Institutional Management of Irrigation Systems in Northwest China: A Case Study of The Yellow River Valley in Ningxia

By

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INSTITUTIONAL MANAGEMENT OF IRRIGATION SYSTEMS IN NORTHWEST CHINA: A CASE STUDY OF THE YELLOW RIVER VALLEY IN NINGXIA

BY

YUEDONG ZHANG

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MASTER OF ARTS

Abstract

Located in the arid northwest of the People's Republic of China, the Province of Ningxia contains two types of institutional management systems for irrigation: centralized (governmental) and localized (township or village-based). The centralized institutional management has relatively long history back to imperial times. Special governmental agencies at the levels of the province and county control main canals and water allocation. The situation changed little from the imperial period to that of the People's Republic of China. Currently, township and village-based organizations usually manage marginal irrigation networks which have to receive water from state-managed main canals. However, the structure and functions of local management appears to be easily disturbed by social and political changes.

Township and village-based groups for irrigation management interact systematically with special governmental agencies. There is a cooperative relationship between governmental and local organizations. This cooperative relationship is designed to allocate irrigation water among townships and villages and to maintain the normal operation of canals with labour input from local farmers. Cooperation is based on two institutional connections between township and village-based organizations and governmental agencies. They are respectively administrative and canal-centred. Yet, the dominance by

provincial and county governmental agencies has heavily affected the process of this cooperation in favour of governmental control.

This thesis attempts to demonstrate that localized institutional management can operate within a large-scale irrigation system controlled by a centralized state authority. But, the structure and functions of township and village-based management organizations have been institutionalized by the powerful governmental agencies. Recent changes, such as the practice of the Contract System, have empowered local farmers to self-manage marginal parts of large-scale irrigation systems and are leading a trend of decentralization. It remains to be seen, however, exactly how these relationships will evolve in the future.

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Chapter One

Introduction

1.1 Irrigation and Institutional Management

With the growth of population during ancient times, agriculture emerged as an important way of increasing food production in many parts of the world. Agriculture usually requires appropriate soil and water supply. This is particularly true in arid or semi-arid regions, where the annual amount of evaporation is higher than the amount of rainfall, and climate conditions are unfavourable for agriculture to support a large population[1]. Irrigation must be applied in order to provide enough water for the growth of crops such as wheat. Generally, irrigation refers to techniques that are adopted to supply water to an area where crops are grown so as to reduce the length and frequency of the periods in which a lack of moisture is a limiting factor to plant growth (Agnew et al. 1992: 139). In other words, irrigation consists of techniques to control soil water in the root zone in order to assure the optimum growth of crops. All of these techniques cooperate to make intensive agricultural

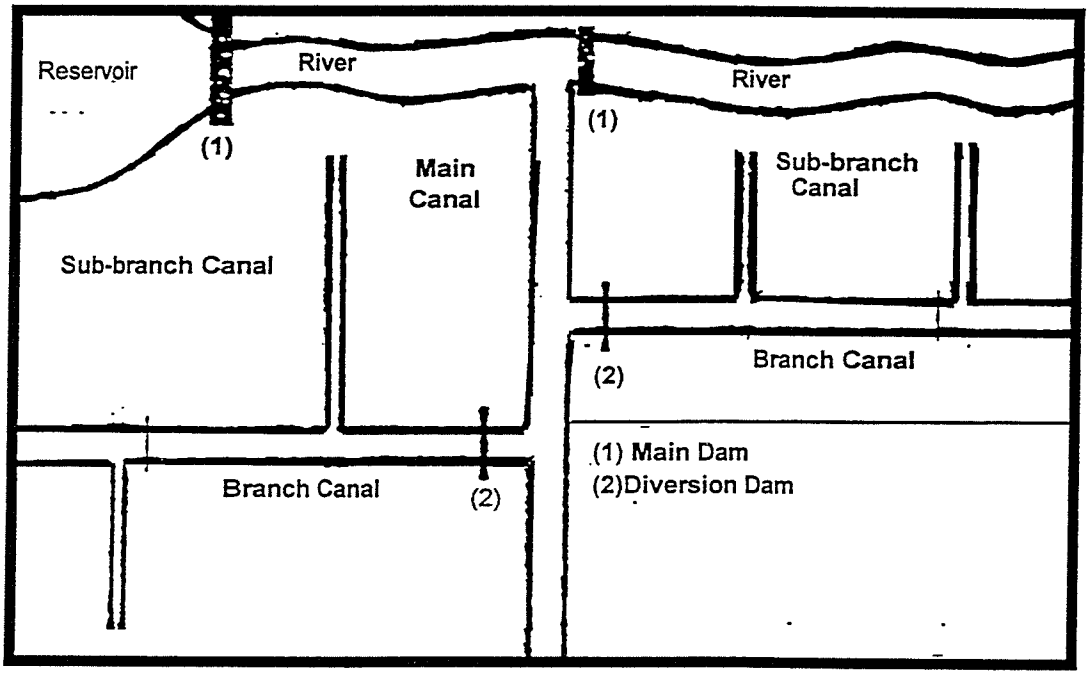
1. Certainly, farmers in arid regions may pursue their agricultural activities in wet seasons. However, this occurs when a small population exists. One example is West Sudan where millet is planted through fallow farming (Agnew et. al 1992).

