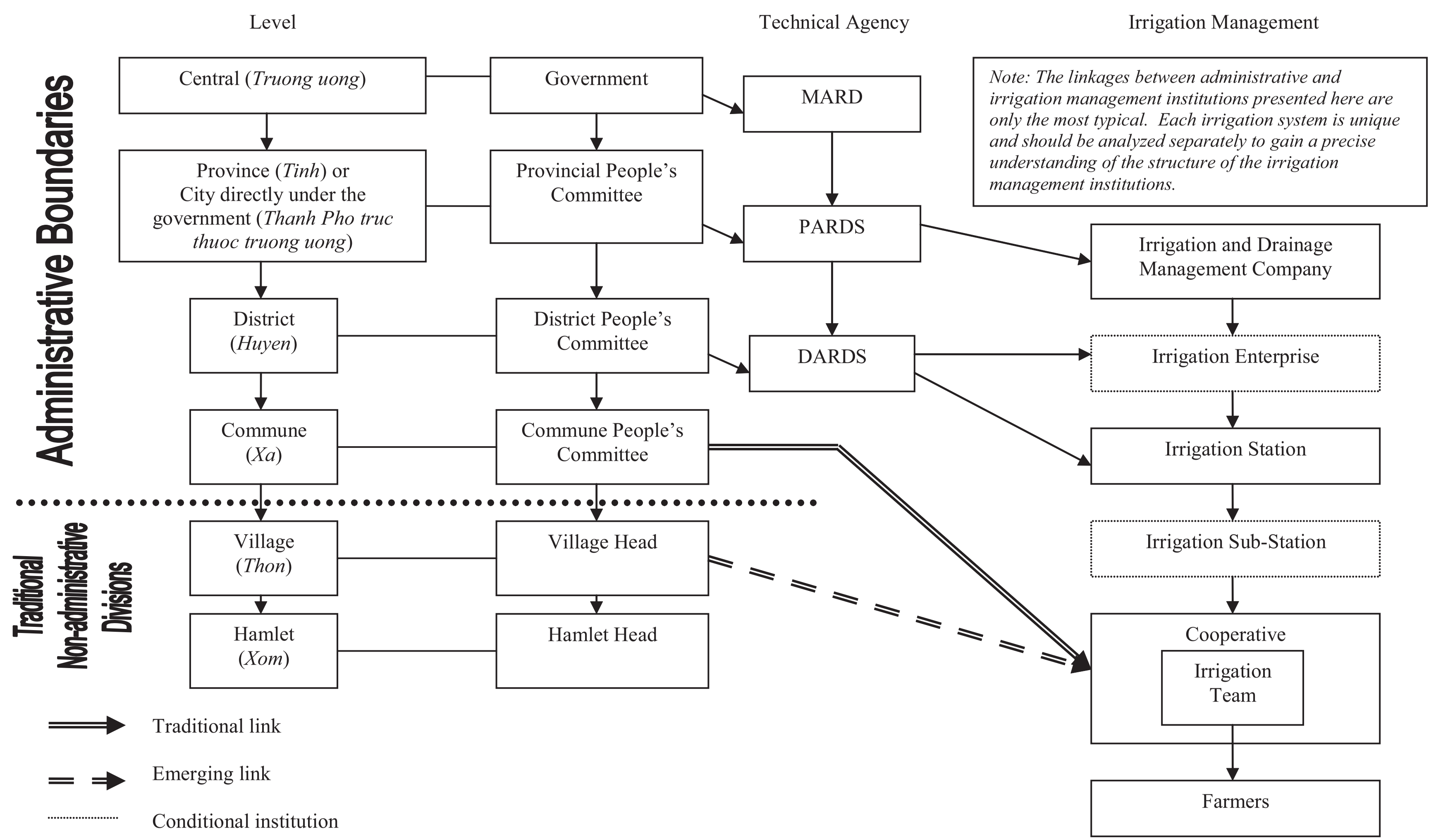
In general, irrigation management at the system level is the responsibility of the Irrigation and Drainage Management Company. Management of irrigation at the farm level is typically done by the Cooperative. These two institutions have undergone a series of changes over time as well as possessing a significant degree of variability between themselves. It is important to have a broad understanding of these organizations in order to fully understand their current ability to function and their potential as irrigation-management institutions. This section will offer an assessment of how well these institutions are functioning, what their strengths and weaknesses are, and what their implications for the poor are.

Irrigation and Drainage Management Company (IDMC)

The primary institution involved in the O&M of irrigation systems is the Irrigation and Drainage Management Company (IDMC). They were first established in 1970 under Government Circular 13-Tl/TT as a way to improve irrigation services. The IDMC is typically established at the Provincial Level within the Provincial Agricultural and Rural Development Services (PARDS). However, IDMCs can be established at the District level if an entire system falls within a district (Tiep 1998). The IDMC is supervised by the relevant People's Committee acting through the PARDS or DARDS under which the IDMC was established.

The responsibilities of the IDMC can include the provision of irrigation water, construction, planning and management of the O&M of the system, management of the system's finances, collection of irrigation fees, and support for Irrigation Enterprises at the district level (van den Oever 1994; Ehera 1998; Biltonen et al. Forthcoming). The IDMC manages the main irrigation system infrastructure that has been constructed by the government, distributes the water through its network of Irrigation Enterprises and Station down to the 150-hectare level (World Bank et al. 1996). Currently, there is no water licensing mechanism established in Vietnam, although licensing is called for in the Law on Water Resources. Water withdrawal allocations are based on the irrigation system's designed capacity and approved by MARD and the Provincial People's Committee. However, there is no monitoring mechanism for the water withdrawals the IDMC makes from the water source. The IDMC does not make any payment for the water it takes. The IDMC is typically responsible for the main canal and the principal infrastructure; however, it may take on responsibility

Figure 8.1 The general structure of irrigation management in Vietnam.



down to the secondary canals. The IDMC may coordinate with the Commune People's Committees to assess important issues, such as system protection, flood mitigation, and identification of damaged canals (Biltonen et al. Forthcoming). The main point of interaction between the IDMC and the farmers is normally through the Irrigation Station (Ehera 1998).

The IDMCs are established under the law as state-owned enterprises (Ehera 1998). The setup of the IDMC is described as being a mix of private company and government agency (Biltonen et al. Forthcoming). This setup causes serious weaknesses in the IDMC where they lack the power of a pure government agency, especially in terms of policy enforcement. They also lack the tools of a private company, such as exclusion of services due to nonpayment. This causes the IDMC to rely on "soft" policy approaches.

Under Decree No. 388 (November 20, 1991), the IDMC is supposed to be financially self-sufficient. However, due to the situation of fee establishment and collection, very few IDMCs are financially self-sufficient.[6] Water fees may be set by the Provincial People's Committee or the IDMC in consultation with the Cooperatives. Collected water fees are the main revenue source for the IDMC. In cases of natural disaster that seriously diminish yields or destroy crops, the fee may be waived. Subsidies are received from the Provincial Peoples' Committee.

For water delivery, the IDMC devises its seasonal plan, based on intended irrigated area (from Cooperatives), cropping pattern and planting calendar (from PARDS), and availability of water. This information comes in the form of requests from Cooperatives. In general, this plan does not vary significantly from year to year. The plan for water delivery serves as the basis for the IDMC's budget, which is submitted to the Provincial authorities for approval. Due to poor enforcement abilities, the water delivery plan is rarely well executed.

Irrigation Enterprise

Irrigation Enterprises were established in 1984 at the district level. The Irrigation enterprises are normally seen as below the IDMC (normally at the district level); however, in many cases they are not subordinate to the IDMC. Many Irrigation Enterprises are subordinate to the IDMC, for example in the Nam Duong irrigation system where the Irrigation Enterprises are completely dependent on the mother IDMC for technical input, funding and administration. Instead the Irrigation Enterprises maintains a technical partnership with the IDMC. It is the District People's Committee that actually makes decisions on the operation plans of the Enterprises. Their responsibilities are to manage irrigation and drainage infrastructure, such as pumping stations, at the main and secondary levels. They do not exist in all irrigation systems, but are conditional upon need. For example, in the Nam Duong irrigation system there are Irrigation Enterprises because large pumps are required to operate the system. However, in the Nam Thach Han irrigation system, which is largely gravity flow, no Irrigation Enterprises exist. They are supposed to be financially self-sufficient based on collected irrigation fees. However, this condition is rarely met. Existence of the Irrigation Enterprises may hinder the IDMC's ability to form a relationship with the farm-level water users (Chinh 2002).

[6] The Provincial People's Committee sets the water fees using guidelines from the national government.

Irrigation Stations

The Irrigation Stations are located under the IDMC. If an Irrigation Enterprise exists, the Irrigation Station is beneath the Enterprise as well. The Irrigation Station may be established at either the district level at the canal level, as in Nam Thach Han. The Irrigation Stations possess the technical staff that communicates directly with the communes regarding irrigation. Before each cropping season, farmers submit their irrigation plans to the Irrigation Station, which compiles a report to be filed with the IDMC (or through the Irrigation Enterprise if one exists).

The Irrigation Station holds the responsibility for delivering water to the Cooperatives. This arrangement is made by negotiated contract. The chief of the Irrigation Station makes contracts on behalf of the IDMC and also holds responsibility for collecting the agreed fees.

Cooperatives

The Cooperatives are the organizations through which farmers are represented and served. They are an important part of the irrigation management setting. Cooperatives have undergone significant changes since they were introduced. In general, the Cooperatives act as a service provider for farmers. Typical services include irrigation water, seed, fertilizer and extension. The typical arrangement has been for Cooperatives to be formed at the commune level; however, this pattern is now changing. This section first briefly examines the history of Cooperatives and then briefly describes their current status and direction.

Cooperatives were originally formed based on political ideology that called for collective production units. The formation of Cooperatives began in 1958 through a process of collectivizing labor and production means (Duc 2003). This process was completed in 2 years in North Vietnam. After 1975, the process of collectivization was carried out in the central and southern regions of Vietnam. Several critical problems quickly arose with the Cooperatives. The rapid pace of formation led to critical problems in their formulation; foremost are a lack of voluntary membership and an ineffective operational mode (Duc 2003). The ineffective operations were due largely to the lack of management capacity among the management who were often made up of poor and landless farmers, whereas in the south, farmers were strongly reluctant to cooperate with the collective system.

The government undertook several actions to improve the performance of agricultural production in the Cooperatives including increased use of labor and capital from the Cooperatives and increasing the level of State investment. Despite these increases in government spending and increased production in other areas, Cooperatives remained ineffective in agricultural production (Duc 2003).

The government began to expand the scale of Cooperatives. However, the experience was that larger Cooperatives experienced lower effectiveness on production (Duc 2003). In 1965, the government initiated the formation of hamlet-level agricultural Cooperatives. In 1970, the hamlet-level Cooperatives were consolidated into village- level Cooperatives, which were thought to better match the needs of irrigation and field construction (Tuan et al. 1996). The overall effect saw per capita food production decline from 305 kg in 1961-1965 to 253 kg in 1966-1975. By 1980, the average per capita food availability in the North had declined to 214 kg (Duc 2003). Nationally it was recognized that the Cooperative form of production as originally conceived would not be effective compared to other structures for economic production (Duc 2003). However, as Cooperative production was one of the primary underpinnings of socialist ideology, this system endured until the 1980s when the new *doi moi* policies saw the rapid privatization of agriculture.

The government responded with new legislation that allowed the farmer to control their own production. The two main instruments were Directive 100 and Resolution 10 issued by the government (also known as Contract 100 and Contract 10). Directive 100 was issued in order to get the farmers to realize surplus production in rice. Under Directive 100 issued in 1981, farmers would agree to produce a certain amount of rice in exchange for the services necessary to do so. Therefore, any surplus production could be kept by the farmers. Resolution 10, issued in 1988, aimed to help the agriculture-sector transition from a command economy to a market economy. Resolution 10 defined rural farm households as autonomous economic units. Thus, the principal economic unit in agriculture was shifted from the Cooperative to the household.

In 1996-1997, a new Cooperative law was passed which reestablished the commune- scale Cooperative. The modernized Cooperatives did not require compulsory membership by farmers. There are two general types of Cooperatives: Farmer Cooperatives and Service Cooperatives (Biltonen et al. Forthcoming). Farmer Cooperatives comprised most of the farmers receiving a given service and tend to exist where water is scarce and off-farm employment is limited. Service Cooperatives exist where water is abundant and off-farm employment is greater. These Cooperatives comprised only 10 to 50 persons responsible for the service provision. The Farmer Cooperative has a broader representation of the community.

In general, Cooperatives are the main local-level organizations related to agricultural production. Cooperatives can undertake a variety of activities including procurement and distribution of inputs (e.g., seeds and fertilizer), organization of marketing activities, and management of irrigation services. They are most often related to the commune administrative level, but this does not always hold. They also often hold the responsibility for collecting taxes from farmers falling within their area of responsibility. These broad characterizations do not hold uniformly across Vietnam.

The primary service provided by cooperatives is irrigation with 93 percent of the Cooperative providing this service (Tiep 2001). The Cooperatives are the main link between farmers and the IDMC. The Cooperative makes a contract with the IDMC to obtain a supply of water from the main canal (including delivery to some fields), while the Cooperative is responsible for the delivery to the remaining fields (Chinh 2002). The Cooperatives retain a portion of fees collected for the IDMC.

Cooperatives currently suffer from several problems. They tend to be ineffective in providing services as designed. These include extension services to farmers as well as irrigation services. The financial arrangements lack a sustainable arrangement. Members do not contribute fees in adequate amounts. Moreover, fees collected are not necessarily put back into the O&M of the service for which they were collected. In some cases, Cooperatives fail to make contracts with the IDMC, while at the same time failing to prevent water stealing by Cooperative members (Chinh 2002).

In some cases, the Cooperative does not want to make a contract with the IDMC as they wish to retain control of distributing water to the fields, while the IDMC only conveys water to the main canal (Chinh 2002). This is because the Cooperative believes it is entitled to a portion of the collected fees and attempts to protect its position as a secondary service provider. Additionally, some Cooperatives will not reveal the actual land area irrigated to the IDMC in order to reduce the amount of water fees paid to the IDMC (Chinh 2002).

The effect of the recent changes has diminished the role of the Cooperative. The Cooperative has become a strictly service organization. In some cases, where strong leadership prevailed the Cooperative maintained a degree of influence in the village affairs (Tuan et al. 1996). Cooperatives were largely able to maintain their importance where service required a scale beyond the household level, such as irrigation. Currently, the Cooperative's water management role is to deliver water from the turnout of secondary canals to the last-level permanent canals (Tuan et al. 1996).

There have been two implications for water management due to the change in the role of the Cooperatives: 1) more effective Cooperative-led management of irrigation at the farm level, and 2) weak Cooperative action leading to poor farmer-led management of irrigation (Tuan et al. 1996). Where Cooperative leadership was strong and water supplies were ample, the Cooperative was able to hold on to its water management duties. This had the benefit of maintaining a standard of service and behavior. This also facilitates the mobilization of farmers when labor inputs are needed to maintain the canals. A strong Cooperative can aid in the mobilization of resources within a village to overcome shortcomings in the existing irrigation service. Finally, collection of fees for irrigation service serves as a major source of income for the Cooperatives.

Alternatively, where Cooperative leadership was weaker and irrigation supplies uneven, the Cooperative lost its role in irrigation management. Farmers acting only in their own interest damage the canals without concern for the system's functioning. Moreover, farmers do not contribute much in the way of labor for rehabilitation and maintenance. Due to the haphazard application of irrigation water, great inefficiencies in use exist and inequitable distribution persists.

Strengths and Weakness of IDMCs and Cooperatives

This analysis has reviewed the institutional-management structure for irrigation in Vietnam. Specific focus has been placed on the institutions of the IDMC and the agricultural Cooperatives. Typically, the IDMC provides irrigation water from the main canal to the Cooperative. The Cooperative is the service provider of irrigation water to the farmers. There are both strengths and weaknesses in the current structure that are reviewed here.

IDMC

Strengths

- Management of the whole irrigation system for bulk deliveries to commune level facilitates more effective management by not taking responsibility for micromanagement needs below the commune level.
- The water-delivery schedule is based on actual projected needs.
- The water-delivery schedule can be adjusted due to climatic changes (e.g., rain).
- High collection rates for irrigation fees (85–95%) in study areas.
- The water-delivery schedule can be flexible depending on cropping patterns.
- In cases of severe drought, the IDMC will waive irrigation fees to protect the livelihoods of the affected farmers.
- The water-delivery schedule often favors disadvantaged areas such as high-elevation or tail-end areas (at least in theory).

Weaknesses

- Public company as a state-owned enterprise. Lacks authority to apply strict enforcement measures and lacks autonomy to apply strict market measures. IDMC must rely on soft policy approaches to foster compliance.
- Enterprise management is often at the administrative boundary rather than at the hydrologic boundary.
- Water-delivery schedule is not responsive to changes in demand and is, often, not adequately fulfilled.
- Water-delivery schedule is a general plan, but it is not binding or is not strictly enforced (especially timeliness aspect).
- May not have direct link to farmers hindering effective management as the Cooperative must protect their economic and political position.
- Little control against illegal withdrawal and unauthorized structural modifications made by people illegally taking water.
- Irrigation fees insufficient to cover costs.
- Electricity costs are a substantial portion of annual expenses and payment is due in a time not consistent with the collection of irrigation fees (and harvesting).
- Often, a lack of water-storage infrastructure prevents the IDMC from responding adequately to changing demands.
- Relies on government subsidies to fully meet expenditure requirements.
- Water fee is set by the Provincial Government and not by the IDMC. This creates a gap between the actual fee and the actual costs of providing irrigation service.
- Extension services are poorly implemented despite widely recognized need for diversified crops and utilization of more modern technologies.
- Lack of compliance with IDMC's management practices where good communication with on-farm water managers does not exist.
- Often, the IDMC responsibility does not extend to the Cooperative leaving a large portion of the secondary canal in a sort of "no man's land" with the result that no one is in charge of O&M in this area. A possible solution is for the IDMC to provide support and enlist the Cooperative to better manage these sections. This is caused by insufficient resources, both human and financial.

Cooperatives

Strengths

- Tradition of providing service to farmers at the local level.
- If effective, Cooperatives provide an institution that can maintain control, so that irrigation does not become an open access resources at the local level.
- Have power to make contracts with the IDMC.
- In Nam Thach Han, Cooperatives are at the village level, which strengthens farmer involvement.
- In Nam Thach Han, the fee is set during the annual meeting between the Cooperatives and the IDMC, based on actual expenditures.
- In some areas, a self-monitoring process has been developed to verify actual water use and prevent wasteful or illegal water practices.
- In Nam Thach Han, Cooperatives monitor each other to ensure compliance with scheduled water intake times.
- Arrangement during times of drought that allows the Cooperative to take quick action in the interest of protecting farmers, but before official approval from the PARDS can be obtained.
- Water-management responsibilities are often divided at the village level, which is a strong traditional rural community unit.
- Some places, such as Tri Qua, possess clear guidelines to resolve conflicts, such as what type of land gets priority in water delivery.
- Irrigation team communicates directly with the farmers.

Weaknesses

- Government policy changed in the 1980s, removed their responsibilities as an organizer of production. They became strictly service providers.
- Irrigation fees go into the Cooperative's general funds and may not be put back into irrigation services.
- Cooperatives tend to be formed at the commune level even though they cannot provide services efficiently.
- Unclear regulations as to whether membership is voluntary and/or if a fee is required.
- In some areas, the Cooperative has been separated from the commune, which has lowered salaries and diminished the Cooperatives' role. This also makes it more difficult to mobilize farmers in helping with maintenance.

- Cooperatives' effectiveness is weakened where water supplies are unreliable or insufficient and there are limited off-farm income opportunities. These are, perhaps, the conditions where a Cooperative is most needed.
- Poor information-sharing regarding system management needs and impacts from improved or degraded irrigation performance.
- Financial arrangement lack sustainability.
- Secondary service provider of irrigation water provides an incentive to not cooperate with the IDMC.

In general, there are two main problems with the irrigation-management structure in Vietnam. The first problem is that the accountability structure is divided between administrative and irrigation-management institutions. Sub-institutions are accountable to the administrative unit they belong to and to the higher irrigation- management institutions. The IDMC, however, is responsible for the entire system management and is accountable to the Provincial People's Committee. This can create serious ambiguities as to how irrigation management is to be handled. This problem is exacerbated with commune-level agricultural Cooperatives. The Cooperatives must serve the interests of the commune and handle multiple services (with varying degrees of financial return). The financial arrangements are a further complication of this problem. Institutions lack proper incentives to pass along fees accurately to higher institutions. Moreover, some individual institutions may not hold irrigation fees for the provision and maintenance of irrigation services. A well-entrenched system of government subsidies prolongs this situation.

The second major problem facing irrigation management in Vietnam is the status of irrigation institutions. Irrigation institutions are state-owned for-profit establishments. However, they are bound by policy and regulation to provide a public good regardless of financial return. They are restricted in their abilities to administer government tools and to administer private-sector tools. These institutions lack autonomy both financially and administratively. They lack both incentives and ability to greatly improve their situation.

Implications for the Poor

The implications for the poor of the existing institutional setup are that conditions are unlikely to improve significantly. Knowledge of pro-poor management techniques is generally lacking among the irrigation staff. However, members of the irrigation staff are normally aware of poverty within their irrigation scheme. Capacity-building measures could be implemented to build awareness of the importance of good irrigation management in fighting poverty. Additionally, analysis would need to be conducted to determine an acceptable and appropriate level to which the IDMC and Cooperatives should act as social managers.

Cooperatives vary in their degree of farmer representation. It is not clear how successfully Cooperatives could incorporate representation for the poor; especially since the Cooperatives are strictly service providers. Farmer-led irrigation management can be done when it is undertaken in a situation of Cooperation, coordination and communication. Alternatively, farmer-led irrigation can be quite detrimental when it is undertaken under the perspective that irrigation is an open-access resource. The current movement to create village-scale Cooperatives is perhaps a very successful endeavor as it can take advantage of traditional social ties to strengthen its activities.

Moreover, village-level managers are likely to have a better understanding of poverty in their area of responsibility.

A promising alternative solution is to focus on the formation of farmer organizations or water user groups. However, such a group would need to have legal status in order to be successful. Success of these groups requires the ability to negotiate contracts, open bank accounts, secure credit, etc., all of which require a legal status.

The IDMC has very little actual interaction with poor farmers. This situation is unlikely to change in the near future. This is probably appropriate as the IDMC is an irrigation-management institution and not a social institution. However, as good irrigation management and performance have been shown to be strongly linked to poverty alleviation, it is imperative that steps be taken to strengthen these institutions. These institutions should be given greater autonomy to run irrigation management, including the authority and resources to carry out effective management and enforcement of irrigation-management policy. Guidance and support can come from the central government regarding ways and means on managing irrigation for poverty alleviation.

Conclusion

There is much potential to develop the existing institutions into effective irrigation managers with the aim of poverty alleviation. There is a tremendous advantage to utilize existing institutions, as they are familiar and often traditional. The traditional foundations, particularly with the hamlet and village, can be extremely helpful in improving irrigation management. However, there is always the danger of existing institutions becoming overly bureaucratic, which may be the case in some of the existing irrigation-management institutions.

It should be pointed out that despite the many weaknesses and constraints discussed there are many examples of success and good management. Nam Thach Han has been highlighted in the overall study as an example where good management exists (despite poor system performance due to extreme seasonal variations in rainfall and river flow, as well as a lack of adequate storage capacity). This is because the local arrangements have fostered a condition of understanding and communication between the farmers and the irrigation managers. Whether these conditions can be implemented in other areas of Vietnam is a topic for a future study.

The background of this chapter has provided the main institutional framework in water-resources management. This part, using field survey data from Nam Duong and Nam Thach Han irrigation systems, details the organizational structure of an irrigation system.

Nam Duong Irrigation System: Organizational structure

The Nam Duong Irrigation and Drainage Management Company employs 310 staff, of which there are 84 officials with university degrees. The management structure of the Nam Duong irrigation system is given in figure 8.2. The IDMC manages the main system through its five enterprises:

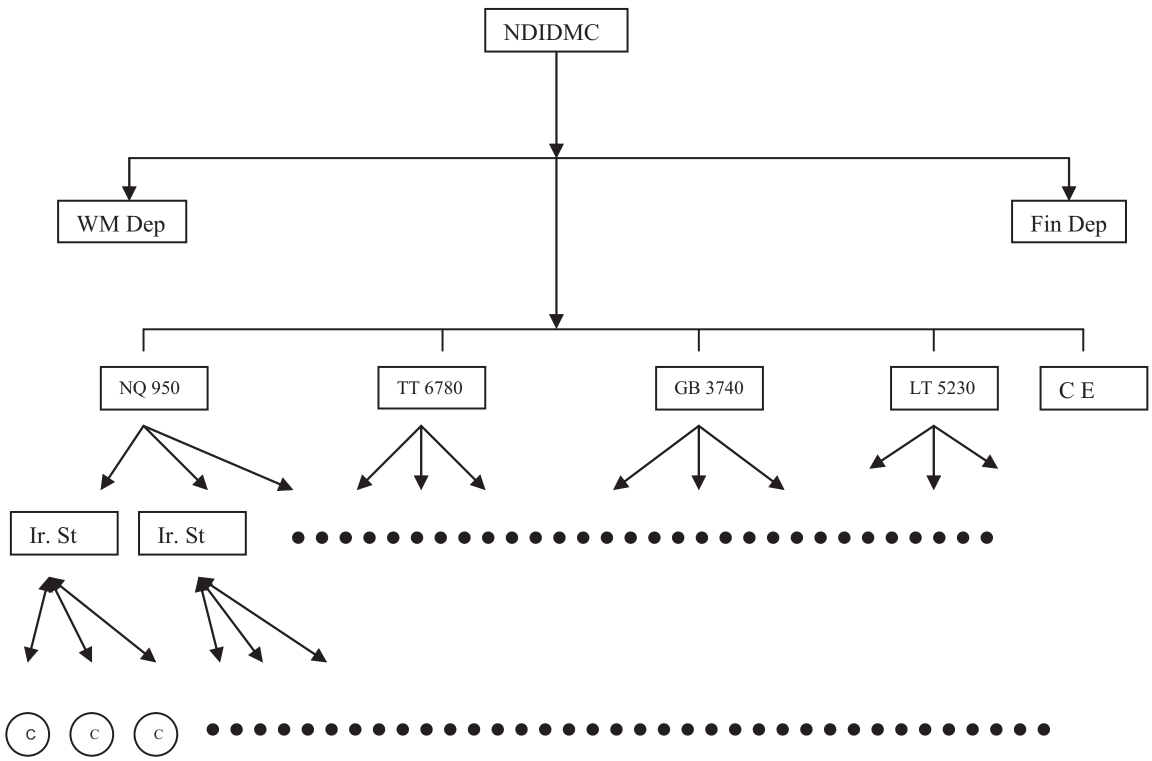
Nhu Quynh head work enterprise manages the Nhu Quynh pump, intake gates into secondary canals in Chung canal and operates, under instruction of the head office, the Keo regulator.

Thuan Thanh enterprise manages canal sections within Thuan Thanh District and provides irrigation and drainage services to Thuan Thanh and My Van Districts. Its function consists of managing intakes into secondary canals, pumps located within Thuan Thanh District and operating regulators following instructions from the head office.

Giabinh enterprise manages canal sections and facilities located within the boundary of the Gia Binh District. The enterprise provides water services to the Cooperatives of the Gia Binh District.

Luong Tai enterprise is managing the main facilities within the Luong Tai District.C*onstruction enterprise* is in charge of construction work.

Figure 8.2. Management structure of the Nam Duong irrigation system.



Note: WM Dep: Water Management Department; Fin Dep: Financial Department NQ 950: Nhu Quynh Enterprise, 950 hectares; TT: Thuan Thanh Enterprise; GB: Gia Binh Enterprise; LT: Luong Tai Enterprise; C E: Construction Enterprise. Ir. St: Irrigation Station; c: Cooperative. One-end arrow: Instructive relation. Two-end arrow: Contract relation.

Source: Developed from results obtained in consultation with the Nam Duong IDMC and PRA in survey communes.

Water distribution: Irrigation blocks and water delivery

Water distribution is rotationally practiced among sub-blocks or independently delivered within an irrigation block. Block 1 takes water from the Nhu Quynh pumping station and is supplemented by a number of small-scale pumps. Block 1 is divided into three subblocks, Chung, Bac and Nam the command areas of which are 1,070, 2,410 and 2,680, respectively, for rotational water supply. The rotation for this block is generally divided into two water turns for North (Bac) and Center (Giua) canal sections. The main section (Chung) is allowed to have water at the same time with both North and Center sections. However, water intakes from the Chung canal are put under the IDMC head office control in case the water level at Keo is lower than 5.35 m.

Block 2 takes water from the Mon Quang pumping station, supplemented by Xuan Lai and Nhan Thang pumps. Block 2 is further divided into three subblocks with a total command area

2,850 hectares. Block 3 gets water from the Kenh Vang 1 pumping station and is divided into two subblocks with a command area of 1,640 hectares. Block 4 gets water from the Ngoc Quan pumping station. Block 4 serves 3,140 hectares and is divided into 3 subblocks. Block 5 takes water from the Van Duong pump and supplies water to 480 hectares. Block 6, 7 and 8 are command areas of Ap Dua, Minh Tan and Song Giang pumps.

Water delivery for land preparation and rice-transplantation period

The IDMC considers crop varieties, the calendar and water-resources availability to prepare water delivery for the season. Water rotation is applied between the Bac and Giua canals. Each water turn lasts a week (table 8.1). The water-delivery calendar does not change significantly from year to year and serves as the plan for water delivery. The water schedule is a general plan that the IDMC attempts to fulfill, but not according to any strict rule, especially where the time dimension is considered.

Table 8.1. Water-delivery schedule for land preparation (year 2001).

Pumping station	Water turn	Water source	Canal section	Control water level (m)	Accumulated area irrigated (ha)
Nhuquynh	1	Nhuquynh, Nghiadao	Giua canal	Nhuquynh 5.7, Keo 5.35	1,400
	2	Nhuquynh, Monquang, Xuanlai	Bac canal	Nhuquynh 5.7, Keo 5.4, Ho 4.45, Huongvinh 3.5, Thaibao 2.6	1,600
	3	Nhuquynh, Nghiadao, Nguyetduc	Giua canal	Nhuquynh 5.7, Keo 5.35	4,000
canal (5,300)	4	Nhuquynh, Monquang,	Tail-end of Bac canal Xuanlai	Nhuquynh 5.7, Keo 5.35, Ho	All command area of Bac 4.5 Huongvinh 3.6, Thaibao 2.8
	5	Bac and Nam canal			For area with no water as yet, priority is given to a larger area
Kenhvang, Ngocquan, Vanduong Songiang, Minhtan, Apdua		Pump's independent command area			6,000

Note: The water level at the regulators is an important indicator of water delivery. Irrigation blocks show that in reality the system is already divided into many subsystems with its managing enterprises.

Water delivery for the rice-growing period

Water delivery for the rice-growing period is simultaneous and intermittent. A schedule for the growing period is prepared based on a no-rain case. Each water delivery lasts a week followed by a week of no water delivery. In case of rainfall of more than 40 mm, water delivery for that period is canceled.

A field survey showed that the Nhu Quynh pump delivers water up to the Ngam Luong regulator in the Bac canal and to the Tuyen Ba regulator in the Giua canal. Mon Quang supplies water for an area from Ngam Luong to Dinh Dong. Xuan Lai irrigates an area from Dinh Dong to Thai Bao. The downstream part of the Bac canal gets water from the Kenh Vang pump. Ngoc Quan provides water to its command area from Tuyen Ba to Van Duong. Van Duong supplies water to the tail-end area of the Giua canal. Other independent pumps, Song Giang, Minh Tan, and Ap Dua irrigate their command areas.

The water-delivery schedule is used as a production plan, upon which the IMDC makes a financial plan for the approval of the provincial authority. It is also used as a guide for water delivery. There is no other written water-delivery schedule. The enterprise has limited linkage in water delivery with the mother company.

Despite the fact that the IDMCs and their enterprises set up a water-delivery schedule, it is rarely well operated. Upstream village farmers take water first to satisfy their need before water flows downstream. To cope with this situation many pumps are used in the downstream to supply return flow water for the downstream area. To have a sufficient water supply, people lowered and widened intakes from the main canal into the secondary canal and, as compared to designed, 40 percent of secondary canals were additionally developed. This situation causes water levels in the main canal to be much lower than what is required (table 8.2). The IMDC is unable to control intakes from the main canal to the secondary canals. Their main function is managing the headwork and regulators in the main canal

Table 8.2 Water level in the main canal (m).

	Keo	Quan Tranh	Nghia Dao	Hung Vinh	Van Ty
Designed	5.35	4.79	4.2	3.88	2.88
Actual	5.35	4.2	3.5	3.0	2.2

Note: System hydraulic complication is beyond management capability. To improve performance, system physical structure must be improved to an easy hydraulic regime, thus matching management capability with hydrology.

Financing and Water Fees

The Nam Duong IDMC, where pump irrigation and drainage mode predominate, based on average yield of the previous 5 years, sets the water fee at 209 kg of rice/ha for spring rice for full irrigation, 181 kg/ha for partial irrigation, 195 kg of rice/ha for summer rice for full irrigation, 146 kg/ha for partial irrigation, and 80–90 kg of rice/ha for upland crop (table 8.3). The success rate of fee collection is 85–95 percent.

The annual income of the Nam Duong IDMC comes mainly from the collection of the water fee, which is approximately VND7 billion. The State Government subsidizes the IDMC with approximately VND2 billion. Annual expenditures are VND11 billion. The Nam Duong IDMC is short of VND2 billion every year, mainly indebted to the electricity company. Of the total expenditures, 60 percent is spent on staff salary and repairs and 40 percent on electricity. The highest

Table 8.3. Water fee of IDMC.

Water-service level	Spring (kg/ha)		Summer(kg/ha)	
	Rice	Upland crop	Rice	Upland crop
Gravity irrigation	209	80.5	195	90
Partial gravity irrigation	181		146	
Non-gravity irrigation	146		139	

Note: The water fee rate seems too low compared to many other irrigation systems in the Red river delta.

output for the whole system was VND10,848 million in 1996 and the lowest VND5,439 million in 1994 (table 8.4).

Table 8.4. Financial balance for the last 5 years of the Nam Duong irrigation system (VND million).

No.	Items	1994	1995	1996	1997	1998
I	Expenditure	7,053.7	7,780	10,639	11,896	11,703.5
1	Salary and allowance	829.4	780.9	1,037.2	1,112.6	1,508.7
2	Other payments enclosed with salary: social insurance, health insurance etc.	129.2	128.5	166.0	181.0	206.0
3	Asset amortization following Decision No. 1062	1,131	1,017.3	1,744.5	3,167.4	1,538.7
4	Fixed asset repairs	366.6	1,170	1,094.3	1,369	2,167.0
5	Material and fuel for maintenance					
6	Electric costs	3,437	3,372	4,664	3,818	4,446.8
7	Water-sources fee	400.0	400	647	600	600.0
8	Administrative costs	357.7	446.8	655	1,091.5	438.0
9	Drought and flood prevention					
10	Contribution to flood- protection fund					
11	Education, research					
12	Protection of equipment and labor safety					
13	Allowance for water-fee collection	268.8	357.6	443.9	377.9	418.4
14	Others	134.0	88.9	187.1	178.6	380.3
II	Revenue	5,439.4	7,824.2	10,848.5	7,904.5	8,538.4
1	Water fee	4,480	6,260.6	7,399.7	6,531.8	6,973.4
2	Others	959.4	1,563.6	3,448.8	1,372.7	1,565

On-farm level

On-farm water-irrigation management is charged by the Cooperative with its water management team and local village communities. More details on on-farm management in Nam Duong are presented in chapter 10.

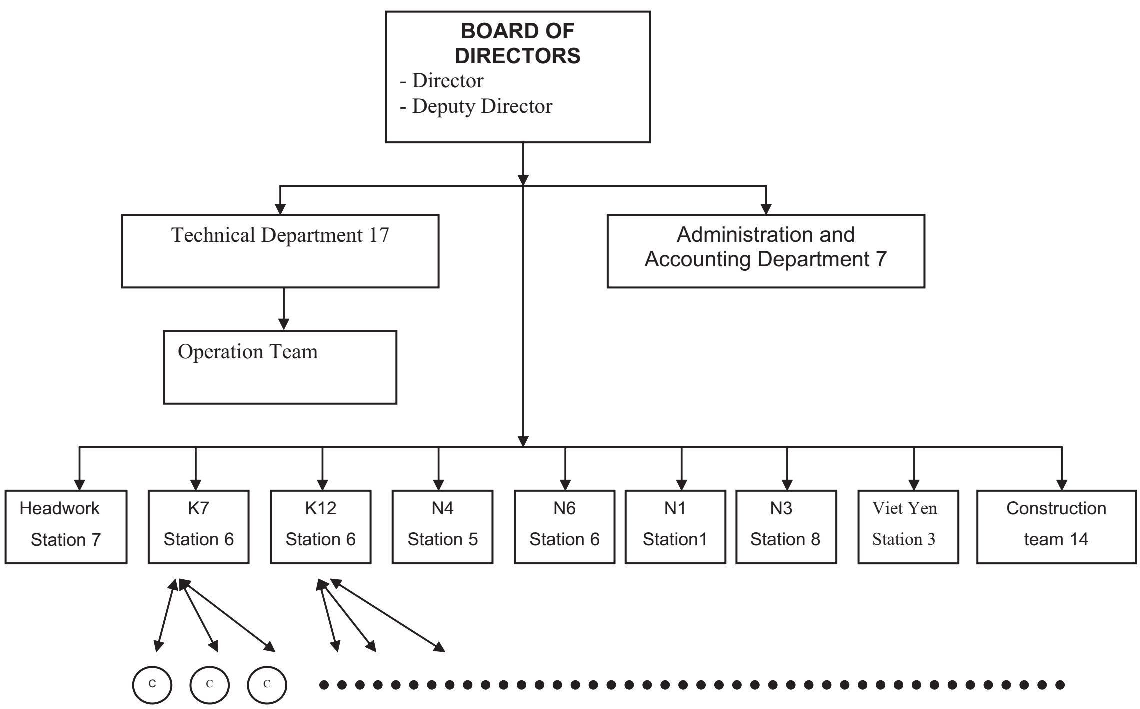
Nam Thach Han System Irrigation Organizational Structure

The Nam Thach Han Irrigation and Drainage Management Company employs 100 staff. A diagram of the management structure at the system level is given in figure 8.3. At headquarters, there is a Board of Directors with its technical and administration department which oversees all IDMC activities. The department is in charge of designing and regulating water in the main canal, managing water, regulators and intakes into secondary canals and maintaining the main canal from 6 km to 7 km.

For O&M of the irrigation network, the IDMC divides the irrigation system into sections. The management task is assigned among stations and the team under the overall supervision of the IDMC. The operational team operates regulators in the main canal and intakes in the secondary canal. The headwork station manages the headwork, 6 km of conveyance canal, and operates intakes in this canal section. K7 station, located km 7 from the headwork manages the main canal section from km 8 to km 10 and N2a and N2b canals. K12 station manages the main canal from km 10 to km 17. N4 station manages the N4 secondary canal and N6 station manages the N6 secondary canal. N3 station manages the N3 secondary canal and the Phuoc Le pump. N1 station manages the N1 secondary canal and the Quang Dien, Hien Luong, Gio Lo pumps.

On-farm water management is managed by water users themselves. There are 115 Cooperatives which have signed irrigation and drainage contracts with the Nam Thach Han IDMC. With village communities they manage on-farm-level irrigation and drainage network.

Figure 8.3. Structure of the Nam Thach Han IDMC.



Source: Consultation with the Nam Thach Han IDMC and communes.

Water Distribution

When there is an abundance of water continuous water delivery is practiced. During the water-shortage period, depending on the degree of water scarcity, rotational water supply is applied for the main canal only or both the main canal and the secondary canals. Chapter 10 gives more detailed information on water distribution

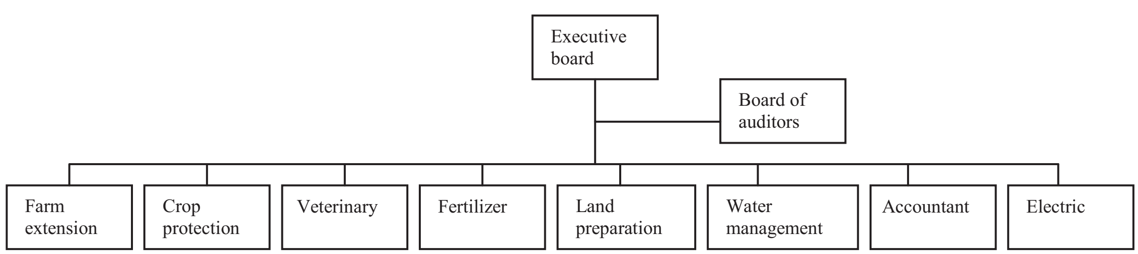
Financing

Similar to the Nam Duong irrigation system, the main income source of Nam Thach Han comes from the water fee. The water fee is set by the Quang Tri Province People's Committee, at 290 kg of rice equivalent per hectare per season for full irrigation and 90 kg for partial irrigation. The fee collection rate is 99 percent. The total annual income is approximately VND4.5 billion. The expenditure, where capital repair occupies 30 percent, minor repair 15–20 percent, administration and salary 30 percent, Research and Development 5 percent, fee collection 5 percent, and provincial fund for irrigation development 10 percent, is balanced to the income. In Quang Tri, a provincial fund for irrigation development, where the gravity irrigation system is required to submit some fund from its income, is established to support pump irrigation.