production feasible (Fukuda 1976).

For millennia, large-scale irrigation has been practised in Egypt, China, India, and the Middle East. According to the sources of irrigation water, there are three types of irrigation systems, which are primarily found in arid regions across the world: surface, drilling, and underground water irrigation. Drilling irrigation relies on wells to get ground water available for irrigation. In India, 5 million wells were used for irrigation in 1973 with a lift from 1 m to 30 m (Agnew et al. 1992:143). Underground water irrigation consists of utilizing a group of underground channels to transfer water from melting snow in mountains. Typical examples can be found in Iran, Azerbaijan, Afghanistan, and Oman. A surface irrigation system obtains its water mainly through canals from rivers or reservoirs. Surface irrigation is the most common irrigation system and accounts for more than 95 per cent of irrigation in the world (Kay 1986:121). As shown in Figure 1.1, a typical surface irrigation system consists of three types of canals: a main canal, branch (or lateral) canals and sub-branch (or sublateral canals)[2]. Within a surface irrigation system, in order to keep the optimum content of water in the soil, canal irrigation supplies land with water through the canal network, while drawing water from the land

[2]. The terminology used in this thesis for canals is the one adopted by the International Commission on Irrigation and Drainage. The categories of irrigation canals in China appear to be equivalent to their English counterparts.

Figure 1.1 A Simplified Model of Modern Irrigation



Source: adapted from A World Geography of Irrigation (Cantor 1977).

through drainage when water is oversupplied.

Where one major river supplies irrigation water, a group of main canals are usually directly connected to the river and branch canals receive water from main canals. Then, a large number of sub-branch canals transfer water to an area with irrigated land. This kind of large-scale surface irrigation system is characterized by its lengthy canal networks and long history of centralized management, as exemplified by the irrigation systems of Egypt and the Middle East. Large-scale irrigation systems have supported large populations in ancient state societies such as those of China and India.

In this thesis the term "irrigation" will refer to "surface (canal) irrigation". The study of this thesis focuses on large-scale surface irrigation systems. A surface irrigation system can usually be divided into irrigation water and hydraulic facilities (e.g., diversion dams, canals and reservoirs). Irrigation water refers to the fresh water available from river systems which can be used by means of hydraulic facilities for agricultural production. The analysis of this thesis centres on the institutional management of irrigation water and hydraulic facilities. The region studied in the thesis is Ningxia Province in northwest China where an arid climate characterizes the local ecosystems. Canal irrigation systems have been extensively used in this area for more than one thousand years.

Large-scale irrigation systems are crucial for ensuring and increasing agricultural production in arid regions. But such irrigation systems are more than complicated hydraulic engineering projects. They require institutional management for allocating water and coordinating maintenances of canals and other hydraulic facilities. As noted by Kelley (1983:880):

> Irrigation is economically important as the disposition of a critical input of agricultural production; it is politically significant as a source of power and leverage in local, regional, and national political arenas, and it is of considerable social consequence because it defines patterns of cooperation and conflict in irrigated regions.

Institutional management of irrigation systems has systematic relationship with the political and social structures of societies where irrigation systems are important for local agriculture. For example, some earlier anthropological studies have emphasized the importance of the autonomy of local user-based organizations for operating irrigation networks, such as the Valencian *communa* in Spain (Glick 1970), and the Balinese *subak* in Indonesia (Geertz 1973).

Institutions for irrigation management have been studied by a number of cultural anthropologists and scholars from other disciplines (e.g., Childe 1954, Mitchell 1975, Hunt et al. 1976, Baumann 1987 and Ostrom 1990). There are two kinds of definition of the term "institution". Ostrom (1990: 51) defines "institution" as:

> the sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what

> information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions.

On the other hand, Craine (1971:522) describes "institution" as:

> a definable system of public decision making, one that includes specific organizational entities and governmental jurisdictions, but transcends conventional emphasis upon definition of agency structure.

The concept of "institution" in this thesis refers primarily to "specific organizational entities". Yet, it covers as well a set of regulations, either social or political, since these regulations can not be separated from those institutions discussed in the thesis.

With the purpose of defining the concept of "institutional management (arrangement)", Mitchell (1975) distinguishes five aspects of water resources management: (1) existing or proposed legislation which establishes the manner in which water is used by a society, (2) organizations responsible for implementing policies or responding to cooperation or conflicts, (3) the decision-making process, (4) the perceptions and attitudes of individuals, groups, firms and public organizations about water resources, and corresponding social conventions, and (5) specific resource decision situations in which a range of legislation, organizations, interest groups and water resources come into juxtaposition. Mitchell's framework of institutional management focuses on socially-based approaches in order to identify and explore the range of management alternatives.

The management of water resources dealt with in this thesis refers to a variety of institutional arrangements involved in water distribution, usage, and facility maintenance. The emphasis is on both governmental agencies and user groups, and on their administrative or legal institutions and the corresponding regulations. However, other factors like traditional social organizations, political and economic mechanisms, technological changes and local ecosystems may complicate the entire process of institutional management. In particular, the features of local ecosystems, such as water supply, topography, land resources and climate, may influence the institutions managing water for irrigation. As analyzed in chapters 2 and 3, an arid climate and the sole water supply from the Yellow River, together with the topography of plains in northern Ningxia, have led to a large-scale canal irrigation system which has been mainly managed by a group of centralized institutions.

1.2 "Hydraulic Society" and "Oriental Despotism"

Ancient civilizations along the Nile, the Indus, the Yellow River and the Tigris & Euphrates rivers are famous for their large-scale, sophisticated irrigation systems that were managed by strong state governments. In two articles published in the New York Daily Tribune (June 25 and August 8, in 1853) (see Oriental Despotism (Wittfogel 1957)), Marx used the concept of "Asiatic society" to discuss the social

institutions of ancient India . He argued that "climate and territorial conditions" made "artificial irrigation by canals and waterworks the basis of Oriental agriculture". He also observed that water control necessitated the interference of the centralizing power of the government in "Asiatic society". Marx gave his attention to imperial China as well, which is discussed in vol.3 of Das Kapital. According to Wittfogel (1957), following Marx's interpretation of Russian society, Engels proposed the term "Oriental despotism" in 1875 to describe the relatively centralized societies of Russia as well as those of India. As pointed out by Wittfogel (1955, 1957), the major features of societies characterized by "Oriental despotism" are the construction and maintenance of large hydraulic networks for productive and protective purposes, along with the centralized power of the state.

Wittfogel (1955) applied the concept of "hydraulic society" to those agrarian state societies in China, Egypt, India and Mesopotamia. He suggested that the concept of "hydraulic society" be applied to agrarian societies in which agro-hydraulic works and other large hydraulic and non-hydraulic constructions are managed by a strong government (1955:44). In Wittfogel's definition (1955:44), a "state" refers to a government that is operated by a substantial number of full-time specialists: civil and military officials. Regarding the origin of "hydraulic society", Wittfogel (1957:18) said:

> A large quantity of water can be channelled and kept within bounds only by the use of mass labour, and this mass labour must be coordinated, disciplined, and led. Thus a number of farmers eager to conquer arid lowlands and plains are forced to invoke the organization devices which--on the basis of premachine technology--offer the one chance of success: they must work in cooperation with their fellows and subordinate themselves to a directing authority.

Obviously, Wittfogel was trying to explain how the centralized "hydraulic societies" located in arid ecosystems are structured by large-scale irrigation systems. He compared the situations of irrigation management in ancient India and Imperial China by means of cross-cultural study in Oriental Despotism (1957). Wittfogel noticed as well the role of a certain type of ecosystems (e.g., arid climates) in the management of hydraulic networks. As pointed by Hunt et.al (1976), Wittfogel's discussion focused on the control of labour input during the construction and maintenance of large-scale hydraulic works. An arid climate and a large water source from a major river necessitates large irrigation works which could only be established through massive, centrally organized and controlled labour. Subsequently, there arose a group of specialist bureaucrats together with an authentic political power; for example, a powerful emperor and his officials, as in Imperial China. According to Wittfogel (1955, 1957), in arid areas where water is a scarce resource the centralized control of large-scale irrigation systems leads to increased political integration. Thus, large-scale irrigation is considered to be a major cause of the emergence of

centralized political authority and supracommunity political organization.