8.2.2. On-farm level

Most Cooperatives in Nam Thach Han are at the village level. The Nai Cuu Cooperative is analyzed to show Cooperative and on-farm water-management institutions The structure of the Cooperative is given in figure 8.4.

Figure 8.4. Structure of the Cooperative.



This Cooperative has a land area of 259 hectares, of which agricultural land accounts for 180 hectares. The agricultural land is divided as riceland of 113 hectares, subsistent crops of 17 hectares and garden plots of 50 hectares. There are 670 households with 2,794 persons. Of these, 635 households participate in the Cooperative. All family members of labor age join the Cooperative. There are 1,762 members in the Cooperative. The structure of the Cooperative is similar to that of Dong Bao. In 2001, the total Cooperative income of VND592 million was as follows: water-management service, VND131 million; electricity, VND112 million; canal lining (60% of the funding is from the government) VND157 million; material supply, VND105 million; crop protection and farm extension, VND21 million; communal land VND63 million; and other services VND3 million.

The executive board and the board of auditors are selected at the Cooperative meeting. There are four production clusters headed by four leaders. Each cluster has seven production teams, formed upon a resident cluster, headed by a team leader. There are 27 field blocks in the Cooperative land.

The electric service team has three staff members. For land preparation, there are no staff members. The executive board signs a contract for land preparation with contractors. The production clusters collect payment from Cooperative members, and together with the executive board oversee, manage and make payments to the service providers.

The farm extension and veterinary service employ three staff members who are paid by the government and they receive some payment from the Cooperative at the time of mobilization. For field protection, one person is employed. There is no regular staff for material and fertilizer services. Instead, the executive board carries out this service.

The water-management team comprises eight staff members. A common consensus is that if the farmers themselves are taking water into their fields, then a conflict over water distribution will arise. The farmers are fined by the Cooperative if it is discovered that they themselves are conveying water into their field plots. The farmers will inform the Cooperative when their field plots are suffering from water shortage for the Cooperative to convey water into their field plots. Water-service members are fined if it is discovered (by farmers who report to the Cooperative or Cooperative patrol) that a farmer's field plot is suffering from water shortage.

At the beginning of each year, the Nam Thach Han IDMC organizes a meeting of water-using clients at its headquarters or at their field station. The head of the Cooperative signs a contract with the Nam Thach Han IDMC for irrigation services. The actual irrigated area is checked at the end of each cropping season by both the Cooperative and the IDMC staff.

The field station assigns each of its staff several Cooperatives. The staff goes to the Cooperative field to check the water supply status, which is reported to the field station for water-supply adjustment in case of oversupply or undersupply of water.

The on-farm irrigation network has two water-supply sources from Nam Thach Han. One is from N1 and the other is from the K12 field station. Branched off from these tertiary canals there are quaternary canals supplying water to field blocks. The Cooperative has a pumping station and several mobile pumps. These pumps have return flow into drainage courses but they are operated during water shortages.

The irrigation team comprises eight members headed by a leader. There are two water-supply channels from the Nam Thach Han canal. One is from section N1 and the other from section N12 (see table 8.5). Payment for on-farm water management is based on the size and complexity of each field area. Generally, the payment is 6 kg of rice/40 m for canal cleaning and 16 kg of rice/ha for water conveyance.

The Cooperative assigns an irrigation service member to clean the canal at the beginning of each season and checks the cleaning before payment. In the middle of each season, the Cooperative rechecks the canal status; if the canal is not in a sufficiently good condition for the water supply, then the Cooperative requests the irrigation staff to clean and repair the relevant sections of the canal. If the volume of work involves more than 2 m^3 of soil, then the Cooperative will mobilize its members from each production cluster/team to implement the necessary repairs.

Water fee

The fee is set through the Cooperative meeting based on actual expenditure. In 2002, the water fee rate was 42 kg of rice/ha, of which 29 kg is paid to Nam Thach Han IDMC and the remaining 13

Table 8.5. Field area, production cluster, production team and irrigation.

Field area (ha)	15.3	11.7	10.9	14.5	12.6	18.9	22.7
Water source			Station N1				Station K12
Irrigation staffs (men)	1	1	1	2	1	1	1
Production team no.	I	II	III	IV	V	VI	VII
Production cluster no.	I		II		III		IV

is spent on on-farm water management services (water conveyance, canal cleaning, repairs, administration management and drought protection).

When there is a drought and the Nam Thach Han IDMC cannot supply water (insufficient water in the pond), the IDMC will go to the drought area to clarify the situation and then sign a memorandum (see box 2 for an example of the 1998 drought). The Cooperative operates its pumps to supply water. The IDMC then submits the memorandum to DARD that will then request the provincial authority to give financial support to the Cooperative. A distinguishing action is that the Cooperative operates the pump before DARD agrees to this action. Thus, the Nam Thach Han IDMC and DARD create an environment for quick and timely action. The Nam Thach Han IDMC exempts the Cooperative from paying water fees in case of a yield reduction of 30 percent.

Water delivery

For the irrigation-service staff, canal cleaning and water conveyance are assigned to staff of each production team that take responsibility for these activities within the production team area when there is sufficient water supply (i.e., continuous water supply). When a water shortage arises, the executive board (there is a deputy head in charge of water management) will directly manage the water-management team. Depending on the situation, there may be several persons or even all seven persons carrying out water delivery for an area.

Water delivery depends on the water supply from the Nan Thach Han canal. Continuous water supply is practiced when there is a continuous water supply in the Nam Thach Han canal. Rotational water delivery is carried out when Nam Thach Han rotationally supplies water. If it is judged that there will be sufficient water for Cooperative field the Cooperative will practice a high-elevation and tail-end area as a first rule. If water is not deemed to be sufficient then low-elevation and head areas will receive water first (the objective of this policy is to get as much water as possible not only for irrigation but also to store it in the Cooperative's low areas and ponds, drainage courses, etc.

New water and irrigation sector policies: Implications for the poor

Analysis of the macroeconomic growth rates (7% from 1990 to 2000) over the past 10 years tends to show that much of the growth is probably due to the reforms and it is unlikely that the rates can be maintained in the long term.

During the past period agriculture's share of the GDP reduced from 38.7 percent in 1990 to 24.3 percent in 2000 while 70 percent of the population remains in rural areas and mostly employed in agriculture. This situation is expected to continue and require the government's attention to the issues of equitable distribution of the gains from growth.

Box 2. Water delivery during drought, 1998 summer season

During the drought, of summer 1998, the Nai Cuu Cooperative received water rotationally by 3-3, 4-4, 3-6 and 3-9 (Table 8.6). In contrast, at the beginning of the drought water was delivered for three days and then stopped for three days. As the drought increased, the water delivery rotation shifted to longer periods of no water delivery. The executive board members direct the water delivery, patrol canals and prohibit farmers check up water. Their objective is to irrigate the largest area possible and take as much water as possible.

Table 8.6. Rule on water delivery during droughts.

Rotation	3 days–3 days	4 days–4 days	3 days–6 days	3 days–9 days
Rule	High elevation and tail-end first	Shifting from high elevation/ tail end to low elevation/head first	Supplies water from Nam Thach Han for low elevation/ head and pump for high elevation/tail end	No control

i) Ong Sin Pump (taking water from Vinh Dinh river) operated continuously delivering water rotationally for left (25 ha) and right (25 ha) canal on 4-4 schedule.

ii) N1 Canal: on a 3-day water-delivery phase, water is rotationally delivered into three sections starting from the regulator separating water from Ong Xin and from N1. On 6 non-water supply days, the Cooperative uses its diesel pumps to pump up leaked (and stolen) water from N1.

iii) From ponds and swam: pumping water using mobile pumps.

iv) From drainage course.

Population growth and urbanization require investment policies to keep pace with water demand in the urban sector and in the irrigation sector to increase agricultural production and thus meet the food needs.

Rapid economic growth will increase the demand for energy, which in turn will create more demand for hydroelectric projects.

Land use and settlement will raise the financial and economic risks associated with flooding, which need support policies and funds for emergency management.

Although the expanded economy and government commitment will help finance investment in water infrastructure, the requirements are very large. While private- sector investments and external assistance will provide some relief, the government will need to make difficult decisions, prioritize water investment and rely more on support from beneficiaries.

As the result of the governmental policies on poverty alleviation, the rate of the poor declined from 50 percent in 1990 to 30 percent in 2000 as estimated by the World Bank or 17 percent as estimated by MOLISA. As 90 percent of the poor are in the countryside, poverty alleviation programs will depend on the extent to which growth is broad-based and involves the rural sector. This requires policies to increase investment in the irrigation sector in order to increase agricultural production and incomes—in flood control to protect households from damage, and in a clean water supply to improve health status. Subsidies are needed for irrigation and drainage projections, rural water supply, sanitation and flood control in the poorest areas.

Institutions (e.g., community organizations, groups of water users) need to be restructured and newly created in order to respond to the pressing needs of the water sector and poverty alleviation.

There are growing problems with environmental pressures of degraded watersheds, and waterlogged crops in poorly drained soils.

The most important factors in the success of the pro-poor irrigation policies are:

- Party's innovative policies, strategies in agriculture and rural development.
- Applying advantage science and technology in agriculture, especially technology transfers to farmers, e.g., creating a new variety by crossbreeding.
- Investment of the government and people for many decades, especially in irrigation to irrigate and drain water, prevent flood and lighten natural disaster.

Managing and monitoring of Central Government and local government levels and exerting the strength of all farmers.

Chapter 9

Analysis of Constrains and Opportunities for Increasing Crop Productivity

Irrigated Rice Yield: Nam Duong

A model was run to examine the impact of different cultivation inputs on rice yield. All variables that represent cultivation inputs are included into the model. These are inundation (IN) and drought (DRO) frequencies, education (EDUC), herbicide (HERBIS), nitrogenous fertilizer (N), phosphate fertilizer (P), potassium fertilizer (K), manual fertilizer (MFERTIL), family labor (LABFAM), hired labor (LABHIRED) and seed (SEED). The model has R2-adjusted of only 0.23 for spring rice season and 0.11 for summer rice season. The model is not a perfect fit but regression of *spring rice yield* indicates that education, hired labor and seed positively impact rice yield while inundation, nitrogenous fertilizer and potassium fertilizer negatively impact the rice yield. Spring drought also negatively influences the rice yield (table 9.1).

Table 9.1 Regression results for rice yield (kg/500 m^2) in Nam Duong.

Variable	Spring season		Summer season	
	Coefficient	t-Statistic	Coefficient	t-Statistic
DRO (%)	-0.03	-0.3	0.28	2**
EDUC (grade)	1.02	2.2**	1.05	2.4**
HERBIS (VND1,000/500 m^2)	0.27	0.5	0.18	0.5
IN (%)	-0.36	-1.8*	-0.20	-1.3
K (VND1,000/500 m^2)	-0.89	-2.3**	-0.24	-0.8
LABFAM (man.day)	-0.82	-4.2***	-0.51	-3.7***
LABHIRED (VND1,000/500 m^2)	0.11	1.8*	0.0459	1.0
MFERTIL	0.02	0.2	0.01	0.1
N (VND1,000/500 m^2)	0.11	0.3	-0.17	-0.6
P (VND1,000/500 m^2)	-0.71	-2.6***	-0.49	-2.7***
PEDTIS (VND1,000/500 m^2)	-0.21	-0.8	-0.13	-0.9
SEED (VND1,000/500 m^2)	2.34	6.3***	0.41	1.4
Constant	207.97	18.8***	222.48	23.8***
Adjusted R-squared	0.23		0.11	
* significant at 10%; ** significant at 5%; *** significant at 1%				

Regression of summer rice yield shows a positive influence on rice yield of drought and education and negative association of family labor and potassium fertilizer. Inundation in summer also negatively impacts the rice yield. The positive impact of summer drought on rice yield is possibly because of positive influence of land exposure to the air in rainy summer season.

Irrigated Rice Yield: Nam Thach Han

The rice yield regression has adjusted R2 of only 0.03 for spring and 0.04 for summer rice season (table 9.2). The spring rice model shows a positive impact of herbicide, family labor and pesticide and a negative association of potassium fertilizer and seed. Inundation and drought negatively impact the rice yield though not strongly and the education level positively influences the rice yield.

Table 9.2 Regression results for rice yieldhRice Ri (kg/500 m²)hRice Ri in Nam Thach Han.

Variable	Spring season		Summer season	
	Coefficient	t-Statistic	Coefficient	t-Statistic
DROSP (%)	-0.68	-0.4	-0.17	-0.2
EDUC (grade)	3.248	1.1	1.27	1.3
HERBIS (VND1,000/500 ²)	9.2	2.2**	2.39	2.4**
INSP (%)	-0.15	-0.1	-0.36	-0.4
K (VND1,000/500 m²)	-3.51	-2.1**	-1.97	-2**
LABFAM (man-day)	15.51	2.6***	-3.42	-3.4***
LABHIRED (VND1,000/500 m²)	0.38	0.4	0.20	0.2
MFERTIL (VND1,000/500 m²)	-0.05	-0.2	-0.53	-0.5
N (VND1,000/500 m²)	-0.65	-0. 5	0.49	0.5
NPK (VND1,000/500 m²)	0.92	1. 5	1.07	1.1
OTHER (VND1,000/500 m²)	-11.65	-0.7	-0.24	-0.2
P (VND1,000/500 m²)	1.29	0.9	1.29	1.3
PEDTIS (VND1,000/500 m²)	3.92	1.9*	3.05	3.1***
SEED (VND1,000/500 m²)	-5.28	-2.3**	-1.81	-1.8*
Constant	127.26	1.7*	3.69	3.7***
Adjusted R-squared	0.03		0.04	

* significant at 10%; ** significant at 5%; *** significant at 1%

Summer rice yield model indicates positive impact of herbicide and pesticide and negative association of phosphate fertilizer, family labor and seed. Drought and inundation negatively impact the yield and education positively influences the rice yield.

Rain-fed vs. Irrigated Cultivation: Nam Duong Area

In the Nam Duong irrigation system, the irrigated land area is planted with 95 percent paddy and the remaining 5 percent planted with vegetables. In the rain-fed areas, 95 percent of land is maize, while the remaining 5 percent is planted with potato and beans. The income from irrigated land shows that 95 percent of paddy cropped area brings only 79 percent of the total income while 5 percent of vegetable land gives 15 percent. In rain-fed areas, the land area planted with maize brings 97 percent of income generated in the rain-fed areas. The land productivity of irrigated areas is VND1.2million/500 m² (US$1,600/ha). Rain-fed area crops frequently suffer from both inundation and drainage and, therefore, usually they have only one harvest per year. The land productivity in rain-fed areas is 0.6 million/500 m² (US$800/ha).

In the Vann Ninh commune of Nam Duong the land is divided into two parts with distinguishing characteristics: the irrigated land inside the dike embankment and the rain-fed land area located on the riverside of the dike embankment. For the irrigated land 95 percent is paddy and approximately the remaining 5 percent is vegetables. In the rain-fed area, more than 96 percent of land is maize and sweet potato and less than 4 percent is bean (table 9.3). Income from irrigated land shows that 95 percent of the paddy cropped area brings 79 percent of total income and 5 percent of vegetable land gives 15 percent, while maize and sweet potato brought an insignificant portion of income (table 9.4). In the rain-fed area 96 percent of the area under maize and sweet potato brings more than 98 percent of income.

Table 9.3. Cropping pattern, irrigated area and rain-fed area (%).

Area	Total	Paddy	Maize	Sweet potato	Beans	Potato	Groundnut	Vegetables
Van Ninh Com.	100	75,45	19,58	0,26	0,91	0,04	0,05	3,70
Irrigated area	100	95,00	-	-	0,23	0,05	0,07	4,65
Rain-fed area	100	-	95,18	1,28	3,54	-	-	-

Table 9.4. Structure of output value and land productivity in irrigated and rain-fed areas.

	Area	Structure of cultivation output value (%)							Land productivity
	Total	Paddy	Maize	Sweet potato	Bean	Potato	Groundnut	Vegetables	VND1,000/ 500 m²
Van Ninh Com.	100	70.79	10.09	0.07	0.61	0.14	0.53	13.35	1,046.41
Irrigated area	100	78.96	-	-	0.47	0.15	0.59	14.89	1,163.56
Rain-fed area	100	-	97.52	0.64	1.84	-	-	-	558.89

No irrigation and drainage have been implemented for the outside embankment area and it frequently suffers from inundation, and thus the rain-fed area typically has only one harvest a year. Land productivity in the irrigated area is VND1.2 million/500 m^2, which is twice higher than rain-fed land productivity (VND0.6 million/500 m^2).

Rain-fed vs. Irrigated Cultivation: Nam Thach Han Area

In the Nam Thach Han irrigated areas, paddy rice is grown in both summer and spring. The main cropping pattern of irrigated land is paddy rice. In contrast to the irrigated areas, only upland crops are grown in nonirrigated land. For the system overall, in the nonirrigated area, sweet potato occupies 31.4 percent, cassava 28.5 percent, groundnut and chili 26 percent, and water melon and vegetable 13 percent. Land productivity and income from an area unit of irrigated land is much higher than for rain-fed land. On the system average, a farmer has an output value of VND 811,000 from 500 m^2 (US$1,081/ha) of irrigated land but only VND381,000 from 500 m^2 (US$ 508/ha) of rain-fed land.

Table 9.5. Cropping pattern, rain-fed area (%).

Location	Cassava	Maize	Sweet potato	Groundnut	Water melon	Chili	Vegetables	Total
Overall	28.49	1.21	31.38	13.27	6.56	12.67	6.43	100
N2	79.56	3.32	13.38	3.74	-	-	-	100
N1	20.96	2.76	15.00	45.12	5.33	3.79	7.05	100
N6	20.62	-	43.12	0.40	8.61	19.68	7.57	100

Land productivity from an area unit of irrigated land is much higher than from rain-fed land. On the system average farmers can have an output value VND811,000 from 500 m^2 of irrigated land but only VND381,000 from 500 m^2 of rain-fed land.

Table 9.6 Land productivity and income from cultivation (1000VND/500 m^2).

Location	Irrigated	Rain-fed
Overall	811	381
N2	731	383
N1	795	468
N6	880	339

Seasonal Influences: The Irrigation/Production and Poverty Linkage

Thus far, this report has examined the general conditions of the irrigation systems, farmer response to irrigation availability, the impact of different income sources on per capita income and negative deviation in income, and the impact of irrigation availability and irrigation performance on predicting poverty. This has shown that the incidence of drought is a significant influence on poverty, but it is the general availability of irrigation that guides farmers' planting decisions. Moreover, it is the dry-season crop that has a special relationship with low per capita incomes and deviations of incomes below the poverty line. The final step is to analyze the magnitude of irrigation's impact on poverty alleviation.

Vietnamese farms typically have several plots scattered over a wide area. Furthermore, these plots were distributed with the aim of equalizing quality differences between families. This is known as the "near with far, good with bad" principle. Plots may or may not have irrigation water available. Therefore, it is impossible to directly link irrigation availability with a farm household's poverty situation. Irrigation is primarily an input into crop production. This production is then either consumed or sold. A good measure of the potential impact that crop- raising activities will have on poverty can be found through an examination of the gross-value product per hectare. It is assumed that, ceteris paribus, higher GVP/ha will have a stronger impact on poverty alleviation. To examine this aspect, a plot-wise analysis was undertaken that examines availability of irrigation on GVP/ha.

An additional component is examined in this section, which is the importance of seasonal conditions. Vietnam is marked by its monsoonal climate with periods of heavy rain followed by periods of little or no rain. These natural conditions drastically alter the importance of irrigation. To capture this impact three linear regression models were constructed, with irrigation characteristics, irrigation availability and farm inputs. Results of the three regressions are shown in table 9.7.

Table 9.7 Seasonal influences: the irrigation/production and poverty linkage.

	GVP/ha Both seasons	Rainy season	Dry season
Irrigation dummy	1752.13	-1984.61	5365.22
	(8.36)***	(-5.09)***	(43.12)***
Irrigation characteristics			
Middle-location dummy	-314.01	-233.83	-347.30
	(-2.62)***	(-1.06)	(-4.87)***
Tail-end-location dummy	-493.45	-286.33	-671.17
	(-4.48)***	(-1.41)	(-10.15)***
Gravity drainage	-74.39	-98.72	71.18
	(-0.518)	(-0.37)	(0.84)
Inundation	-93.09	-75.35	-2.00
	(-1.23)	(-0.61)	(-0.04)
Drought	-55.64	31.92	-74.16
	(-0.99)	(0.23)	(-2.39)**
Farm inputs			
grade	-465.99	-443.44	-483.18
	(-13.22)***	(-6.82)***	(-22.90)***
Seed	-152.27	-104.33	-354.25
	(-3.49)***	(-1.35)	(-12.01)***
Manure	2.38	1.29	2.90
	(5.46)***	(1.56)	(11.29)***
Urea	24.11	-34.54	65.40
	(1.25)	(-0.97)	(5.64)***
Potassium fertilizer	17.70	-45.09	67.82
	(0.86)	(-1.17)	(5.67)***
Household labor	25.74	17.68	24.39
	(3.20)***	(1.13)	(5.32)***
(Constant)	8026.45	12474.74	4906.69
	(19.22)***	(16.54)***	(17.94)***
Observations	12,595	6,291	6,304
Adjusted R-square	0.07	0.02	0.58

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%.