Concerning the changes in social structures of "hydraulic societies", Steward (1955:63-64) claimed that there are cross-cultural regularities (e.g., southern Mesopotamia, coastal Peru and north China). He maintains that in the formative and florescent eras, there occurs the formation of a supracommunity sociocultural system that is integrated principally through cooperation in irrigation works under the control of a theocratic class. In the era of militarism, fusion or conquest and cyclical empires irrigation was the principal cause of multi-community or territorially-expanded, theocratically-controlled societies. Finally, population pressure and competition for resources led all states to militarism and then to conquest; the militaristic state authority was able to concentrate labour in large aggregates and to enlarge irrigation works wherever it was feasible.

The approaches of Steward and Wittfogel both focused on the causal relationship between hydraulic works and the origin and changes of state society. However, as pointed out by Carneiro (1970:734), archaeological evidence shows that "full-fledged states" developed well before large-scale irrigation in ancient China or India. Irrigation seemed not to play the causal role in the rise of the state as Wittfogel claimed. Similarly, Adams (1974:3) has argued that:

> large-scale irrigation systems did not exist at the time states made their first appearance (in Mesopotamia), and

> nineteenth century and recent practices in the area make clear that there is absolutely no requirement for a bureaucracy of any sort to construct and maintain irrigation networks even larger and more complex than those that are known from the late fourth and early third millennia.

In addition, according to Adams (1974), even after the consolidation of political power in dynastic city-states had continued for some centuries, agricultural management in Mesopotamia was pluralistic and failed to disclose a rigid state super-structure rooted in its control of hydraulic works. However, still valuable for the study in this thesis is the argument by Wittfogel that in arid regions, large-scale irrigation systems necessitate a group of centralized management institutions.

As discussed in chapters 3 and 4, centralized institutions still dominate the management of current canal irrigation in northwest China. While there is no doubt that the state and its agents are powerful, or even overwhelming in a peasant society like China, neither Wittfogel nor Steward gave attention to the existence and significance of community-level control of irrigation water and hydraulic works in "hydraulic societies". When establishing and maintaining large irrigation works across territories of villages and townships, the coordination and leadership of a centralized institution could be rationalized, especially in case of arid regions where irrigation water is usually only available from one major river (e.g., the Yellow River or Nile). But this is only one side of the coin. Another side, ignored by Wittfogel and

Steward, is the effort by peasants to claim their somewhat limited power to manage land, water, and some irrigation facilities. More recent studies (e.g., Glick 1970, Mitchell W. 1975, Hunt et al. 1976) have focused on the later and have described institutional systems of localized management of irrigation.

In his Irrigation and Society in Medieval Valencia (1970), Glick studied the local management of irrigation by a peasant society in eastern Spain during the 14th century. He described several levels of social organization relevant to irrigation management. The basic water-use unit in medieval Valencia was the community of irrigators, comprising all who drew water from a single canal system. Glick (1970:4) argued that:

> The social function of these communities, whether autonomous or municipally controlled, was similar throughout southeastern Spain and was the common denominator among local systems that differed in other aspects of irrigation practice and law. The communities' objectives, expressed in their regulations and in the principle of proportional division of water, were to apportion water justly and fairly to each user and to prevent conflict among the irrigators."

In Valencia during medieval times, the towns, the Church, and the king as high levels of local and regional authority, had significant political influence on communities of local irrigators. But there was no political centralization in the management of irrigation of Valencia. Contrary to Wittfogel's argument of the centralized "hydraulic society" associated with large-scale irrigation, the case study of the small-scale irrigation in Valencia indicates that: "Social control has

traditionally rested in the collective will and institutions of the irrigators themselves. The autonomy of local irrigation communities was accepted by all levels of the power structure and enshrined in customary law" (Glick 1970:5).

1.3 Major theories on Institutional Management of Irrigation Water: A Literature Review

Since the 1980s, more studies have analyzed institutional management of irrigation systems, either centralized or localized. Most of those focus on poor countries such as India, Nepal, and Morocco, where local management has a relatively long tradition. For the convenience of the following discussion, we can roughly divide the relevant studies according to two major types of ownership of water resources. Water rights here include ownership and use rights of water as a resource, while attention is given as well to ownership and use rights of hydraulic facilities for irrigation. The first type of approach focuses on commonly owned irrigation water; the second type, on state-owned water.