In all three models, availability of irrigation and land grade (quality) are the most significant variables. The model with both seasons performed poorly with an adjusted R-square of 0.07. A similar result is found with the rainy season model (adjusted R-square 0.02). Moreover, the irrigation dummy is negative in sign.

The model run for the dry season yielded an acceptably high adjusted R-square of 0.58. The irrigation availability is the most significant variable in the regression as well as being positive.

The estimated coefficient indicates that the availability of irrigation water in the dry season has the potential to increase GVP/ha by VND 5,365,000 (USD358). For an average sized farm of 0.31 hectares, this would mean an increase in GVP of VND 1,663,000 (USD111) per household or VND 332,600 (USD 22) per person for a family of five. This is roughly 28 percent of the income needed to reach the Vietnamese poverty line and 19 percent of the income necessary to meet the World Bank's overall poverty line based on expenditures (World Bank 1999). This is a significant contribution to the fight against poverty.

Conclusion

Rice yield in Nam Duong is positively associated with education level, hired labor, seed and negatively associated with inundation and drought in both seasons. Fertilizers are used excessively causing negative impact on rice yield. Rice yield in Nam Thach Han is positively impacted by herbicide and pesticide, education level and negatively associated with inundation, drought. Some major input uses such as seed and fertilizer are negatively associated with rice yield indicate non effective use of these inputs. For both systems, reducing inundation and drought by improved irrigation, drainage and better input use by improvement of education are main measures for rice yield improvement.

Increasing irrigation performance by reducing drought in the spring and reducing inundation in summer will increase rice yields. Moreover, improving irrigation and drainage will improve conditions for crop diversification by providing appropriate conditions for farmers to change from rice to valuable cash crops, such as vegetables. Providing irrigation and drainage to the rain-fed area will help increase cropping intensity and thus increase crop productivity.

A regression model run to examine the seasonal importance of irrigation on land productivity showed that irrigation is most important in the dry season. This is a much more significant result than for the model with dry- and rainy-season crops or for the rainy season. In fact, the result for the rainy season indicated that irrigation had a negative effect on land productivity. This model, however, had a very low adjusted R-square (0.02).

A closer examination of the importance of irrigation for the dry-season crop showed that irrigation can have a significant impact on a farmer's income. The increase in dry-season productivity translates to an increase in income of VND332,600 (US$22) per person per year. This increase amounts to 28 percent of the income needed to reach the Vietnamese defined poverty line or 19 percent of the World Bank-defined poverty line. This is a major contribution to poverty alleviation in the irrigated areas.

Chapter 10

Institutional and Technological Interventions: Implications for the Poor

Institutional Interventions

Since the early 1990, there have been several institutional renovations in the water sector in Vietnam. The most important are a) decentralization, b) privatization, c) financial autonomy, and d) farmer involvement (Svendsen 1995).

The implementation of the renovation process, *doi moi,* has brought in high progress in many aspects of irrigation management. However, in the process of renovation implementation there remain many unclear directions, and thus potential results are still unrealized.

Improving irrigation performance has proved to be a measure to effectively increase farm income and reduce poverty. This section uses field survey information from Nam Duong and Nam Thach Han irrigation systems to clarify the irrigation organizational structure focusing on the farm water-management level and the articulation between IMDC and on-farm water-management organizations. First, the Nam Thach Han irrigation system, which possesses clear rules, roles and groups in its irrigation activities, is used to highlight factors making good system performance. Second, recent changes of Cooperatives in the Nam Duong irrigation system are used to demonstrate the practical on-farm water-management institutional major role. Third, the role of water-control infrastructure in Nam Thach Han is analyzed to show its importance in poverty reduction; and lastly some recommendations for further improvement of irrigation system performance are proposed. The ultimate aim is to increase irrigation's contribution to poverty reduction in the irrigation system.

System level organizational structure: The case of the Nam Thach Han system

Water Delivery

At the beginning of each season, water delivery is scheduled by the IDMC basing on requested irrigation area from Cooperatives to field station, on cropping pattern and plantation calendar provided by the provincial DARD and, of course, on water availability and climatic information. This water delivery schedule is fed back to Cooperatives. Based on the sown area, field stations request for water deliveries in written form from the IDMC. From the water level in the headwork, the technical department makes a refined water delivery for each 5-10 day period (table 10.1).

Table 10.1 Water delivery rule.

Water availability at headwork		Water delivery
Water level (m)	Discharge (m^3/s)	
9.5–10.5	>14 (18–20)	Continuous
<9.5	12–14	Rotation: Left-right banks
	<7	Rotation: Downstream/upstream (K12 regulator)

During severe drought, to keep rotational water delivery works, the IDMC has to involve the police to keep the intakes into tertiary canal gates closed during the off-turn period.

Table 10.2 Water schedule from 5th to 12th of April, 2002.

Group I				Group II			
No	Canals	Water turn	Q,a	No	Canals	Water turn	Q,a
1	N1	5+6+7+8	3.5 m^3/s	1	N2-B	9+10+11+12	2 m^3/s
2	N6	5+6+7+8	2.8 m^3/s	2	N4	9+10+11+12	2 m^3/s
3	N1-A1	5+6+7+8	a=0.6 m	3	N3	9+10+11+12	2.4 m^3/s
4	N1-A3	5+6+7+8	a=0.3 m	4	N4-B2	9+10+11+12	a=0.6 m
5	N1-A5	5+6+7+8	a=0.2 m	5	N1-A2	9+10+11+12	a=0.25 m
6	N4-C	5+6+7+8	a=0.3 m	6	N1-A4	9+10+11+12	a=0.2 m
7	N0-7	5+6+7+8	a=0.2 m	7	N4-B3	9+10+11+12	a=0.15 m
8	N0-9	5+6+7+8	a=0.2 m	8	N4-B4	9+10+11+12	a=0.15 m
9	N0-6	5+6+7+8	a=0.15 m	9	N2-A	9+10+11+12	a=0.2 m
				10	N0-8	9+10+11+12	a=0.15 m

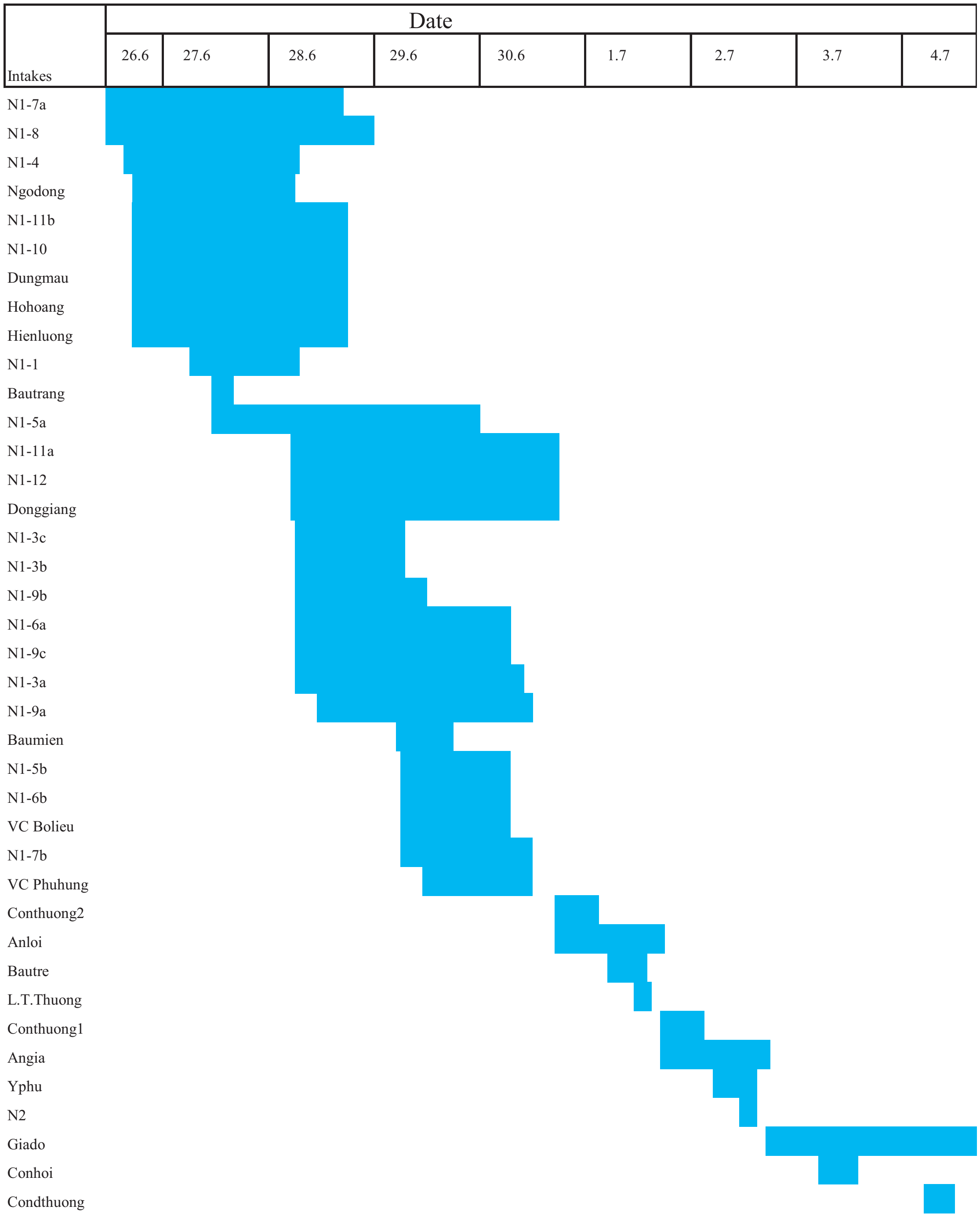
Secondary canal: Example of N1 canal

There are 32 Cooperatives for 8 communes in the catchment area of N1 canal. The length of N1 canal is 15.8 km. In both cases of rotational water delivery in the main canal, rotational water delivery is practiced along secondary canals.

For water scheduling, the tertiary canals are divided into two major groups. Group no. 1 consists of 18 canals supplying water for 872 hectares upstream of the K6 regulator and group no. 2 consists of the remaining 23 canals that irrigate 762 hectares downstream of it. Group no. 1 is further divided into two subgroups and group no. 2 is divided into 5 subgroups.

If there is insufficient flow and water level, the K6 regulator is used to increase the water level in N1 canal and rotation is practiced among subgroups of upstream or downstream groups of the regulator. In case of sufficient water level, the water-turn rotation is practiced among subgroups upstream and downstream of the K10 regulator (figure 10.1).

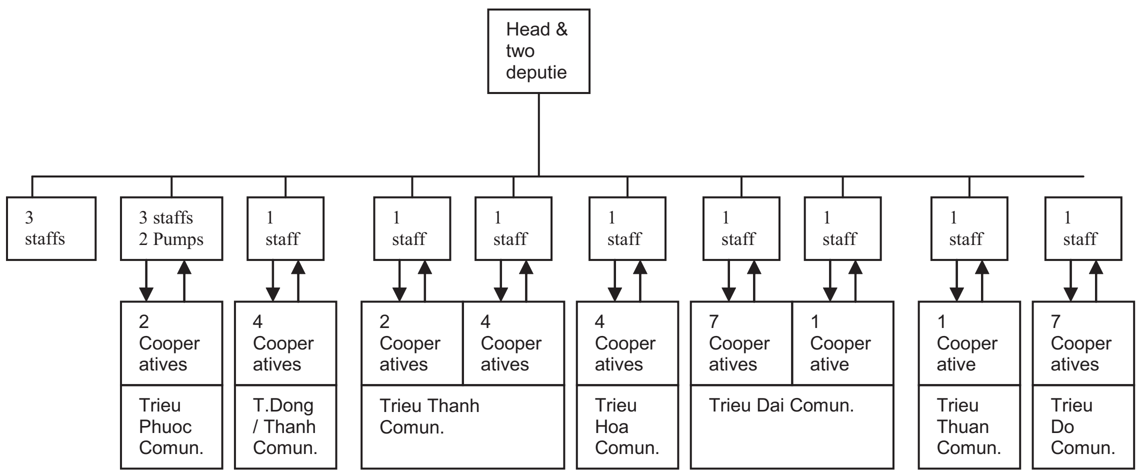
Figure 10.1 Water delivery schedule in N1 canal, 26 June to 4 July, sufficient water.



The N1 field station informs the Cooperative, in written form, of the water-delivery schedule. The Cooperatives check the water supply schedule of each other. If an intake gate is not opened as specified in water-delivery schedule causing water deficiency to some Cooperatives, the Cooperative head goes to the field station office to complain and request an opening adjustment.

The N1 field station has 17 staff members. There are a head and two deputies. Three staff members are in charge of the An Tiem siphon, three operate the Hien Luong and Quang Dien pumps, and the remaining eight staff members are in charge of water delivery to several Cooperatives of a commune (figure 10.2).

Figure 10.2 Structure of N1 field station and its articulation with water-user Cooperatives.



Members of staff in charge of specified Cooperatives have several tasks:

- Defining contract/actual area having water service
- Keeping intakes opening conforming to the water-delivery schedule
- Delivering water into their served Cooperatives
- Exploring the status of water delivery
- Defining water deficient/insufficient areas and informing field-station office
- Defining the area in drought for financial support to the Cooperative pump operation.

The staff must patrol the tertiary gate openings and check water levels at the canal head and at the regulator in the secondary canal twice a day at 6.30 a.m. and 2 p.m. The head of the station checks the water level at the uptake and downstream of the intake gate into the secondary canals and informs/requests the technical department for adjustment in time. In case of water shortage at the head work and the IDMC cannot provide sufficient water as specified in the contract, the field station together with the Cooperatives investigate the field status to verify drought areas and apply to DARD for supporting water supply (in a form of financial support to the Cooperative pump operation). The authority allows the procedure to be carried out before approval. This creates quick action for drought prevention.

Tertiary canal, N1-5a canal

There are four Cooperatives having water from the N1-5a canal. In a water turn of 4 days, the-water delivery schedule is set by the field station. In the first 2 days all Cooperatives can take water; this means that the upstream Cooperatives can take as much as they can which leaves the downstream little water. For the last 2 days only the downstream Cooperatives can have water (see table 10.3 for sample water- delivery schedule).

Table 10.3 Water delivery in N1-5a for water turn from 6 p.m., 5th to 7 a. m. 8th of July.

Cooperatives	Area	Canal	Water turn, from/ to
Bich Khe		N1-5a	6 pm, 5th to 5am, 6th
Nam Long		N1-5a	6 pm, 5th to 5am, 6th
Bich Nam		N1-5a	6 pm, 5th to 9am, 6th
Bich La		N1-5a	5 am, 6th to 5 am, 6th (low water)
Bich La		N1-5a	5 am, 6th to 7 am, 8th (high water)

The Cooperatives have an unofficial institution for self-management (i.e., checking each other to ensure conformity with water-intake time). The downstream Cooperative has to guard from head to their field during their water turn. If the case of insufficient water arises, the Cooperative informs the field station and opens a meeting with the participation of field staff in charge.

Financial aid during water shortage and drought

In case of drought Nam Thach Han cannot supply its water (little water in the pond), the IDMC will arrive at the drought area to clarify the reason and sign a memorandum. The Cooperative operates its pumps to supply water. Then the IDMC submits the memorandum to DARD that later on requests the provincial authority to give financial support to Cooperative. The Nam Thach Han IDMC and DARD create an environment for quick and on-time action. During the 1998 drought, the Nam Thach Han IDMC supported Cooperatives with approximately VND450 million, in the fight against the drought affecting 2,560 hectares. A distinguishing action is that the Cooperative operates the pumps, not waiting for the DARD agreement.

Maintenance of the no-man's land (Dai Hao Cooperative)

The Dai Hao Cooperative is located downstream of the N1- 9c inter-Cooperative tertiary canal. To improve water flow to its field the Cooperative requires production groups to repair the intake gate and dredge the bed of the tertiary canal upstream and asks Nam Thach Han for financial support. On average, Nam Thach Han supports 70 percent of the expenditure (table 10.4).

Table 10.4 Expenditure for maintenance of structures not managed by the Dai Hao Cooperative.

Year	Work	Real expense (VND)	Subsidized by NTH IDMC (VND)
2000	Dredging of tertiary canal	2,000,000	0
2001	Reparation of intake gate	500,000	500,000
2002	Dredging of tertiary canal	4,700,000	4,500,000
Total		7,200,000	5,000,000

Changing roles in on-farm water management: Case of the Nam Duong irrigation system

The role of the village in on-farm water management has been analyzed elsewhere (Doan et al. 1996). This section analyzes only recent changes of Cooperatives to demonstrate practical on-farm water-management institutional progress.

Communal-Level Cooperative: The Tri Qua Cooperative

In the Tri Qua commune, as elsewhere in the Red river delta, Cooperatives have changed form many times. In the early 1960s, there were village-level Cooperatives. Commune-level Cooperatives were formed in from the late 1970s to 1985. From 1986–1991, the Cooperative changed into a commune-scale integrated agricultural service Cooperative. With land redistribution to farmers for long-term use, the Cooperative collapsed. With the new Cooperative Law of 1996 and government policy, the commune-scale agricultural service Cooperative was reestablished in 1996–1997.

The Cooperative runs four main activities: water management, seed supply, crop protection and farm extension. The Cooperative has 50 official members, each contributing at least a membership fee of VND100,000, with a board of manager as the highest managing body. The headman and accountant of each village are members of the Cooperative. The headman and accountant play an extremely important role in managing service activities within the village and in resource mobilization from the villagers. The general structure is given in figure 10.3.

The water-management team has 22 members. The Deputy Head of the Cooperative is directly in charge of water supply. The water-management team is divided into 5 groups according to five villages. Group 1 has 8 persons from the Tu The village, group 2 has 3 persons from Van Quan, group 3 has 3 persons from the Phuong Quan village, group 4 has 5 persons from the Tra Lam village and group 5 has 3 persons from the Xuan Quan village. Their duty is water management and field protection, i.e., to convey water from secondary canals to village farmer field plots and protect canals and field embankments.

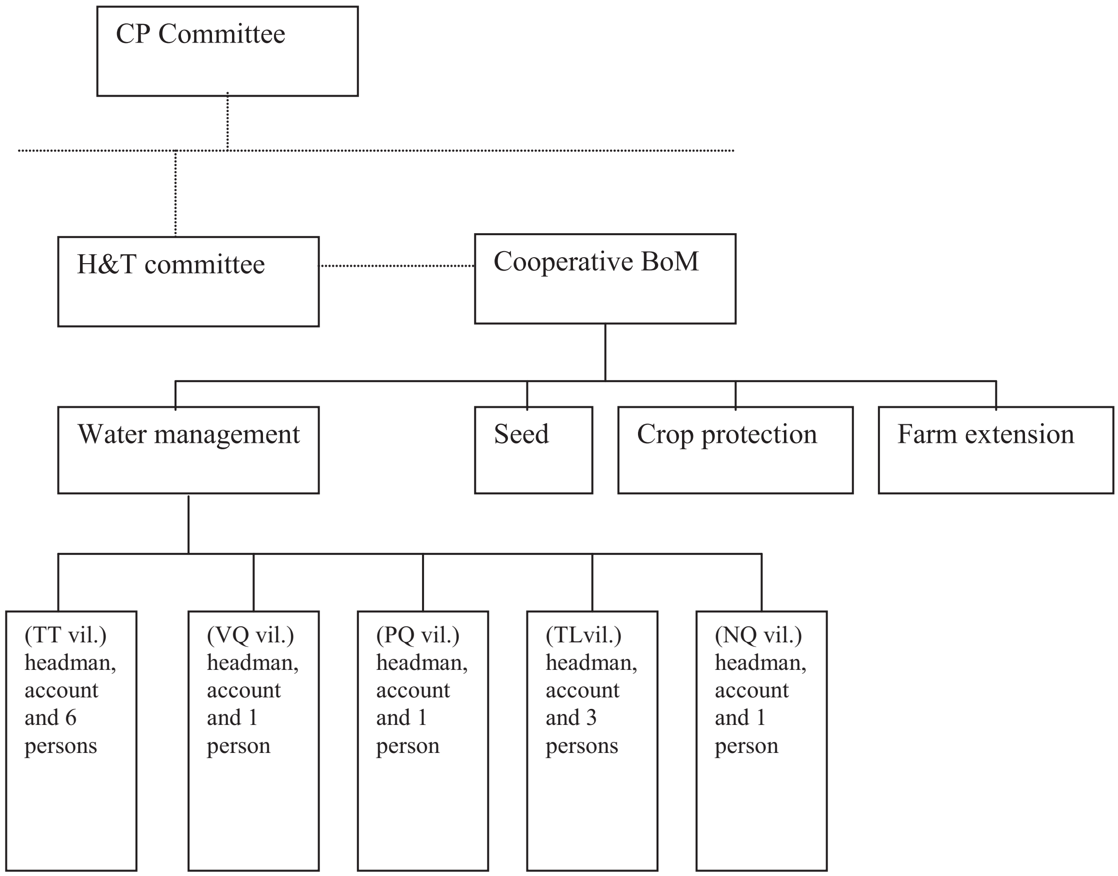
Division of tasks for on-farm water management

The water-management task is divided between commune (hydraulic and transportation works committee), Cooperative (water management team), and villages (headman and villagers) (table 10.5). The inter-village facilities, such as secondary canals, are managed by the communal committee for hydraulic and transportation works and the Cooperative. The facilities that serve a village such as tertiary and quarterly canals are managed by the villages.

With a relatively abundant water source, Tri Qua applies the water distribution that gives privilege to high-elevation areas first. The Cooperative board and village administration board play a major role in water distribution. The water-service team delivers water and farmers take water into their field plots.

A canal breach is repaired by the water-service team at the spot and canal cleaning is carried out annually with all farm households contributing in cash or in kind. Conflicts are resolved on the basis of negotiation with the understanding that high-elevation areas are privileged. CPC (H&T committee), the Cooperative-Management Board, and the village-administrative board have major roles in both canal maintenance and conflict resolution. The Cooperative cannot, however, run

Figure 10.3 Structure of the Tri Qua Cooperative and its relation to CPC and villages.



Note: CPC: Commune People Committee. H&T Committee: Hydraulic and Transportation Committee. BoM: Board of Managers.

Table 10.5 Division of tasks for on-farm water management.

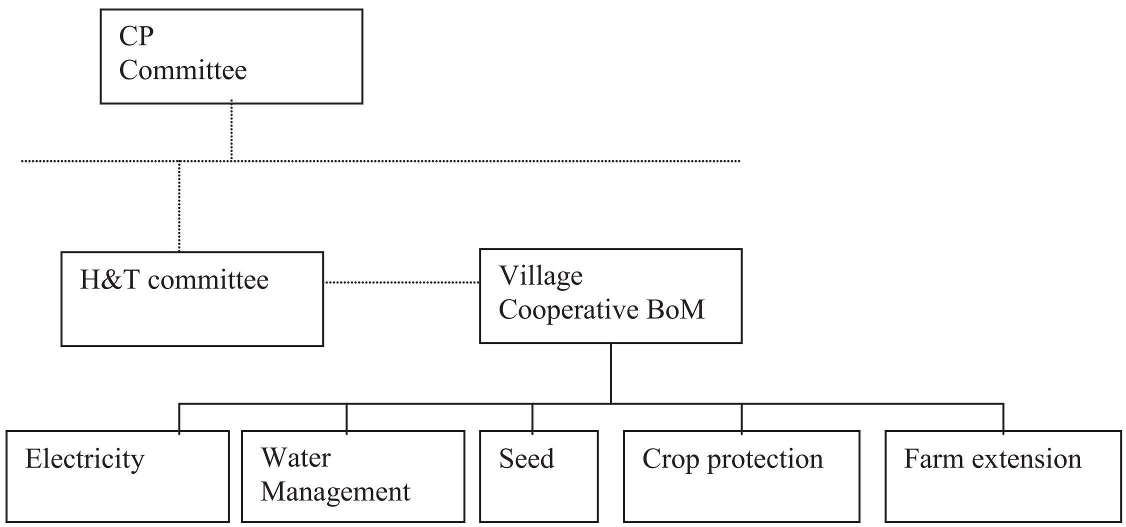
	Water distribution	Maintenance	Conflict resolution
Rule	Land-preparation period: Simultaneous during water delivery in main canal. Growing period: high located area first	Annual canal cleaning. All farmers have to contribute (in cash or in kind)	Negotiation on the basis that high located area has privilege.
Role	Cooperative Management board, village headman	CPC (H&T committee), Cooperative Management board, Village administrative board	Cooperative Management board Village administrative boardCPC (inter-village case)
Group	Water-service team. Farmer householdsboard	Farmers.Water-service team	Cooperative Management Village security H&T committee

agricultural services effectively and the effective role in farmer economic activities is played by the village. There is ongoing discussion to establish Cooperatives on a village basis.

In the Van Linh commune, the communal Cooperatives were split into five village- based Cooperatives. A difference to Tri Qua is that all farmers within each village are members of the Cooperative. No one has to pay a membership fee. The hydraulic and transportation committee, based on the annual cleaning plan of the village Cooperative and actual need, makes a cleaning plan. The village Cooperatives have to conduct canal cleaning, including secondary canals, according to the plan made by the hydraulic committee.

Located at the end of the water source, the Cooperatives of Van Linh (see figure 10.4 for the organizational structure of this Cooperative) can rarely receive gravity irrigation. The payment to the IDMC for system-level water service is 10.4 kg/Sao. The contribution for on-farm water service is nearly the same as the payment of 9.6 kg/Sao to the IDMC. This contribution is used to pay water management members for their water delivery service and for canal cleaning. No payment is paid to the hydraulic and transportation committee.

Figure 10.4 Organizational structure of the village-based Cooperative in Van Linh.



Division of tasks for on-farm water management

The on-farm water management involves farmers, the water service team, the Cooperative management board, village administration board and the commune. The division of tasks for on-farm water management is summarized in table 10.6.

Table 10.6 Division of tasks for on-farm water management.

	Water distribution	Maintenance	Conflict resolution
Rule	Simultaneous during water delivery in the main canal. Store as much water as possible in ponds, drains.	Annual canal cleaning. All farmers have to contribute (in cash or in kind)	Negotiation on the basis of need
Role	Cooperative Management Board	CPC (Hydraulic & TransportationCommittee). Cooperative Management Board	Cooperative Management Board Village administrative board CPC (inter-village case)
Group	Water-service team. All farmers have to pay for water-delivery service	Farmers.Water-service team	Cooperative Management BoardVillage security H&T committee

Located in a water-scarce area, the village tries to obtain as much water as possible during water deliveries in the main canal. The rule for water distribution is to deliver water to every field block and to store as much water in the drainage and pond. The major role in water distribution is played by the Cooperative Board and the major group is the water-service team. Farmers have to pay for on-farm water delivery to water-service members.

Canal cleaning is conducted, after the rice harvest during the dry season or once a year. The major role here is again played by the Cooperative Board. The farmers have to contribute in cash or in kind for canal cleaning.

Conflicts rarely occur among villagers. The basic rule for conflict resolution is water delivery for those who urgently need it. The village administration board and the Cooperative Board play important roles. Conflicts involving different villages may need the intervention from the CPC.

Technological interventions: Case of water-control infrastructure implementation in the Nam Thach Han irrigation system.

The Nam Thach Han irrigation system, constructed during 1978–1981, consists of a concrete dam, principal intake, main canal and 6 secondary canals (chapter 7). Since the operation of the irrigation system, approximately 7,000 hectares of cultivation land is supplied with irrigation and drainage. However, droughts, mainly in summer season, and inundation, in the winter-spring season, still cause human loss and damages to crop yields.

The survey data show that, on system average, one inundation occurs in 20 years and one drought occurs in 5 years damaging crop yields. This information is confirmed by data on inundation and drought, recorded by the Nam Thach Han IDMC. For a period of 8 years, from 1993 to 2000, droughts occurred 4–5 times (table 10.7). The drought area ranged from10 percent to 80 percent and rice yield reduction ranged from 14 percent to 81 percent. The total damage amounted to VND5 billion (US$330,000) to the Nam Thach Han area (table 10.8).

Table 10.7 Drought area and rice yield damage in the Nam Thach Han command area.

Year	1993	1994	1995	1996	1997	1998	1999	2000
Drought area (% of total irrigated area)	80	0	23	0	32	78	10	0
Yield damage (% of potential yield)	81	0	20	0	14	42	0	0

Source: Nam Thach Han IDMC.

Table 10.8 Total damages caused by flood/inundation in the Nam Thach Han area.

Year	1983	1990	1995
Damages (BVND)	1.8	2.2	1.0

To reduce the damages caused by natural hazard, several major water-control infrastructures have been implemented with ADB loans, since 2000. A rubber dam was installed at the headwork above the existing concrete dam in March-September, 2000. It is 135 m long and 2 m high. Due to the rubber dam, water storage increased by approximately 20 million m^3/year.

The N1 secondary canal section, crossing Vinh Dinh river, a tributary of Nam Thach Han river, was formerly an earthen canal section, which also acted as a dike separating the main Nam Thach Han river and its tributary, the Vinh Dinh river. In times of high flood the canal is damaged and flood water causes vast floods and inundation damaging the area. From May 2000 to July 2001 the 157 m long An Tiem Siphon, was constructed, crossing the Vinh Dinh river, and with a flood-diversion dam above it. The siphon and flood diversion dam complex replaced the former N1 earthen canal section crossing the Vinh Dinh river. In case of high flood, the diversion dam is operated to release flood water downstream.

Downstream of the Vinh Dinh river, where it flows to the sea, formerly a large area had to suffer from saltwater intrusion. In March 2000, the Cua Viet sluice was constructed and its function is control drainage and flood.

Due to these major water-control infrastructures, drought and inundation damages have been reduced substantially. The water-control infrastructure has a high poverty- reduction effect. During 2002, a drought similar to that in 1998 occurred in Nam Thach Han (IMDC report). If the rubber dam had not been installed, there would have been 13 percent of farmers falling back under the poverty line (chapter 7).

Due to the hydrological regime and topography characteristics, a large portion of water diverted to the irrigation system is just released to the Vinh Dinh river and flows to the Eastern Sea thus being wasted. Although the Nam Thach Han irrigation system has brought about high irrigation benefits, there are still important parts of the designed command area that are not benefiting from the system (chapter 7). To further improve irrigation system performance, drainage management/ capacity improvement of the Vinh Dinh river (to drain flood water better and thus store irrigation water better) is highly recommended.

Conclusion

A typical organizational structure for managing an irrigation system consists of an IDMC for the system level and a Cooperative for on-farm-level management. The IDMC usually consists of a Board of Directors with its several departments (e.g., technical/water management and financial/ administration) to oversee system operations and field stations operating different sections of the system.

As a rule, the IDMC is in charge of managing main and secondary canal networks. Communes (and Cooperatives) are in charge of tertiary and quaternary canal systems. The IDMC can rarely exercise effective control over secondary canals due to limitation of resources (e.g., human and funding). For secondary canals supplying water for only one commune, the commune (hydraulic-transportation committee) has the responsibility for resource mobilization for its maintenance. As the water supply directly affects their production, there is no major issue. If a canal supplies water for several communes, the IDMC will request the related communes to mobilize resources for maintenance of the canal. The role of the hydraulic and transportation committee is limited to planning and monitoring the canal maintenance. The villages have to mobilize resources for maintenance of canal sections related to village water delivery.

The administrative body effectively responsible for agricultural activities, especially water management, is the village. The village manages water management within its boundary (tertiary canals). The on-farm water distribution rule, depending on the water availability, may give priority to the drought area first or simultaneous water delivery with the purpose of storing as much water as possible in the drain. Canals are repaired on the spot by the water-service team and annual canal cleaning is carried out with all farm households contributing. Conflict is usually resolved by negotiation. The water-service team and farm households are to carry out water distribution and canal maintenance. The CPC, the Cooperative board and village administration board play the main roles in all water-management activities. There is still ongoing reformulation of Cooperatives from the communal to the village base. Although in some areas the communal Cooperative still exists, their role is very formal. The actual body responsible for agricultural activities, especially water management, is the village.

There is no one responsible for secondary canals. The situation seems to be better for on-farm (within village) water management, but it is worse for secondary canals, especially maintenance for village Cooperatives.

Management of the system that is divided into many sections and layers requires close coordination and effective communication among the different sections and layers. A clear written water delivery schedule/request from the IDMC head office - field stations - Cooperatives and information among related parties, and a refined schedule for each water delivery are just a first essential step. During water delivery, timely information on water availability and delivery status to head office, strict control/patrol of field stations/Cooperatives on water delivery in secondary/ tertiary canals, administration environment for quick and timely action during drought are required to enforce water delivery schedule.

No-man land is weakest area in the system. With a village-scale Cooperative in the irrigation system this area becomes weaker. IDMC supporting, Cooperatives O&M in this land area is effective measure to involve water users and thus strengthen the articulation between IDMC and Cooperatives. Many IDMCs cannot adopt this policy due to low water fee. Provincial authority allowing water fee increase thus enabling IDMC to leave a part of water fee collected to Cooperative conducting maintenance of secondary canal section related to Cooperative water delivery is a measure for farmer involvement.

Natural hazards—drought, mainly in the dry season, and inundation, in the rainy season—still cause damages to crop yield and human loss. The implementation of water control infrastructures prevent damages to crop and human lost and thus keeping farmers from falling back under the poverty line.

Part III

Chapter 11

Summary and Conclusions: Constraints and Opportunities for Reducing Poverty in Irrigated Agriculture

This study has reviewed many aspects of the irrigation and poverty linkages. The study has sought to identify and devise specific interventions that can be applied to the management of irrigation systems in order to increase the benefits to poor farmers in the irrigated areas. This chapter reviews and assesses the various constraints and opportunities that have arisen from the study. The constraints and opportunities discussed are often covered in more than one chapter. This chapter attempts to consolidate these under general categories.

The examination of the linkages that irrigation availability and improved irrigation performance have with poverty is part of a process to systematically assess, identify, and formulate interventions for improved irrigation system performance. This effort has required that a link be demonstrated between a system level condition and a farm level condition (i.e. irrigation performance and poverty). This is a complicated relationship and could not be demonstrated in a single step.

General Findings

The poor have less access than the non-poor to basic resources, such as education, land, capital, assets, irrigation and drainage. Moreover, the poor depend largely on income from agricultural activities. While land is limited, providing the poor with access to credit, education, better irrigation and drainage are opportunities for poverty reduction. The poor depend largely on agricultural income (62 percent in Nam Duong and 78 percent in Nam Thach Han). Income from cultivation makes up 70 percent. The non-poor rely on both agricultural and non-agricultural incomes with nearly equal shares.

In both studied irrigation systems, water resources are currently sufficient on an annual basis. However, due to extremely uneven evaporation, rainfall and flow distribution, these areas require storage (not necessary newly constructed storage). The topography and uneven water resources distribution are significant constraints to good irrigation and drainage and thus to poverty reduction. Better utilization of storage capacity inside the command area by water control structures, effective management of water storage in internal rivers, serving as drainage courses would increase water storage for dry season and increase command area and irrigation intensity of irrigation system.

While poverty is strongly impacted by the availability of irrigation, it is also related with other factors as well. Regression results showed that land quality is the most significant factor after irrigation availability as a determinant of poverty. Other significant factors include education level, household head's gender, and number of non-agricultural sources of income.

Spatial Analysis of Poverty in Irrigated Agriculture

The study showed that there are spatial patterns to the performance of irrigation within the systems, but that this information is less pronounced when systems are aggregated. The study showed that farmers respond in a rational way to the availability of irrigation through their cropping decisions. Cropping patterns in the two irrigation systems are dominated by paddy, which is a water-intensive crop. In the dry season marked by a higher incidence of drought, farmers make little reduction in cropped area for paddy. This implies that the farmers will make use of irrigation water, if it is available in the canals. This is a strong indication that if irrigation performance is improved (especially in areas of frequent drought), then farm production will improve as well.

The spatial analysis of poverty indicated that there were spatial patterns of poverty within the irrigation system. However, also from an aggregate point of view, no general statement can be made (i.e. poverty rises from head to tail). On a village level analysis, spatial patterns of poverty tend to be related to increased frequencies of drought and inundation. Yields varied unevenly from head to tail, but generally, yields were lower for poor farms compared to non-poor farms. Regression analysis (discussed later) indicates that yield increases are significant in the fight against poverty.

Regression analysis confirmed the importance of location within an irrigation system as an important predictor of poverty. For the aggregate analysis, the middle location was the most important location. In the Nam Duong Irrigation System, the middle location can be divided into two parts based on the location of a major intake pump. The middle part preceding this pump suffers from poor irrigation performance and exhibits high levels of poverty. In the Nam Thach Han Irrigation System, irrigation performance and poverty incidence vary by location. The strong indicator of location reinforces the idea that poverty is caused by a number of factors and not only lack of good irrigation. The results from regression analyses in Chapters six and seven show that location was a more significant predictor of poverty than either availability of irrigation or performance of irrigation. This indicates the multi-faceted nature of poverty. Poverty alleviation efforts must be conscious of the condition.

An interesting factor is the difference in conclusions that can be drawn from areas lacking irrigation infrastructure and areas having irrigation infrastructure, but suffering from poor performance. In the Nam Duong Irrigation System, there was more significant poverty where performance was poor versus areas where infrastructure was poorly or not developed. An examination of cropping patterns showed that farmers did respond to the availability of irrigation infrastructure. However, regardless of performance, farmers tended to stick to the same cropping patterns, if irrigation infrastructure was present. This presents a strong constraint to yields and incomes in the areas with poor irrigation performance. This also presents a definite opportunity where improving irrigation management and performance could hold significant benefits.

The spatial analysis has indicated that there is no regular pattern of poverty that follows a simple head-to-tail formula. Poverty is shown to be tied to areas of poor irrigation performance and areas where irrigation infrastructure is poorly or is not developed. Moreover, poverty is related to other conditions than irrigation. An initial analysis of any irrigation system for pro-poor interventions must investigate these other conditions to get a more informed basis of the causes of poverty. This requires a multi-sectoral approach that extends beyond an irrigation-only approach. Opportunities for improvement derived from the spatial analysis include:

- Improve performance of irrigation and drainage services in areas where performance is poor;
- Improve quality of irrigation infrastructure where infrastructure is poor; and,
- Increase coverage of irrigation provision where it is lacking.

Additional opportunities drawn from conditions in the spatial analysis include:

- Address problems associated with poor land quality such as identify more appropriate crops or activities, find methods to improve land quality, etc;
- Improving other factors related to poverty such as education, health care, labors-to-household size, etc;
- Increase extension services to help farmers more effectively work within the given conditions of their land through crop diversification and enhanced management abilities.

The link between irrigation availability and irrigation performance was examined. Two Logit models were constructed to examine these factors as predictors of income defined poverty. The availability of irrigation was shown to have a significant predictive ability of poverty. However, this relationship was positive (i.e. the greater the area of irrigated land, the more likely one was to be in poverty). This conforms to the data, which shows that the poor seem to have better irrigation coverage (at least in the Nam Thach Han). However, due to the long standing policy of the government to build equality among its people and to alleviate poverty, this result is not so unusual.

The Logit model that examined different aspects of irrigation performance showed that only drought was a significant predictor of poverty. The drought variable also had an expected positive relationship with poverty (i.e. the greater the occurrence of drought, the more likely a household was to be poor. Both models show that, in Vietnam, performance has a key impact on poverty alleviation. Furthermore, this impact is strongly concentrated in the dry season, drought-prone crop.

The two Logit models reconfirmed that location along the main canal can have a strong impact on poverty. This indicates that important factors that inhibit the poor from rising out of poverty are based on location specific conditions. However, these factors cannot be adequately analyzed from the aggregated dataset. Further research at the system level is recommended to better understand these location-based constraints.

Overall, the results show that the poverty situation in the two irrigation systems is impacted by many factors in addition to irrigation. Two factors that are important are education levels and economic diversification. Families with higher education levels and more sources of non-agricultural income tended to be non-poor. Other significant factors involve household land resources relative to family size. In particular, families with few laborers relative to family members tended to be much poorer. This also held for families that had relatively few land resources relative to the number of laborers. As the predominant cropping pattern is paddy and the potential for expanding cultivated land is severely limited, this points to the need to improve management of existing land. This can be facilitated by better performing irrigation systems, particularly in providing a reliable source of water in the dry season. Other areas include increased diversification, especially to drought resistant crops or crops that are less water intensive.

Future research should conduct a detailed water balance study, in consideration of other existing irrigation systems, to ensure that demand for irrigation will not exceed the existing water supply. Farmer knowledge should be enhanced so that cropping choices are in line with actual water supply conditions and that efficiency of use is increased. Finally, environmental considerations should be examined to ensure that any damage from changes in irrigation and irrigation management practices are mitigated.

Determinants of poverty in irrigated agriculture

The study also examined the determinants of poverty in irrigated areas. The study found that most people in the irrigated systems had diversified sources of income. The non-poor typically had more sources of income than the poor. The most important source of per capita income was rainy season crop production. Results from regression analysis also showed that non-agricultural sources of income played a significant part in the total income picture. However, it was the dry season crop which had a special relationship with income and negative deviations in income. This result indicates that ensuring a successful crop for the dry season can have a significant impact on preventing poverty. This is especially true in regard to the vulnerability of low income earners. This indicates a strong need to improve irrigation performance for all people, especially the poor.