Commonly Owned Water and Its Collective Management

Mahdi (1986) analyzes the institutions of water management utilized by the Erguita mountain tribe in modern Morocco. The Erguita consider water to be collective good; its collective management links the various social groups composing the tribe and stresses the social or cultural links among them. At

Erguita, stream and basin irrigation are two major forms of utilizing water for agriculture. Stream irrigation involves taking water directly from the stream using a fragile diversion dam constructed of rocks and branches. Originating at the dam, a dirt canal winds along the slopes above the stream and the terraces. Along this canal, turnouts serve as secondary distribution canals. These, in turn, serve the ditches that irrigate each small parcel. Basin irrigation relies upon spring water. A spring feeds a large accumulated basin constructured below it. Mahdi notes that the local ecosystems as well as irrigation technologies require joint use of water, and thus lead to social and communal aspects of water management. Co-users are the members of groups within the tribe who have contributed to the construction and maintenance of irrigation facilities.

Mahdi suggests that water rights are, in fact, a reflection of local social relationships. Because social relationships are a dynamic process, water rights, either collective ownership or use rights, are changing their form and regulations as well from large social groups to small ones. Among the Erguita two theoretical models of communal ownership of water coexist: property of the "fraction" (large groups above villages) and that of the village. It is possible to distinguish between the water rights of a "fraction", those of one or more villages, those of one or several lineages, and even those of an extended family. Paralleling the collective

ownership of water is the ownership of hydraulic facilities (diversion dams, canals, and basins) that are constructed and maintained by groups in order to distribute water to fields. The technical requirements for such small-scale irrigation systems of the Erguita influence the social organization and the rules regarding water use. One significant factor is that collective water management needs a set of specially designed political institutions at the village level. Madhdi argues that collective management is efficient in terms of utilizing water for irrigation although it should be noted that his study deals with small-scale irrigation systems.

The example of India gives us another perspective, one in which government assists in the maintenance of irrigation facilities operated by communities of users (Easter et al. 1986). After India's independence in 1947, ownership rights to private water tanks (small reservoirs) were abolished and the government of India expropriated them from the Zamindars. In practice, the water tank became a commonly-owned resource: farmers who own land in the area served by each tank have the right to use the water in that tank. The government also provided grants for periodic tank maintenance above the outlet; maintenance below the outlet became the collective responsibility of the farmers.

As studied by Easter et al. (1986), farmers in southern India developed informal water users' organizations (WUO) to manage these tanks. The scarcity of water, and the probability

of a reasonably uniform distribution of benefits, encouraged the collective management facilitated by the WUO. Trusted leadership was a key factor for a WUO's success, and hence for the efficient use of the tank water. Five operational rules were set up at the village level with the assistance from a WUO. Reciprocity was the primary social behaviour pattern for the successful joint use of tank water within villages. As an external arrangement, the government provided loans and installed community wells to supplement tank water supplies during the wet season and for full irrigation in the dry season. Easter suggests in his study that the technical and physical attributes of the tanks, the decision-making arrangements (WUO), and the pattern of interaction (reciprocity) decide the equity and efficiency levels of management that can be achieved.

In Morocco and southern India, commonly owned water resources provided a complex institutional system of traditional norms and conventions that can efficiently regulate the allocation of resources and manage to achieve sustainable development. Water resources can be exclusively owned by one or several particular groups like villages. The joint ownership and use rights adopted by these communities constitute the crucial structure of community-based management of water.

State-owned Water and Its Collective Management

Egypt is famous for its large-scale irrigation systems. According to Hunt (1986), cropping discipline and the supply of irrigation water in Egypt during the 1960s and 1970s were dominated by the national government. The Ministry of Irrigation (MOI) receives water from the dam across the Nile, and distributes it through the irrigated territory by means of barrage (or small dams), canals and gates. In managing irrigation water there are local peasant groups that have rights to the resources. These groups are organized to manage the use of that resource, and individuals within those groups enjoy individual rights to the benefits arising from the joint use. As pointed out by Hunt (1986:200), two such groups are active in the management of irrigation in Egypt. One is associated with the *mesqa* (ditch) and one with the *saqia* (the wheel). Community-level institutions manage the water that small groups of farmers acquire from the MOI canal system, and which they then divide up among themselves. For example, the *mesqa* is a village ditch and totally under the control of the farmers. The farmers who draw water from the *mesqa* are responsible for operating and maintaining it. There is a formally organized institution at each *mesqa* with a group of officers who are responsible for administering allocation turns within the *mesqa*. Membership in the *mesqa* group is a function of owning land watered by the *mesqa*. Hunt notes that water for irrigation is taken from the Nile by the MOI and is

controlled by that Ministry until it is released into the *mesqa*. However at the level of the *mesqa*, farmers collectively arrange water allocation and maintain ditches.

In his study of irrigation water in southern India, Wade (1986) discusses a "public realm" within the local group managing irrigation. Usually, a public realm consists of four main institutions: (1) a village council, (2) a village standing fund, (3) a work group of village field guards employed by the village council and (4) a work group of "common irrigators", employed by the village council to distribute water through the government-run irrigation canal. A public realm has two characteristics. First, the common irrigators do not influence decisions about how much land will make a claim to the irrigation water -- those decisions are left to individuals cultivators. Secondly, once the common irrigators are appointed, they take very important irrigation decisions (e.g., water allocation) out of the hands of individuals farmers in the name of a village-wide authority. In contrast to the Water User Association of tank water in India described earlier, establishment and operation of arrangement institutions of a public realm generate a transaction cost. For example, the common irrigators are paid at harvest time by a collection from farmers.

When farmers select their own officials to govern and manage an irrigation system they own and operate in modern Nepal, the incentives faced by these officials are closely

aligned to the incentives of all farmers in the system (Ostrom et al. 1994). According to the study by Ostrom and her students, the *Sewar* Irrigation System in Nepal is organized in a simple manner. All farmers served by one canal are organized as a water users group, and each group has its own leaders who are generally responsible for seasonal maintenance, water distribution, and collecting fines. In this system the leaders and employees of farmer-organized institutions have a strong motivation to keep the system operating effectively since they are not only selected among users, but also paid by their villages.

Although modern national governments in Egypt and Nepal control water resources as well as all other natural resources, farmers in these countries have been effectively allowed to self-organize and develop a diversity of organizations that result from tough bargaining with governments and among users. Farmers of those poor countries demonstrate substantial capabilities to make regulations and reach compromises that sometimes have achieved efficiencies greater than those of government-based management (Ostrom and Gardner 1993:109).

Co-management and Co-operation

Concerning the interaction between governmental and community-based institutions for managing water resources and other resources, a more recent approach involves the concept of "co-

management or "cooperative management"[3] (e.g., Pinkerton 1989, Ruddle 1989, Acheson 1989 and Berkes 1994). According to Berkes (1994:18), co-management can be understood as various degrees of integration of local-level and state-level management systems. The process of co-management involves shared decision-making power by different levels of participants, and requires government to devolve some power to local participants. Co-management therefore emphasizes: (1) the importance of governmental policies as well as of community-based regulations, and (2) the cooperation of organizational entities at a variety of governmental and community levels.

Pinkerton (1989) lists three possible benefits which can result from the practice of co-management. These include: (1) co-management for community-based economic and social development, (2) co-management to decentralize resource management decisions, and (3) co-management to reduce conflicts through a democratic process. But in a poor countries such as China, the government not only legally owns water and other natural resources, but also manages them administratively. Especially, large-scale irrigation systems in China are built by the state. These irrigations systems, usually managed by specialized governmental agencies, may

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[3]. In April, 1995, many scholars across Canada presented discussions of the concept of co-management and its practices during a conference on Community-based Resources Management, hosted by the Natural Resources Institute of the University of Manitoba.

provide water to farmer-managed small irrigation networks. Under this circumstance, the practice of co-management seems far from the reality of irrigation management in China.

In fact, most studies related to co-management deal with community-level collective management of fisheries or irrigation systems in both poor and rich countries. Few studies have been done to deal directly with the interaction between management institutions of both government agencies and local user groups in the People's Republic of China where strong state governments at the provincial and county levels dominate the process management of irrigation systems, particularly large-scale ones. As discussed later in this thesis, a cooperative relationship characterizes the interaction between governmental and township and village-based organizations for irrigation management. This type of cooperation is not a process of equally sharing power over decision-making among participants. It is rather a process dominated by a group of powerful governmental agencies. Still, governmental agencies need township or village-based organizations to provide necessary assistance in order to maintain the normal operation of the whole irrigation system, although the later tends to be marginalized by the former.

1.4 Irrigation Management in China

China has a long history of hydraulic management, much of which is dominated by the co-existence of the State and

community-based institutions (Nickum 1982). Unfortunately, only a few studies have been done to deal with the situation of China. Abel (1976) studied the irrigation management in Taiwan, which was characterized by decentralized institutions. Abel (1976) listed four interrelated factors in his discussion of the case of Taiwan: (1) the recognization of water as a scarce resource which must be developed and managed intensively, (2) a legal and administrative system which recognizes decentralized management of irrigation systems, (3) an active and effective exchange of information between the users and managers of a irrigation system, and (4) efficiency-oriented incentive structures for both managers and users. As noticed by Bottrall (1977), however, the management system in Taiwan is the outcome of a long evolutionary process independent of the Chinese mainland.