Following on this conclusion, the study examined the importance of crop production as a source of income in the study areas. Regression analysis showed that both dry and rainy season crops were significant sources of income. The dry season crop, however, was shown to have a unique negative relationship with per capita income. This relationship was even stronger for negative deviations in income below the poverty line. This result indicates that it is the dry season crop which has the special relationship with poverty and poor incomes. This negative relationship may be the result of farmers who are less dependent on crop production backing off on their input use in response to expected poorer returns. Future research is recommended to examine the impact that poor irrigation performance has on differentiated patterns of input use between the poor and non-poor. The important outcome is that the dry season crop has a particularly unique relationship with poverty.

Analysis of village-level data indicated that poverty was strongly correlated with the number of laborers per household. That is, poor households tended to have fewer people working earn income per household member. The poor also tended to show lower levels of education, but this relationship is not so strong in the Nam Duong. This result may occur if higher educated people leave agriculture. Also associated with poverty is the amount of land per person. Households with less land per person tend to be poorer. This effect is stronger in the Nam Thach Han, than in the Nam Duong.

Trend analysis, using village level data, shows a strong negative correlation of poverty with land/man ratio and total assets and capital in Nam Thach Han. It also shows negative correlation of paddy rice yields with spring drought and summer inundation in Nam Duong.

In Nam Duong, income is positively associated with total asset and capital, education level, land-man ratio, and nonagricultural income. In Nam Thach Han income is positively influenced by total asset and capital, land-man ratio and non-agricultural income.

For both systems, the general cause of poverty is households lacking access to inputs for production such as labor, land, capital, advanced technologies, irrigation and drainage. This lack of access to inputs, including management knowledge, affects cropping patterns in such a way as to keep the poor from rising out of poverty.

Many of the identified constraints and opportunities from the determinants of poverty section do not relate directly to irrigation. However, this analysis did confirm that agriculture is a major source of income for both poor and non-poor alike. The main direct area for interventions from this analysis is:

- Improve irrigation performance in the dry season. This is especially true for addressing income vulnerability among the poor;
- Carry out comprehensive studies to determine the whole picture on causes of poverty in the irrigated area. This will also help to ensure that irrigation interventions achieve their full poverty alleviating impact.

Other areas for intervention include:

- Increased use of irrigation water for livestock raising (which has a significant impact on poverty);
- A follow up to this would be to devise appropriate methods for handling the water to ensure quality is maintained for other users;
- Extension work to help farmers develop additional sources of income or increase value of production.

Irrigation system performance and its impact on poverty

The research then examined the impact of irrigation performance on poverty. This section determined that water shortages in the Nam Thach Han were curtailing cropping intensity. Additionally, the levels of water productivity were rather low. The Nam Thach Han irrigation system, which suffers from serious percolation and evaporation, has a much lower water productivity than the Nam Duong.

In general, there is an uneven coverage of irrigation and drainage services. This leads to a less than clear picture concerning the impact of irrigation on poverty. In general, yields did seem to decline from head to tail, however, the declines were reported to not be significant.

Regression analysis examining the impact of different performance factors found that only drought frequency was significant, while three other performance indicators were not (timeliness, inundation, and sufficiency). Other factors found important were the number of non-agricultural income sources and the amount of land area. This confirms through empirical methods that incidence of drought is a significant area for improving irrigation performance, as it is significantly related to incidence of poverty.

In the Nam Thach Han, the net irrigated area is approximately 7,500 ha, the design command area of Nam Thach Han is 17,000 ha thus irrigation density is approximately 44 percent. In winter-spring rainy season when water is abundant upstream of Nam Thach Han dam, the tail end area of secondary canals, especially N2, N4, and N6 suffer from inundation thus do not require much water supply and substantial water quality is released to the sea. In summer, when water is scarce in the upstream of the dam, tail-end canals suffer from water shortage. Increased water storage upstream the dam and inside the command area by effective management of water storage in Vinh Dinh internal river, serving as drainage courses would increase water storage for summer season and increase irrigation intensity of Nam Thach Han system.

In Nam Duong, irrigation intensity of 100 percent is mainly due to additional implementation of various supplemental pumps, such as Mon Quang, Ngoc Quan, Kenh Vang, and water reuse pumps, at latter stage.

Cropping intensity in Nam Thach Han is less than two is because of unplanted area due to water shortage during the summer and inundation in winter spring. Cropping intensity of 2.1 in Nam Thach Han is due to winter crop. Output per unit of command area in Nam Thach Han of VND 15 million is much less than in Nam Duong of VND 20 million, due to more valuable crops such as vegetables.

A major part of water diverted into Nam Thach Han system is lost to downstream and the sea. Lost is meant in terms of production. A full and appropriate accounting would need to consider environmental flows as well. Water use in Nam Duong is more effective than in Nam Thach Han. From one cubic meter, Nam Duong can produce as much as VND4,800 while Nam Thach Han can produce only VND700.

Because of higher percolation and evapotranspiration output per unit of water consumed in Nam Thach Han is less than in Nam Duong. Relative water supply and relative irrigation supply in Nam Duong better meet crop and irrigation demand. Water delivery of Nam Thach Han is twice higher than the requirement of existing net irrigated area meanwhile water delivery of Nam Duong is only 60 percent of required by net irrigated area. Forty percent of the water required is met by other pumps developed at latter stages.

Head-tail equity in terms of water delivery shows better water availability in the tail-end for Nam Thach Han system. Much of the water supply is from return flow and drainage course storage. In Nam Duong, however, the water quality in terms of gravity irrigated and drained area at the tail end, Van Linh commune, is three times less than the head at Tri Qua Commune.

Output value per unit of labor in Nam Thach Han is higher than in Nam Duong. This is due to less labor being used on agricultural production, especially on irrigation. In both systems, the head has better yield than the tail-end but the differences is not big, only 4 percent in Nam Thach Han and 16 percent in Nam Duong. Nam Duong has higher irrigation benefit, especially per unit of diverted irrigation water, than Nam Thach Han. The same is true for system level profitability.

Infrastructure in Nam Thach Han is better than in Nam Duong. The number of IDMC staff in Nam Duong, 18.5 people/ha, which is required by the nature of pump system, is higher than in Nam Thach Han, 13.1 people/ha. The number of on-farm irrigation staff in Nam Thach Han is, however, almost two times higher than in Nam Duong. This is due to the nature of different on-farm management structure. In Nam Thach Han, farmers are not permitted to deal with water intake into their field plot meanwhile in Nam Thach Han farmer has to take water into their plot. In general, the performance indicators show that Nam Duong irrigation system has better performance than Nam Thach Han system.

Drought and inundation frequencies are used for cross system comparison. In Nam Duong, regression analysis shows that both income and rice yield are negatively influenced by inundation and drought, though not significantly, in both spring and summer seasons.

Water Management Institutions: Implications for the Poor

The institutional analysis examined the institutional organization and structures for management of water resources in Vietnam. On a national level, the analysis found that the legal foundation was still lacking in clarity and effectiveness. The Law on Water Resources was adopted in 1998. However, there are several areas that remain weak for various reasons. These include the establishment of the new Ministry of Natural Resources and Environment, which takes over some responsibilities for managing water. Other responsibilities will remain with the Ministry of Agricultural and Rural Development. While irrigation management will remain within MARD, it is still unclear how the new division of responsibilities will look like and how it will impact management of irrigation. Additionally, in the context of achieving integrated water resources management, the National Water Resources Council, which is charged with overseeing management of Vietnam's water resources, is still not functioning at full capacity. Moreover, river basin organizations, while established on paper, are not functioning at all. How this will impact irrigation management are issues needing urgent attention.

The management of irrigation and drainage systems is divided into two levels. The system level is managed by state companies (IDMC). The farm level is managed by the Cooperative. For the management of an entire irrigation and drainage system, the organizational structure is from the principal IDMC to the subsidiary IDMC, or enterprises, to the O&M field stations and finally to the agricultural Cooperatives. Most IDMC consider their role to include (a) providing irrigation water, (b) collecting irrigation fees, and (c) maintaining irrigation facilities. IDMCs typically are headed by a director who is assisted by a deputy. Under him are usually three or four departments for finance, administration, planning, and technical activities. In practice the director reports, IDMC's activities, to the DARD or to the PPC through DARD.

IDMCs are expected to operate as businesses and to be financially self-reliant, that is, to recover their own operating costs through user fees and other subsidiary income. At the system level, the issue of cost recovery remains a sticking point with managers reluctant to raise water fees and users reluctant to pay higher fees. The situation remains that collected water fees do not fully cover costs. This is despite very high collection rates in the studies systems (95 to 99 percent). The water fee remains the main source of revenue for the IDMCs. One pro-poor point is that water fees are reduced in times of drought (which will seriously diminish yields and incomes). Costs for construction of main infrastructures are subsidized by the government meanwhile O&M is paid by farmers in the form of water fee. Water fee is usually not sufficient for system proper maintenance causing deterioration of irrigation system.

The "no-man land" (secondary canals) is the weakest area in the system. With village-scale Cooperatives in the irrigation system, these areas become weaker. Support from the IDMC and Cooperative-led O&M in this land area would be an effective measure to involve water users and strengthen the communication between IDMC and Cooperatives. Moreover, many IMDCs cannot adopt this policy due to low water fees. *If Provincial authorities allowed the water fee to increase, this could enable the IDMC to give part of the water fee collected to the Cooperative conducting maintenance of secondary canal sections related to Cooperative water delivery. This is a measure for farmer involvement*. The constraint is that the authorities are reluctant to increase water fees.

Agricultural Cooperative consists of executive board, board of editors and service teams. Commonly Cooperatives deal with farm extension, crop protection, land preparation, electricity and water management services. On farm water management is in charged by water management team and local village communities. Farmers have to pay water fee to IDMC, conformed to water fee set by the government, and to Cooperative, on the need, for on-farm water management. The portion of payment to Cooperative and IDMC varies depending on the extent of services that IDMC provided to Cooperative and farmers and on the degree of farmers participation in irrigation management.

There is close communication between Cooperatives and IDMC in planning and carrying out O&M activities. For irrigation, IDMC and Cooperatives sign an irrigation contract specifying crop areas to be irrigated and make provision for water- delivery schedules and quality standards.

On a system level, the water-delivery schedule is devised by the Cooperatives and the IDMC. Farmers have varying degrees of input into the water-delivery schedule. In Nam Duong, farmers have little say, while in Nam Thach Han, the relationship with the farmers appears to be much better. This results in the farmers having a greater say in the water-delivery schedule.

Water distribution, in principle, is rotational among canal sections, especially for pump systems and those facing water-shortage problems. However, on the system level, it is rarely well operated. Upstream village farmers take water first to satisfy their need before water flows downstream. To cope with this situation many pumps were used in the downstream to supply return-flow water for downstream area. The on-farm water delivery, within each village community, is more equitably distributed.

In general, the water-delivery schedule tends to be poorly executed as the IDMC lacks adequate monitoring and enforcement resources and capabilities. In Nam Duong, for example, farmers at the head end will take water when they need it, rather than letting it flow to the tail end in an organized manner. This undermines the water-delivery schedule.

Issues that are identified for pro-poor interventions include:

- Resolution of recent restructuring including division and clarification of responsibilities.
- Revision of the law on water resources.
- Clarification and effective operation of river basin organizations.
- Examination of the impact of a full financially self-sufficient irrigation- management system on the poor.
- Improved farmer participation in the management of an irrigation system (especially setting the water delivery schedule).
- Improved monitoring and enforcement mechanisms for agreed water deliveries.
- Development of an incentive system for mutual good performance between managers and users.

Constraints and opportunities for increasing crop productivity

Rice yield in Nam Duong is positively associated with education level, hired labor, seed and negatively associated with inundation and drought in both season. Fertilizers are used excessively causing negative impact on rice yield. Rice yield in Nam Thach Han is positively impacted by herbicide and pesticide, education level and negatively associated with inundation, drought. Some major input uses such as seed and fertilizer are negatively associated with rice yield indicate non effective use of these inputs.

Increasing irrigation performance by reducing drought in spring and reducing inundation in summer would increase rice yield. Improving drainage will improve conditions for crop diversification and provide conditions for farmers to change from rice to more valuable cash crops. In both systems input use level is inefficient. Improving farmer knowledge on production would be a measure for productivity increase. One of the constraints is that the cost of further irrigation improvement is much higher than the initial investment.

Irrigation can raise farm incomes by increasing the cultivable land area, enhancing crop choice, cropping intensity and land productivity. The main crops in the irrigated area are rice and vegetables, and in the rain-fed area they are maize, cassava and potato. Crop intensity in the irrigated area is twice higher than in the rain-fed area. Land productivity in the irrigated area is twice higher than that in the rain-fed area. On a village average basis, there appears to be definite gains from irrigation over rain-fed agriculture. Within the system, land productivity does not always vary as predicted. In Nam Thach Han, for example, land productivity increased from head to tail of the irrigation canal.

In rain-fed areas, there are potential opportunities for poverty reduction by providing irrigation. *Providing irrigation to rain-fed areas and improving irrigation and drainage quality*, of currently irrigated areas, would not only increase farmer incomes, but also increase land-use intensity and provide conditions for crop diversification from rice to vegetables. This constraint, associated with better irrigation and drainage, would require a high-cost investment.

The results of the analysis show a high benefit from irrigation. Land productivity in the irrigated area is more than twice higher than in the rain-fed area. Due to a mismatch in information for Nam Thach Han, the hypothesis of the irrigation benefit across irrigation system is referred to only the Nam Duong irrigation system. The pattern of irrigation and drainage quality, rice yield and farmer welfare status at the head is higher while at the tail end it is lower, and there is a high correlation between irrigation and drainage quality, and land productivity and poverty rate. There is, however, no pattern where there is a higher irrigation benefit at the head and a lower irrigation benefit at the tail end.

As results from the previous analyses strongly indicated that irrigation played an especially important role within the season, additional analyses turned to an examination of the impact of irrigation in a seasonal context. Three regression models were run for a) both seasons, b) rainy season only, and c) dry season only. The models estimated the impacts of irrigation availability on the gross value product per hectare. Only the dry-season model yielded an acceptable fit with an adjusted R-square of 0.58. The analysis indicated that the availability of irrigation had the potential to significantly raise incomes. For a family of five, with an average-sized farm, this would amount to an increase in per capita income of VND332,600 (US$22) per person. This is equal to approximately 28 percent of the official Vietnamese poverty line and 19 percent of the World Bank's overall poverty line based on expenditures (World Bank 1999). Irrigation provides a significant contribution to the fight against poverty. This is also a strong indication for the necessity of maintaining the existing irrigation infrastructure.

Institutional and Technological Interventions: Implication for the Poor

A typical organizational structure for managing an irrigation system consists of an IDMC for the system level and Cooperatives for on-farm-level management. The IDMC typically consists of a Board of Directors with its several departments, mainly technical/water management, financial/administration to oversee system operation and field stations operating different sections of the system. Management of the system that is divided into many sections and layers requires effective coordination and good communication among the various sections and layers.

Clear written water delivery schedules and requests from the Head, IDMC office, field stations, and Cooperatives, as well as better information shared among related parties, to determine a refined schedule for each water delivery constitutes just a first essential step. It is important to have *timely information* on water availability and delivery status delivered to the head office, *strict monitoring and enforcement* of field stations and Cooperatives on water delivery in secondary and tertiary canals. Thus an *administrative environment for quick and timely action* during droughts is required to ensure implementation of the water-delivery schedule. The constraints associated are a lack of incentives for irrigation managers to improve water management. Providing an *effective incentive environment to irrigation managers* is an opportunity for better management.

There are ongoing efforts at reformulation of Cooperatives from the communal to a village base. Although in some areas communal Cooperatives still exist, their role is very formal. The actual body responsible for agricultural activities, especially water management, is the village. The *traditional village community is the most effective terminal unit in the multilevel/multilayer of the organizational structure for irrigation management*. The constraint is lack of detailed research on terminal units and pilot models to test the findings.

In the central region, natural hazards are a major cause of poverty. Improving irrigation and drainage conditions, by implementation of water-control structures, would greatly improve farmers' welfare status and prevent the non-poor from reentering poverty.

In Nam Thach Han, due to a major water-control infrastructure implemented during 2000–2001, drought and inundation damages have been reduced substantially. The water-control infrastructure helped prevent 13 percent of farmers from falling back under the poverty line during the 2002 drought.

Due to the hydrological regime and the topography characteristic, a large portion of water diverted into the irrigation system is just released to the Vinh Dinh river and wasted to the Eastern Sea. Though the Nam Thach Han irrigation system has brought about many irrigation benefits, an important part of the design command area has not yet benefited from the system. To further improve irrigation-system performance, improving the drainage management/capacity of the Vinh Dinh river (to drain flood water better and thus store irrigation water better) is highly recommended.

From the research results, several questions have been answered; however, many new questions have arisen. The research highlights, among other things, the critical need to continue efforts to address the topic of irrigation and poverty. One thing that is clear is that access to irrigation can play a pivotal role in reducing poverty in rural agricultural areas. In Vietnam, there is large scope for improving the current status of irrigation management. However, poverty alleviation from irrigation is interrelated to many other factors. Continued poverty alleviation efforts must address a wide range of issues in order to maximize their effect.

Chapter 12

Pro-Poor Interventions and Actions: The Way Forward

Interventions and Actions: The Way Forward

The research results and workshop discussions highlight four main areas in moving forward to improve irrigation management in a pro-poor manner in Vietnam. These are:

- Strengthening the policy environment
- Developing action-/policy-oriented research
- Innovating irrigation management
- Achieving financially/managerially self-sufficient irrigation institutions

Strengthening the legal/policy environment concerns the development, implementation and enforcement of appropriate laws and regulations. Of particular note from the discussion is the need to make laws that are clear and consistent. However, policy must be flexible and dynamic to be suitable to conditions in different areas and at different times. A frequently mentioned topic was the need for regulations that clearly dealt with the issue of water charges. There is a need for regulations that are specific in how punishments and enforcements should be carried out. This will require identification of responsible parties at different levels (grants of authority), means of funding or otherwise supporting efforts, and means of educating the users and managers.

Action-/policy-oriented research concerns what several participants pointed out as "unrealistic" research, i.e., research that targets topics that are not of issue to policymakers and/or yield results that are impractical in implementation. Researchers and policymakers should attempt to coordinate their efforts so that research is based on the practical needs of policymakers. Moreover, a sustained process of cooperation could help research results feed into the policymaking process. In this way, a system could be set up that increases cooperation between often disparate agencies and institutions, and refine the national-sector research agenda.

Innovating irrigation management is primarily centered on two ideas: a) participatory-management process and b) sound financial practices. The workshop and study consistently brought up the need to include farmers strongly into the management process. This would help make management more transparent, responsive and accountable to the water users. This is also related to a need to make irrigation management more autonomous. Currently, management is hampered by "too many cooks." Efforts are urgently needed to pursue this agenda, perhaps initially through pilot studies.

Achieving financially/managerially self-sufficient irrigation institutions is a subcategory of innovative management, but such a strong issue that it needs to be considered separately. Sound financial practices are related to water fees. There is a strong feeling in place that fees should be kept low in order to reduce the burden on poor farmers. Additionally, it is often felt that fees should be kept low due to poor- performing irrigation systems that do not offer reliable water supplies to farmers. Low fee-collection rates, in turn, result in a lack of capital to maintain, construct or repair irrigation infrastructure. There is also the related problem of low salaries for the irrigation managers. This condition results in a lack of incentives for staff to properly carry out their responsibilities. A process for implementing/creating a sound financial cycle needs to be developed, based on local needs and conditions as well as on the limitations of the central government.

The major issues, pro-poor interventions and action plan are summarized in table 12.1. To make progress toward the four identified areas, a coordinated commitment is needed on the part of national government leaders, local water managers and government officers, water users, national and international researchers, and donors. The next step will be to arrange a prioritized list to work with these issues based on feedback from high-level government officials. However, this must be done in a holistic and practical manner. While grassroots stakeholders and national government officials normally receive the focus of similar efforts, the importance of involving local-level water managers and government officials must be emphasized. It is crucial that these local-level players understand, and are committed to, any efforts to improve management of irrigation systems.

Table 12.1 Major issues, pro-poor interventions and action plan.