In the People's Republic of China there is no doubt that the changing political situation after the socialist revolution of 1949 have influenced the management institutions of irrigation. With the exception of major flood control and navigation, rural water management in China before 1949 was most commonly in the hands of families, villages, or clan organizations (Nickum 1982). However, with the collectivization of land-ownership in rural China since 1958, state-planned water use came into practice and played a dominant role. The current situation of centralized management for large-scale irrigation in China has not been dramatically

changed, although current village and township-based institutions for managing irrigation are experiencing some changes.

Vermeer (1977) studied the centralized water and irrigation management system in China before 1978, when the People's Commune system and centralized government agencies controlled most management institutions. He described the powerful governmental agencies from the provincial to the central government levels and emphasized that hydraulic projects contributed to an expansion of governmental agencies and the collective sector of People's Communes in a small-peasant economy. The latter, the rural collective sector, is the result of collectization of land initiated in 1958. Individual farmers had to submit their ownership of land and other resources to the authority of the People's Commune.

While studying water management in the Yellow River of north China, Greer (1979:114) noticed the existence of decentralized management of water during this period:

> Irrigation development (of the Yellow River) illustrates the multilevel structure of organizational units in the modern scheme. National water management directives, such as those emphasizing small-scale projects beginning in 1957 and 1958, are issued by the central government, and are implemented at the provincial, municipal, county, or commune level (and even lower) in accordance with plans for projects of a certain size. The locus for responsibility in irrigation development has shifted downward in this hierarchy from provincial to county and commune levels, as small-scale projects have been emphasized over large projects, contributing to what is in effect a decentralization of the irrigation development.

Since 1978 the liberal policy and economic reforms have changed the political system in rural areas of China. The collapse of the People's Commune system during the 1980s led to the re-establishment of traditional townships and villages in rural areas of China. Through the "Household Responsibility System", Chinese farmers can obtain user rights on land and some natural resources, which are contracted by the state that owns these resources. The decision-making power of rural communities at the levels of township and village have been significantly increased. For instance, villages and townships can now collectively arrange irrigation facilities which are collectively owned by these villages or townships (Zhang 1995).

The focus of this thesis is on the analysis of both centralized (governmental) and localized (community-based) institutions for irrigation management in the People's Republic of China and the interaction between them. The case study focuses on the Yellow River valley located in Ningxia Hui Autonomous Region of arid northwest China (see figure 2.1). The Yellow River valley in northern Ningxia has a long history of canal irrigation with evidence of irrigation being pursued as far back as 127 BC (Zhang 1994). Today, large-scale and sophisticated canal irrigation systems are still functioning and are important for local agriculture (Wang 1987). In detail, this thesis attempts to answer the following questions:

(1) What are the functions and structures of these town and village-based institutions when they have to interact with governmental institutions?

(2) What are the functions and structures of those governmental agencies in charge of irrigation management at county and provincial levels?

(3) How do governmental, and township and village-based institutions work together to manage irrigation systems which have to obtain water from canals controlled by these governmental agencies?

In order to answer these questions, this thesis is divided into six chapters. Chapter 2 describes population, topography, water, and land resources of the region of Ningxia, where the arid climate, the sole water supply from one major river, and a large river valley are the key characteristics of the local ecosystem. A sophisticated large-scale irrigation system is also described in chapter 2. Ningxia and its neighbouring regions used to be a frontier of the Chinese empire. Its unique frontier history has a close relation to the management of local irrigation systems dominated by the centralized institutions. Chapter 3 analyses the historical development of both centralized and localized institutions for irrigation management in Ningxia during imperial times. It is emphasized that the current centralized management institutions share some similarities with their ancient counterparts. Chapter 4 describes the situation of

irrigation management during the period of the People's Republic of China, when socialist political structures were institutionalized. In particular, the analysis is given to the structures and functions of those township and village-based and governmental institutions for irrigation management after 1978, when liberal policies and contract systems have been introduced into rural China. Chapter 5 analyses the cooperative relationships of governmental institutions with township and village-based management institutions.

In the conclusion (chapter 6) this thesis attempts to demonstrate that:

(1) Two types of institutions for managing irrigation exist in Ningxia: centralized and localized. Although they have a relative long history back to 17th century, localized institutions are most likely to be disturbed by political changes happening to China. These changes include the socialist revolution of 1949 and the liberal policy after 1978. On the other hand, centralized institutions have had a much longer history and their functions and structures are not heavily influenced by radical political changes. Specialized governmental agencies, especially at the level of province, control most main canals and water allocation. The situation remained almost unchanged from the times of imperial China to the People's Republic of China.