Issues	Pro-poor intervention	Actions
Unfavorable topography and distribution of rainfall, inflows.	Better utilize natural storage within command	1) Implementation of water-control infrastructures to increase drainage capacity and utilization of internal rivers and drainage courses.. 2) Better management of drainage courses. area.
Natural hazards.	Measures for mitigation of natural hazards.	3) Investment in water-control infrastructures, dam, dike, sluice gate and pump. 4) Increasing forecasting/warning. 5) River-basin water-use planning.
Small farm size/low land use intensity/mono rice culture.	Crop diversification. Increasing land-use intensity.	6) Providing rain-fed area with irrigation and drainage. 7) Improving irrigation and drainage condition of currently irrigated area. 8) Improving land use by identifying appropriate crops/ activitiessuitable for soil types. Restructuring cropping pattern. 9) Improving market and marketing.
Location specifics of poverty.	Locale-specific pro-poor approach.	10) Comprehensive study identifying the locally specific major causes of poverty. 11) Research need on the impact of irrigation performance on input use. 12) Locally specific pro-poor plan.
Farmer limited access to resources/agricultural knowledge.	Providing farmers with better access to resources.	13) Credit. 14) Education. 15) Irrigation and drainage. 16) Farm extension/improving farmers agricultural know-how.
Multi-poor impact factors.	Integrated pro-poor approach.	17) Multi-sectoral approach identifying main poverty causes and making/implementing integrated pro-poor action plan.
Lack of pro-poor-oriented policies	Providing pro-poor-	18) Strengthening coordination between research and policy. 19) Adding poverty reduction as criteria for selecting investment

in irrigation-investment projects.	oriented political framework in irrigation investment.	Project. 20) Inventing new criteria representing both the economic and the social impacts of investment. 21) Coordinated commitment on the part of national government leaders, local managers, government officers, water users, national and international researchers and donors.
Poor irrigation-management institutions.	Improving water-management institutions.	22) Better water management at system level rather than at on-farm level. 23) Clear written water-delivery schedule/request; timely information; strict control/patrol; environment for quick and timely action; incentive environment to irrigation managers. 24) Strengthening linkages between IDMCs and the on-farm water-management body. Clear and strengthening management articulation at the secondary-canal level, the no-man's land area. Enable IDMC to have enough fees for O&M and leave a portion of water fee collected to users for no-man's land irrigation management. 25) Strengthening *legal framework/unclear policy toward on-farm* water-management organization. 26) Utilizing traditional village community as the most effective terminal units in the multilevel/layer of organizational structure for irrigation management. 27) Clearly identifying the rights and responsibilities of IDMCs and water users in managing irrigation system.
Weak user participation.	Involving farmers in irrigation-system management.	28) Farmers' participation and recovery of cost payment. 29) Providing *mechanism for farmers' participation* in monitoring the fee, how it is spent and collected. 30) Providing seats for farmer representatives in the management board of IDMCs. 31) Government commitment and support/no *intervention of government in the activities of WUG.*
Poor irrigation-system monitoring and analysis procedure. Equipment/ irrigation staff does not meet requirement for management of the system.	Improving management capacity.	27) Providing the irrigation system with a water-monitoring system. 28) Developing an accurate database. 29) Training staff (IDMC and on-farm) on:· • hydraulic/hydrological regime of irrigation system.· • rop-water requirement/irrigation requirement.· • water measurement/monitoring.· • modernization of irrigation system.
Lack of fund/system deterioration/poor infrastructural condition.	Increasing water fee/providing effective cost-sharing mechanism.	29) Upgrading infrastructure to increase the reliability of irrigation and drainage. 30) Providing local authorities dialog/information on the importance of water fee and cost sharing. 31) Enabling an environment for IDMC to increase water fee, where it is too low compared to the current water fee frame. 32) Gradually provide IDMCs with financial autonomy. Financial transparency to users. 33) Study on, and assessment of, the technical, institutional, scale and social impact of small-scale irrigation transfer. 34) Transferring small-scale irrigation infrastructures to farmers. 35) Cost-sharing mechanism requiring users and government to share cost at all levels of the irrigation system.

Water-resources management political/ institutional legal foundation lacking in clarity and effectiveness/ unclear distinction of responsibilities and cooperation among policymaking agencies.	Strengthening the legal/ political environment for effective water-resources management.	32) Improving coordination among related agencies/authorities/ stakeholders. 33) Clarifying responsibilities among stakeholders involved in managing water resources. 34) Legally defining water right; utilizing traditional (custom) water right. 35) Strengthening river-basin water-management organizations. 36) Elaborating law, resolution, ordinances, order and decrees, and providing bylaws, decisions, directives, circulars, instructions for implementation of the law that enable effective water-resources management.

Report on the Workshop on

Pro-Poor Intervention Strategies in Irrigated Agriculture in Vietnam 6-7 May 2003, Vietnam Center for Irrigation and Water Supply Research

Inaugural and technical session

The final Vietnamese national workshop on Pro-Poor Intervention Strategies in Irrigated Agriculture in Vietnam was held from 6 to 7 May 2003 at the meeting hall, Vietnam Institute for Water Resources Research (VIWRR). The workshop was coorganized by the CIWRS and the International Water Management Institute (IWMI). The purpose of the workshop was to present results for the Vietnam component of the ADB-funded *Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia* project (the Project). Additionally, the workshop aimed to identify potential interventions, develop ideas for a national action plan, and to identify priority areas for future research. The project was attended by numerous Vietnamese officials, specialists, and international experts (See annex for the complete list of participants).

Day 1. Opening section

The opening speech was made by Prof. Pham Hong Giang, Vice Minister, Ministry of Agriculture and Rural Development (MARD). Dr. Giang highlighted the role of irrigation in poverty reduction in Vietnam. He then emphasized the importance of the *Pro-Poor Intervention Strategies in Irrigated Agriculture in Asia* project in identifying and assessing opportunities and constraints to improving the returns to poor farmers in irrigated areas through increased production while, improving the overall performance and sustainability of established irrigation systems in Vietnam. He was positive of the results of the project and confident about the potential to extend the results to other systems.

Dr. Eric Biltonen, on behalf of IWMI, welcomed everyone to the Workshop for the ADB-funded project on "Pro-Poor Intervention Strategies in Irrigated Agriculture in Vietnam." He briefed the participants on the project's goal and objective. He stated that the purpose of the National Workshop was to present the findings and results obtained from the research as well as to share other experiences and knowledge about the water and poverty link. Participants were encouraged to give their:

1. Feedback on the study outputs.
2. Input in identifying pro-poor interventions.
3. Input in identifying clear actions for alleviating poverty in irrigated agriculture.
4. Input in developing partnerships for implementing identified interventions and actions.
5. Ideas and issues for further research.

Section 1. Irrigation and Poverty

Dr. Nguyen Hai Huu, MOLISA made the first presentation on "The impact of irrigation systems on poverty alleviation in Vietnam." Dr. Huu summarized three groups of poverty causes. The first group included unfavorable natural conditions and poor infrastructure (the most important of which were irrigation and drainage, transportation and electricity). The second group included slow movement in policy changes, especially in the areas of investment in infrastructure, sharing of resources and responsibility, and water-resources management and development planning. The third group was insufficient education and knowledge of farmers. Dr. Huu then presented the results of two cases of successful poverty reduction. The first one was the case of the Bac Lieu province. Due to investment in water supply for diversifying the agricultural production structure, poverty was reduced by 4.1 percent, which was the highest poverty reduction rate in the Mekong river delta for 2002. The second was the case of the Northern Mountainous and Midland Provinces. Due to investment in infrastructure with a special emphasis on water control, the poverty reduction rate was 5.6 percent in 2002 compared to 1.6 percent, as the country average.

Mr. Nguyen Xuan Tiep, MARD made a presentation on "Irrigation institutions and policy aimed at poverty alleviation in Vietnam." Mr. Tiep gave details on the causes of poverty as lack of land, credit, knowledge, job, high population, poor natural conditions, and poor infrastructure (of which irrigation and drainage are the most important). He then argued that improving institutions and policy would have a high poverty reduction impact. Mr. Tiep pointed out that investment and water fees had not received proper attention and that reforms are needed in this area.

There was one question following Mr. Tiep's presentation. One participant asked about policy that has not been properly implemented, which has resulted in suffering in the highland regions due to drought and underperforming irrigation systems. The participant asked why there were no proposed regulations for a solution. Mr. Tiep answered that the government often has long-term plans for the development of systems. However, the government cannot meet excessive water demands of the people. For example, if all people plant coffee in water-short areas, then the government cannot meet those demands. Mr. Tiep also mentioned that many ministries invest in irrigation investment plans; however, there has not been good coordination between the ministries thus far. This is an area that needs improvement.

Mr. Nguyen Van Tu, MARD, made a presentation on "Irrigation and poverty reduction in remote and mountainous areas." Dr. Nguyen Van Tu reviewed major governmental pro-poor directions and policies for mountainous and remote regions. In 1963, the politburo issued Resolution 71 on the development of rural mountainous areas. In 1968, the government issued Resolution 38 on sedentarization and resettlement. In 1989, the politburo issued the main socioeconomic development policy for mountainous areas. In 1990, the government issued more detailed policies for socioeconomic development of mountainous areas. In 1998, the Prime Minister approved economic development for communes with special difficulties in mountainous and remote areas. In all of these documentations, irrigation and water supply occupied central attention. Due to good policy, a poverty reduction rate of 4-5 percent per year had been achieved in mountainous and remote areas. Future poverty reduction would face some difficulties. The poverty rate was still high and varied from region to region. Production in mountainous areas was slowly developing while, seasonal water shortages prevailed. Irrigation technology was not as widespread as other agricultural technology. There was also low irrigation system efficiency and performance. Poverty reduction programs in mountainous areas should pay attention to irrigation for upland crops and improvement of irrigation performance and irrigation extension. Sedentarization and resettlement programs should emphasize more on irrigation

Dr. George E. Radosevich, RAD International, made a presentation on the “Impacts of poverty reduction from formation of water user associations: Experiences in China.” He gave a well received presentation on China’s experiences with the establishment of WUAs. China’s experiences are highly relevant to Vietnam in that there is an urgent dual need to improve the management of irrigation water in the agriculture sector and to enthusiastically pursue poverty reduction strategies. While China initially focused on the improvement in irrigation management when establishing the WUAs, the poverty reduction benefits were both noticeable and significant. The knowledge gained from the Chinese experience could greatly contribute to similar efforts if undertaken in Vietnam.

Mrs. Nguyen Thi Hien gave a presentation on “Pro-poor intervention strategies in irrigated agriculture in Vietnam: Overview of literature.” Her presentation showed that many reports prepared by international and national agencies on the water- resources sector have not paid much attention to poverty eradication. Poverty issues have not been raised in developing goals for the governance of irrigation or in recommended actions. Most of the existing literature is full of technical and economic data on the current status of irrigation, drainage and water resources, but little about poverty or poverty-related irrigation issues in the region. Regarding irrigation and poverty at the system level, the common answer is that water-resources management faces the following challenges: poor institutional and policy framework; ineffective management (e.g., duplication of organizations, too many levels of management, poor implementation of policies and regulations); poor material and infrastructural bases; financial constraints (e.g., lack of funds for investment in new schemes, mismanagement of water fees) and inadequate participation in water fora (e.g., lack of understanding and involvement in water control)

In a review of the formal and informal irrigation-related institutions in Vietnam, from micro to macro level, the reviewer pointed out that the irrigation benefits should be targeted on the poor through mechanisms such as employment-intensive construction, operation and maintenance practices; approaches that allow greater access to water, particularly in times of scarcity (owing irrigation systems, selling water for profit, water rights, and allocations of irrigable land and accessing small or marginal quality supplies); compensation and justice for dispossessed cultivators; institutional reforms that give security of water supply to the poor in times of scarcity; and mobilizing small or marginal quality supplies to help disadvantaged rain-fed farmers.

Regarding research, coordination was recommended in doing research among irrigation professionals, economists, policy analysts, sociologists and gender experts, as the objects of research are multidimensional and, therefore, require diverse approaches and viewpoints. It was also important to have a well-agreed direction for the management of research projects to avoid duplication or fragmentation of the outcomes of studies. An important lesson from the experience here was to strengthen on-time and frequent information exchange.

Mrs. Tran Phuong Diem gave a presentation on the Impact of institutions and policy on the management of irrigation systems. She focused on the institutional and policy shortages regarding irrigation system staff and financial activities and on-farm-level irrigation-management organizations. She concluded her presentation with recommendations on water fee payments, staff training, small-scale irrigation transfers from IDMC to farmers and farmer participation in irrigation-system management.

Mr. Dinh The Hung, CIWSR, gave a presentation on the Method and results of poverty assessments in the Nam Thach Han and Nam Duong irrigation systems. The study used both primary- and secondary-level data and information. Primary data were collected through Participatory Rural Appraisals (PRAs), key stakeholder interviews/consultations and household level surveys. Secondary data were obtained from secondary sources such as past research studies, project reports and documents. Data analysis was conducted indoors using PC.

For this research, four PRA tools were used: Focus Group Discussions (FGDs), Mapping, Household surveys and Semistructure interviews. FGDs were conducted in all communes with the participation of commune leaders (People's Committee Chairman and Party's Secretary), representatives of organizations (Cooperatives, Women Union, Farmer Association, etc.), specialized and responsible cadres (Transportation-Irrigation cadres, Land cadre, etc.) and village leaders. The content of the discussions focused on the commune's institutions and organizations, the socioeconomic situation of the commune, commune policy, development of agriculture, and irrigation and poverty issues. FGDs were also conducted in villages of target communes. The mapping method was used to define the administrative boundary of a village, land distribution pattern, location of households and the on-farm irrigation network.

Altogether 960 households were interviewed. The participatory assessment that went along with the survey provides supplementary information for the quantitative data. The community questionnaire concentrated on socioeconomic aspects (such as population, labor, institutional structure and agriculture) and infrastructural issues (such as roads, schools, markets, water supply and health centers) of the study communes.

The objective of the study was to improve our understanding of how, and to what extent, irrigation contributes to poverty reduction, what are the key dimensions, and are there any spatial patterns in distribution of the poor and access to irrigation water along various reaches of irrigation systems. The research focused on the following research questions: What are the poverty situations in the study area? And where are the poor people located along irrigation systems.

Mr. Nguyen Van Chinh, CWRE, gave a presentation on the Analysis of basics assets of poor and non-poor households in Nam Thach Han and Nam Duong irrigation systems. From survey information in Nam Thach Han and Nam Duong he pointed out that the labor in poor households is spent to earn a living for more people than those in non-poor households. This was a limitation of the poor in the improvement of their living standard because the larger the population of the poor households, the greater the financial burden they incurred.

In both systems, members of poor households were older than those in non-poor households, but the education level of the poor is lower than that of the non-poor. These were the limitations of poor households in the systems in terms of agricultural production. Farmers who are younger and had a higher education may have easier access to advanced technologies and practices for agricultural production as well as to other activities.

As far as cultivation land was concerned, while poor households in Nam Duong had more land than the others, the situation in Nam Thach Han was quite the opposite. This means that in Nam Thach Han cultivation land had a close correlation with the poverty situation or that where there was more cultivation land, there was a lower poverty rate. However, the situation in Nam Duong system seemed the opposite. This implies that other factors may outweigh cultivation land in poverty reduction.

Poor households had less capital, cattle value and production tools than the non-poor households. Overall, the values of these households tended to reduce from the head to the tail end of the systems. This means that the economic capability of households at the head is better than that at the tail end and that the economic capability of non-poor households is better than that of the poor. This may lead to low production capability of poor households and to their limitations in applying advanced technology solutions in production.

Mr. Nguyen Van Quy, HAU, gave a presentation on the Analysis of production structure and income of poor and non-poor households in Nam Thach Han and Nam Duong irrigation systems. The primary household production and income was agriculture, where rice occupied an important position. Thus irrigation played an important role in household production and income. The income was affected by various factors such as inputs, knowledge, and selling price. Cultivation income occupied 50 percent of agricultural income and animal husbandry occupied 50 percent. The main cultivation crop was rice, which occupied 84 percent of cultivation income. The household status is however not impacted by rice cultivation. The non-poor produced cash crops. Nonagricultural income occupied 40-50 percent. The poor had a very limited income from nonagricultural activities: mainly labor-intensive and low-investment activities.

Dr. Eric Biltonen of IWMI gave a presentation on "Pro-poor intervention strategies in irrigated agriculture in Vietnam." The study first showed that there are spatial patterns to the performance of irrigation within the systems, but that this information is less-pronounced when systems are aggregated. Furthermore, within the two systems the spatial patterns do not follow any predictable pattern such as declining factors from head to tail. The study showed that farmers respond in a rational way to the availability of irrigation through their cropping decisions. Cropping patterns in the two irrigation systems are dominated by paddy, which is a water-intensive crop. In the dry season, marked by a higher incidence of drought, farmers make little reduction in cropped area for paddy. This implies that the farmers will make use of irrigation water if it is available in the canals. This is a strong indication that if irrigation performance is improved (especially in areas of frequent drought), then farm production will improve as well.

Following this conclusion, the study examined the importance of crop production as a source of income in the study areas. Regression analysis showed that both dry- and rainy-season crops were significant sources of income. The dry-season crop, however, was shown to have a unique negative relationship with per capita income. This relationship was even stronger for negative deviations in income below the poverty line. This result indicates that it is the dry-season crop which has a special relationship with poverty and poor incomes. This negative relationship may be the result of farmers who are less-dependent on crop production, backing off on their input use in response to expected poorer returns. Future research is recommended to examine the impact that poor irrigation performance has on differentiated patterns of input use between the poor and the non-poor. The important outcome is that the dry season crop has a particularly unique relationship with poverty.

The link between irrigation availability and irrigation performance was examined. Two Logit models were constructed to examine these factors as predictors of income- defined poverty. The availability of irrigation was shown to have a significant predictive ability of poverty. However, this relationship was positive (i.e., the greater the area of irrigated land, the more likely one is to be in poverty). This conforms to the data, which show that the poor tend to have better irrigation coverage. However, due to the long-standing policy of the government to build equality among its people and to alleviate poverty, this result is not so unusual. The Logit model that examined different aspects of irrigation performance showed that only drought was a significant predictor of poverty. The drought variable also had an expected positive relationship with poverty (i.e., the greater the occurrence of drought, the more likely a household was to be poor. Both models show that, in Vietnam, performance has a key impact on poverty alleviation. Furthermore, this impact is strongly concentrated in the dry season, drought-prone crop.

The two Logit models also showed that the location along the main canal can have a strong impact on poverty. This indicates that important factors, which inhibit the poor from rising out of poverty, are based on location-specific conditions. However, these factors cannot be adequately analyzed from the aggregated dataset. Further research at the system level is recommended to better understand these location-based constraints.

As results of the previous analyses strongly indicated that irrigation played an especially important role within the season, the final part of the analyses turned to an examination of the impact of irrigation in a seasonal context. Three regression models were run for 1) both seasons, 2) rainy season only, and 3) dry season only. The models looked at the impacts of irrigation availability on the gross-value product per hectare. Only the dry-season model yielded an acceptable fit with an adjusted R-square of 0.58. The analysis indicated that the availability of irrigation had the potential to significantly raise incomes. For a family of five with an average-sized farm, this would amount to an increase in per capita income of VND 332,600 (US$ 22) per person. This is equal to approximately 28 percent of the official Vietnamese poverty line and 19 percent of the World Bank's overall poverty line based on expenditures (World Bank 1999). Irrigation provides a significant contribution to the fight against poverty. This is also a strong indication of the necessity to maintain existing irrigation infrastructure.

Overall, the results show that the poverty situation in the two irrigation systems is impacted by many factors in addition to irrigation. Two factors that are important are educational levels and economic diversification. Families with higher education levels and more sources of nonagricultural income tended to be non-poor. Other significant factors involve household land resources relative to family size. In particular, families with few laborers relative to family members tended to be much poorer. This also held true for families that had relatively few land resources relative to the number of laborers. As the predominant cropping pattern is paddy and the potential for expanding cultivated land is severely limited, this points to the need to improve management of existing land. This can be facilitated by better-performing irrigation systems, particularly in providing a reliable source of water in the dry season. Other areas include increased diversification, especially to drought-resistant crops or crops that are less water-intensive.

The next step in creating pro-poor interventions involves in-depth research at the system level. This will help formulate specific knowledge on areas where definite actions can be taken. This report has shown that availability of irrigation is important. It has also shown that frequent occurrences of drought are a serious detriment to poverty-alleviation efforts and should be a focal point for the development of irrigation-management interventions.

Future research should conduct a detailed water-balance study, in consideration of other existing irrigation systems, to ensure that demand for irrigation will no exceed the existing water supply. Farmer knowledge should be enhanced so that cropping choices are in line with actual water-supply conditions and that efficiency of use is increased. Finally, environmental considerations should be examined to ensure that any damage from changes in irrigation and irrigation-management practices are mitigated.

Day Discussion

A question was raised regarding the environment and shrimp farming in light of the fact that the environment is a big problem. The respondent pointed out that with shrimp farming there are always advantages and disadvantages. In Bac Bien, two advantages are that a) there is good drainage and b) a good process has been established in regard to shrimp raising that follows through from production to marketing. Additionally, Bac Bien has adopted strict standards regarding shrimp varieties and water quality to mitigate environmental damage.

A follow-up comment was given regarding the difference between shrimp farming in the north and the south of Vietnam. In the north, shrimp farming is normally undertaken by rich farmers, so this is not a pro-poor strategy. The poor often suffer from environmental degradation caused by the shrimp farming. Additionally, continued access to many resources by the poor is blocked by the rich households.

A comment was given regarding the establishment of Water User Associations. George Radosevich stated that it is appropriate to establish them only where irrigation conditions are good and water quantity is sufficient.

Day 2, Section 2. Irrigation Performance and Impact on Poverty

Dr. Su opened the morning session for day two of the workshop.

Dr. Dang The Phong, VASI, made a presentation on the operation and assessment of irrigation performance of Nam Duong and Nam Thach Han systems. He started the presentation with the characterization of two irrigation systems and the performance indicators of each system. The presentation concluded with recommendations for poverty reduction and system performance.

Mr. Colin Steley, ADB, gave a presentation based on the formulation of a water-resources investment strategy developed for the Central Region of Vietnam. The project was the ADB funded TA 3528: subproject 2. This project was charged with devising a method for the identification and ranking of different projects within the water resources sector. The different sectors considered included large multi-purpose hydropower dams, irrigation and drainage infrastructure, sea dykes, flood control, rural water supply and sanitation, municipal and industrial water and waste water, and watershed management and soil conservation.

For their project, they need two key measurements 1) the poverty rate before and after the project, and 2) the likely distribution of project benefits.

There are four main problems with previous studies:

1. Prior feasibility studies had no meaningful social impact assessments,
2. There were no subproject poverty estimates,
3. There were no district level GSO/WB estimates,
4. There was no correlation between MOLISA and GSO/WB provincial poverty estimates.

Faced on these problems, it was decided that provincial staff estimates of subproject poverty incidence would be used. Poverty estimates are usually based on MOLISA criteria; however, there was no correlation between aggregate statistics and official estimates.

The interpretation of the estimated rankings showed that there was limited investment potential. Of the total projects, only 54% had a benefit-cost ratio over 1 and only 35% had a benefit-cost ratio over 2. The study found that only 3% of the subprojects had a poverty incidence over 10% and only 10% of subprojects had a high poverty impact. There were, however, promising subprojects in all seven water sectors. Results showed that the north central coast and the south central coast regions were investment priorities rather than the central highlands. This unexpected result was based on the conceptual approach to examining poverty. The central highlands region is marked by very high poverty rates; however, the study team experience point to significant poverty in the coastal areas. By switching the focus from poverty rates to density of poverty the resulting conclusion was confirmed: there is significant poverty in the coastal areas.

Field visits undertaken during the study indicated significant potential to improve formulation and preparation of subproject, particularly those involving irrigation improvements. None of the proposed subprojects was based on a participatory diagnostic survey of whole irrigation systems. Such an approach would be particularly important to determining performance constraints and to identify measures to alleviate the constraints, including agricultural, management, and infrastructure interventions. Overall, the study found a noticeable lack of social assessments and poverty alleviation concerns in subproject formulation and preparation. The project also found that land holdings had a significant impact on poverty alleviation benefits.

Dr. Nguyen Trung Dung, Hanoi Water Resources University, presented some preliminary results from a study in cooperation with Mekong Economics. The hypothesis for Dr. Dung's study was that improvements in irrigation and poverty are a powerful instrument for reducing poverty. Two approaches are being adopted:

1. A comparison of means (propensity score matching)

2. Regression methods (instrumental variables)

They had also adopted a method of examining differences on a head-middle-tail basis. Additionally, study areas had been chosen to include places both with and without rehabilitation. This project had just finished collecting data.

Mr. Nguyen Khac Suong, Nam Duong IDMC, gave a presentation on the importance of pro-poor irrigation and constraints and opportunities for Nam Duong irrigation system performance. For the Nam Duong Irrigation System it was proposed that the Nhu Quynh (Main) Pumping Station be upgraded as a first priority. As a second priority, efforts should be made to transfer management of the tertiary level canals to local authorities. A third proposal was to improve the general management of the irrigation system. Finally, it was proposed that grassroots irrigation groups be reestablished.

The largest constraint for the Nam Duong Irrigation System was given for the category of financial management. Proposed action for this constraint was the provision of training for the group on payments and expenditures. Water fees are collected as in-kind (paddy) payments. It was proposed that all water fees should be collected in cash. Related to water fees, the legal decree respecting water fees should be improved and made less complicated. Fees should be collected by farmer user associations. Finally, if the payment is made in kind, then it should be at a reduced value to the market price (e.g. 90%). This would provide an incentive to the farmer to sell their crops and pay the water fee in cash.[6]

In regards to payments for operational costs made by the IDMC, mention was made of the electricity costs related to operation of the Nhu Quyen Pumping Station. Currently expenses are due soon after they are incurred. However, water fees have not been collected since crops have not been harvested yet. It was suggested that payment system be established where payment for electricity were due every 6 months or according to the season. It is believed that this arrangement would ease seasonal financial strain on the IDMC.

Mr. Nguyen Dinh Thanh, Quang Tri Department of Agricultural and Rural Development, made a presentation on pro-poor irrigation interventions in Quang Tri Province in general and in Nam Thach Han Irrigation System in particular. The main poverty causes in Quang Tri are natural disasters such as droughts and flood as well as. low farmer education level that are also a constraint.

[6] Dr. Su stated that currently water fees are collected in cash.

Investment in water control has a high poverty reduction effect. Nam Thach Han irrigation system was among irrigation systems that have high performance in Quang Tri. High performance was due to strict and clear rotational water delivery policy, which gave privilege to tail-ends. High water fee collection rate of 100% was due to policies such as open to clients, stimulating by reward, strict punishment and reward.

The Nam Thach Han Irrigation would benefit from several improvements. It was suggested that on-farm network should be improved and that training be provided to farmers so that they better understand the water supply system. In this way, farmers would become aware of both sides of the management problem, which would ease the way for more effective cooperative arrangements.

Some proposals for the Nam Thach Han Irrigation System included rehabilitation of the irrigation works. It was also suggested that increased research on crop diversification could be beneficial. Increased awareness of the entire management picture would aide in effective management operations. Irrigation management staff would benefit for training. Finally, it was proposed that baseline studies in the use of groundwater be conducted.

Dr. Doan Doan Tuan, CIWSR, made a presentation on poverty causes and the impact of irrigation performance on poverty in Nam Thach Han and Nam Duong irrigation systems. Statistical and correlation analysis was conducted on basic household production conditions (i.e., labor, land, irrigation and drainage, and costs), production results (cultivation, livestock, and non agriculture), income, consumption and expenditures to see how different factors impact poverty. Drought and inundation frequencies of each plot were used as the main irrigation performance indicators.

The main cause of poverty was household's lack of access to inputs for production such as labor, land, capital, advanced technologies, irrigation and drainage. This lack of access to inputs, including management knowledge, affected cropping patterns in such a way as to keep the poor from rising out of poverty.

For the Nam Duong, income regression showed that income was positively influenced by agricultural income, total assets and capital, land/man ratios, and non-agricultural income. It was negatively influenced by the dependency ratio, drought in spring, and summer rice production costs. The spring rice yield was significantly impacted by production cost, land productivity, and dependency ratio. It was negatively impacted by drought. Summer rice yields were positively influenced by land productivity and dependency ratio and negatively impacted by inundation.

For Nam Thach Han, income was positively influenced by total assets and capital, the land/man ratio and non-agricultural income and summer inundation. Spring rice yield was positively influenced by land productivity, land-man ratio and negatively impacted by drought, income level. Summer rice yield was positively influenced by land/man ratio, land productivity, and drought frequency.

The impact of summer drought on rice yields was significant and positive. The positive relationship was not as expected. This might be caused by initiation of functioning for a rubber dam at the headworks that increases water storage, as well as the new Viet Yen sluice and An Tiem siphon preventing flooding and salt intrusion since 2001. The inundation and drought frequencies, however, were based on 5-year farmer experience, which had likely been impacted significantly by the new infrastructure development.

Current income distribution and drought damage for the 1998 summer season were used to simulate how drought impacts poverty. If there had not been irrigation and drainage improvements from the construction of the rubber dam, An Tiem siphon and Viet Yen sluice which had began functioning in 2001, and a drought similar to 1998 had occurred in the Nam Thach Han system, the poverty in Nam Thach Han would raise from 18% to 31% and 13 percent of non-poor would fall under the poverty line.

Dr. Doan Doan Tuan, CIWSR, continued to present on irrigation institutional interventions and innovations and the basic unit for on-farm water management. The presentation used field survey information from Nam Duong and Nam Thach Han irrigation systems to clarify the irrigation *Institutional structure* focusing *on farm* water management level and the *articulation* between IMC and on-farm water management organizations.

A clear *written water delivery schedule and request, strict control over hydraulic structure operation* enabling smooth hydraulic regime and administration *environment for quick and timely action* during drought/flood were important factors to improving *system performance*.

The agricultural cooperative had been changed and yet effective form had not been created. During this changing process, the *traditional village* gradually occupied the main role in production activities especially in on-farm water management.

Due to limited resources, many IDMCs could not fulfill their duty on secondary canal O&M and left it to the commune and cooperative. Creating conditions to help IDMC take more responsibility on this no-man land would create a *cost sharing mechanism* that accelerate the village's contribution and strengthen the articulation between IDMC and on-farm water management organizations.

Discussion

A question was raised concerning the government's role and the activities and approaches in other systems than those presented at this workshop. An enquiry was made regarding the existence of other studies examining local level institutional arrangements. This is interesting as the Pro-Poor project is looking at institutional innovations. These should be examined under the premise "if it isn't broke, don't fix it".

Dr. Su commented that from the State management perspective, change has moving from a subsidized approach to a market oriented approach. However, this is taken place under essentially identical institutional arrangement. It was mentioned that MARD had proposed a sub-ordinance on the protection of irrigation systems. There was also a working decree that made all users equal to the state in use and consumption. Work is being carried out to rehabilitate existing systems and construct new systems. Additionally, there are 170 IDMCs working to improve the operation of irrigation systems. It was mentioned that there would be an upcoming meeting in Da Lat to discuss the criteria for selecting WUAs or community based Water User Groups. The goal is to establish public utility IDMCs, but that these would require a subsidy to operate effectively. In the Long Run it is hoped to develop a water market.

Identification of constraints and opportunities, development of country specific action agendas (Dr. Eric Biltonen/Dr. Doan Doan Tuan)

Following the conclusion of the paper presentations, a discussion was undertaken on the constraints and opportunities identified in the study and workshop presentations. The purpose was to identify potential interventions, to determine actions, and to identify future directions for research.

Dr. Eric Biltonen, IWMI, led the discussion with a brief introduction to focus the talk and offer some ideas for further discussion. He restated that regarding potential interventions the discussion should concentrate on management interventions rather than infrastructural interventions. Additionally, interventions should, as much as possible, be related to the specific irrigation systems. It was further stated that it was understood that good irrigation system performance relied on both good management and good infrastructure. However, the focus of the study was on management interventions of existing irrigation systems.

In regard to action, Dr. Biltonen stated that proposed actions should be realistic and practical. This meant that potential partners should be identified as well as processes for implementation. Finally, it was deemed crucial that proposed interventions have enough support to ensure success.

The final topic for discussion regarded future research needs. Through the presentation and preceding discussions it became apparent that there was a real need for policy-linked research rather than only academic research. That is, research topics had to be relevant to the policy makers needs and research results should be practical and useful in meeting management needs. Another issue raised for discussion included the need to strengthen institutions for the effective implementation of laws and regulations. This would further strengthen the effective operation of irrigation systems. Another possible area for research included an investigation into the optimal balance between infrastructure and management development. Finally, it was proposed that the use of budgetary incentives to improve management may be an area for future research. The discussion proper began with a list of constraints as identified by Dr. Doan Doan Tuan, CIWSR and Dr. Eric Biltonen, IWMI.

Constraints to improve management included:

- Lack of pro-poor oriented policies in irrigation investment projects
- Lack of research on the irrigation and poverty linkages
- Lack of accurate data
- Lack of water measurement devices in the systems
- Lack of consistent monitoring procedures
- Lack of coordination among related authorities
- Existing policies not effectively implemented
- Management of water not fully responsive to farmer needs
- Lack of linkages between agencies and stakeholders
- Lack of legitimate and clear rules and roles for group for irrigation activities, as well as a lack of water user groups themselves
- Related non-water sectoral problems (e.g. poor roads, low education level, etc.), and,
- Low water fees compounded by a lack of willingness to pay/charge suitable fees
    - Leading to insufficient salaries for irrigation managers
    - Leading to lack of capital for construction or rehabilitation.

Potential actions included:

- Development of an accurate database
- Strengthening on-farm water management institutions and organizations
- Training of on-farm water management staff
- Development of useful models to aid/guide management
- Strengthening/establishing a participatory management process
- Strengthening coordination between research and policy, and,
- Utilizing the traditional village as the basic/terminal unit in conjunction with a hydrologic boundary approach to overall management.
- Strengthening communication between irrigation authorities and village community regarding no-man land irrigation management.

Potential actions to improve performance included:

- Development of clear delivery schedules and effective enforcement
- Development of cost sharing mechanisms to help create farmer sense of ownership of irrigation system
- Equip irrigation systems with water monitoring devices, even simple devices such as water level meter will greatly improve irrigators knowledge about water deliveries for improved water management
- Investment in infrastructure to increase the reliability of the water supply
- Transfer of irrigation technology, and,
- Invest in pro-poor interventions in management and infrastructure for irrigation in mountainous areas.

Comments by the participants

Colin Steley remarked that there was a definite need for a more holistic approach to resolving problems at the system level. From his work, he noticed a complete lack of a participatory diagnostic procedure for problems regarding infrastructure, irrigation, and agriculture. He stated that from his experience, poor maintenance is normally a symptom of poor performance rather than a cause. At the macro level investment information and data (such as on irrigation, road, market, electricity, credit, pro-poor impacts, etc.) should be collected to build a model for assessing the impact of different factors on poverty reduction.

The participant from the Nam Thach Han IDMC indicated that natural disasters are the main cause of poverty in the central region. The investment in water control infrastructure has had a high pro-poor impact. He then discussed the constraints of the current water fee. He stated that the farmers have many reasons not to pay this fee as there is frequent drought and inundation within the system. Therefore, the farmers would like a lower fee. Often the local authorities are in agreement with the farmers over this. There needs to be a clear regulation on punishment and reward for payment of water fees. Also, an integrated catchment management approach needs to be adopted to improve supply and demand management of all water resources. Proposed potential actions include the improvement of on-farm networks, management capacity building for irrigators, and restructuring cropping patterns.

One participant remarked that there are a number of studies on different regions (within Vietnam). The approach adopted by Colin Steley is in line with a holistic approach. There remain mountainous areas where farmers manage themselves. They are in need of investment from the government. Most can identify the impact that irrigation supply has on poverty.

Peiter Smidt of the ADB stated more attention needs to be paid to management at the time irrigation system is being developed. Currently, most irrigation systems are designed from an engineering perspective. Efforts must be undertaken to improve the transparency of management. Related, the issues of water rights remain a difficult issue. There is a need to clarify the entitlement or share of water in a system at the subsystem level.

Mr. Tiep stated agreement with the idea that there is not much focus on management aspects when a system is being designed. MARD has issued guidelines for investment in management facilities. However, enforcement of policies is a problem. Vietnam must adopt a policy of user-pay. From a holistic approach, there is the issue of formulating realistic regulations and determining ways in which it will be enforced. During times of natural calamities, farmers are relieved of the burden of water fees. These are technically supposed to be paid by the Ministry of Finance; however, the Ministry of Finance normally doesn't provide the necessary support. There is also the problem of "too many cooks."

The fact of the matter is that whoever has the money is the effective owner of the system. The management board doesn't discuss plans with MARD (Dr. Su) because they already have the money. There is a need to pay attention to both hardware and software issues. There is an especially urgent need for effective policies and regulations, especially financial regulations.

For investments in irrigation systems, there is currently priority given to ethnic minorities and construction of small scale irrigation systems. Investments, however, need to be more practical and include tertiary canals as well. One example is a recent World Bank loan that examined the whole system. This project is considered a success (by Mr. Tiep) because it had the commitment from the local people and authorities. In his opinion, the IDMC and WUAs must have financial autonomy. Many people favor having a low fee, however, they also cannot identify a subsidy. He suggests different partners for different levels of an irrigation system. For the large-scale and main canals, the state can be the principal authority, while at the tertiary levels, farmer organizations could have authority. This would reduce the burden on the government.

The participant from the Nam Duong IDMC proposed that the transfer of small scale pumps to farmers would greatly improve performance. Also, if the IMC could pay the electric company seasonally after collecting water fees from users, this would ease IDMC financial difficulty.

There is also the problem of how to hand over small-scale irrigation to the people. In this regard, it was recommended that there be research on and assessments of the technical, institutional, scale and social impact of small-scale irrigation transfer. If appropriate based on the assessment results, a detailed small-scale irrigation management transfer plan should be developed for transfer from IDMCs to local water management organizations. There is also a specific need for general and financial training of irrigation staff and farmers engaged in irrigation management. The IMT of small-scale irrigation should start with a pilot study that could be up-scaled to a larger area. This process must be made clear to the farmers. Additionally, any fees implemented must be fully explained such how they is calculated, what they are used for, and where they go. This can greatly improve collection of the fee. Ironically, it is the poorer regions that tend to have a better payment record, as more advantaged regions tend to rely more on the government.

In regard to IDMCs, they tend to lack proper incentives and legal avenues to operate effectively. The IDMCs must be backed by clear regulations to enforce rules (such as, for people who break canals).

Currently, the Department of Irrigation is working on a government circular to provide guidance on establishing grassroots WUAs. However, to make this practical, there needs to be training at the management level. There needs to be a proper and realist framework to provide a legal corridor to bind all stakeholders in the management activities.

After policy developments, there would be a need for effective models. It is important to follow an action-oriented research agenda suggested earlier. To reinforce this effort, there is a need to improve the accuracy of data and information. Research is needed to coordinate with relevant agencies and local agencies.

Dr. Su summarized the list of constraints discussed. He emphasized that many people are still suffering from natural calamities. At the same time, the country is moving from a subsidized economic system to a market based economy. The policies are currently not changing fast enough to keep pace with changes in the economy. Only through good management can the government effectively support increased agricultural production and poverty reduction. To more effectively pursue this goal, there is a need to narrow the gap between reality and research (i.e. bring the research agenda closer to the needs of the policy makers). Finally, there is a need to enhance the information system and increase the accuracy of the data.

Interventions and Actions –the Way Forward

The presentations and discussions highlight four main areas in moving forward to improve irrigation management in a pro-poor manner. These are:

1. Strengthening the policy environment
2. Action/policy oriented research
3. Innovating irrigation management
4. Achieving financially/managerially self-sufficient irrigation institutions.

Strengthening of the legal/policy environment concerns the development, implementation, and enforcement of appropriate laws and regulations. Of particular note from the discussion is the need to make laws that are clear and consistent. However, policy must be flexible and dynamic to be suitable to conditions in different areas and at different times. A frequently mentioned topic was the need for regulations that clearly dealt with the issue of water charges. There is a need for regulations that are specific in how punishments and enforcements should be carried out. This will require identification of responsible parties at different levels (grants of authority), means of funding or otherwise supporting efforts, and means of education the users and managers.

Action/Policy oriented research concerns what several participants pointed out as “unrealistic” research. That is, research, which targets topics that are not of issue to policy makers and/or yields results that are impractical in implementation. Researchers and policy makers should make efforts to coordinate their efforts so that research is based on the practical needs of policy makers. Moreover, a sustained process of cooperation could help research results feed into the policy making process. In this way, a system could be set-up that increased cooperation between often disparate agencies and institutions refine the national sector research agenda.

Innovating Irrigation Management is primarily centered on two ideas: 1) participatory management process and 2) sound financial practices. The workshop and study consistently brought up the need to include farmers more strongly into the management process. This would help make management more transparent, responsive, and accountable to the water users. This is also related to a need to make irrigation management more autonomous. Currently, management is hampered by "too many cooks." Efforts are urgently needed to pursue this agenda, perhaps initially through pilot studies.

Achieving financially/managerially self-sufficient irrigation institutions is a sub-category of innovating management, but such a strong issue that it needs to be set apart separately. Sound financial practices are related to water fees. There is a strong feeling in place that fees should be kept low in order to reduce the burden on poor farmers. Additionally, it is often felt that fees should be kept low due to poor performing irrigation systems that do not offer reliable water supplies to farmers. Low fee collection rates, in turn, result in a lack of capital to maintain, construct, or repair irrigation infrastructure. There is also the related problem of low salaries for the irrigation managers. This condition results in a lack of incentives for staff to properly carry out their responsibilities. A process for implementing/creating a sound financial cycle needs to be developed based on local needs and conditions as well as the limitations of the central government.

In order to make progress toward these four areas, a coordinated commitment is needed on the part of national government leaders, local water managers and government officers, water users, national and international researchers, and donors. The next step will be to set a prioritized list to work with these issues based on feedback from high level government officials. However, this must be done in a holistic and practical manner. As a final note, while grassroots stakeholders and national government officials normally receive the focus of similar efforts, the importance of involving local level water managers and government officials must be emphasized. It is crucial that these local level players understand and are committed to any efforts to improve management of irrigation systems.

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