(2) Currently, governmental agencies at the levels of province and county dominate the process of managing local irrigation

systems in Ningxia, as exemplified by allocating irrigation water, and controlling most main canals. But below the level of branch canals, township and village-based institutions can self-manage the irrigation network. At the level of the village, local irrigation officials, such as the director of a sub-branch canal and the ditch-water releaser, play an active role.

(3) Despite occasional conflicts, there is co-operation between local users' management organizations and governmental agencies. However, this type of co-operation has often been complicated by the existing centralized political structure. The governmental agencies maintain dominance over this process of co-operation. Most recently, with the introduction of the contract system, management organizations at the levels of both township and village have more power to self-manage the marginal parts of a large irrigation system.

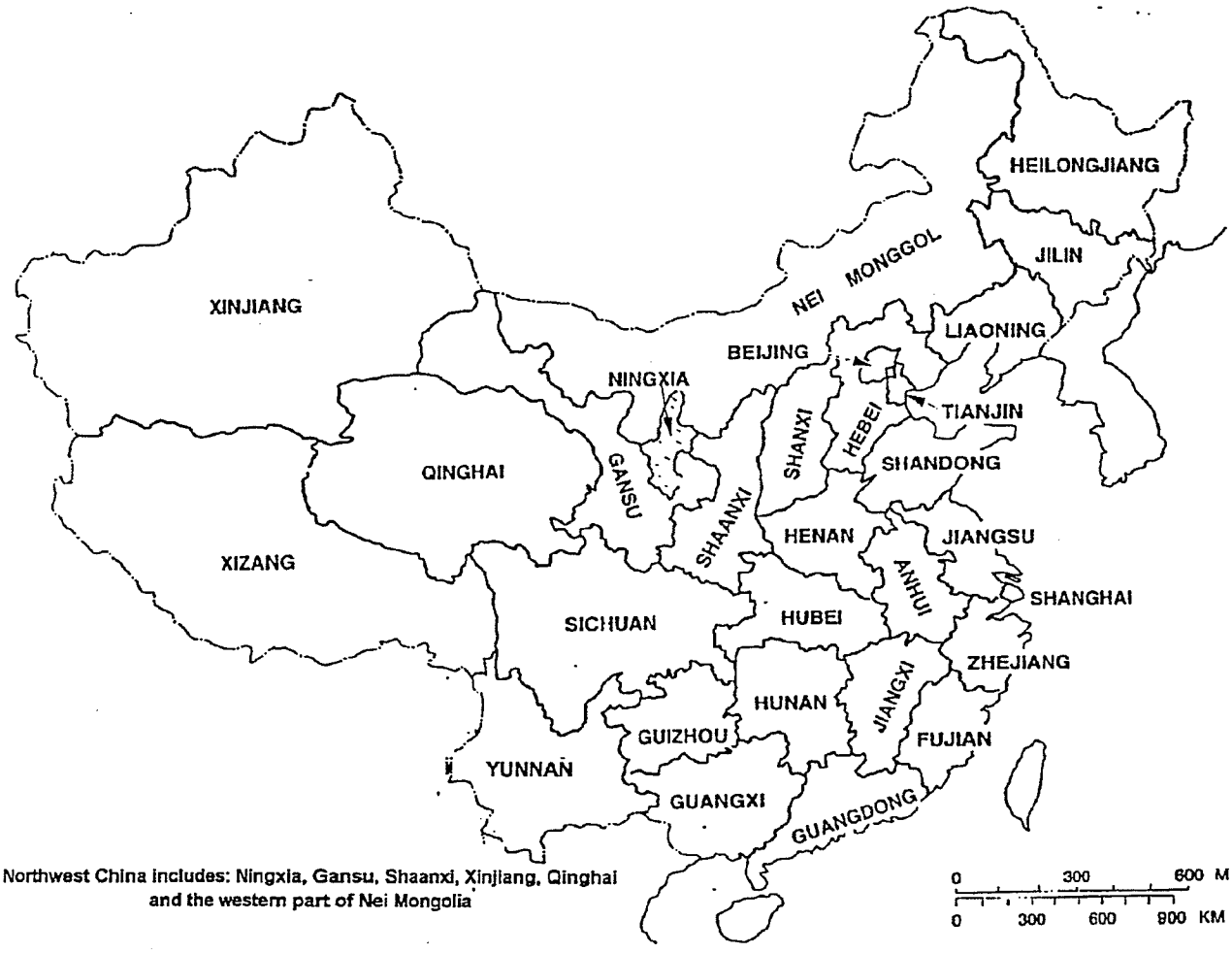
Chapter Two

Water, Land Resources and Irrigation Systems in Ningxia

2.1 Population and Topography

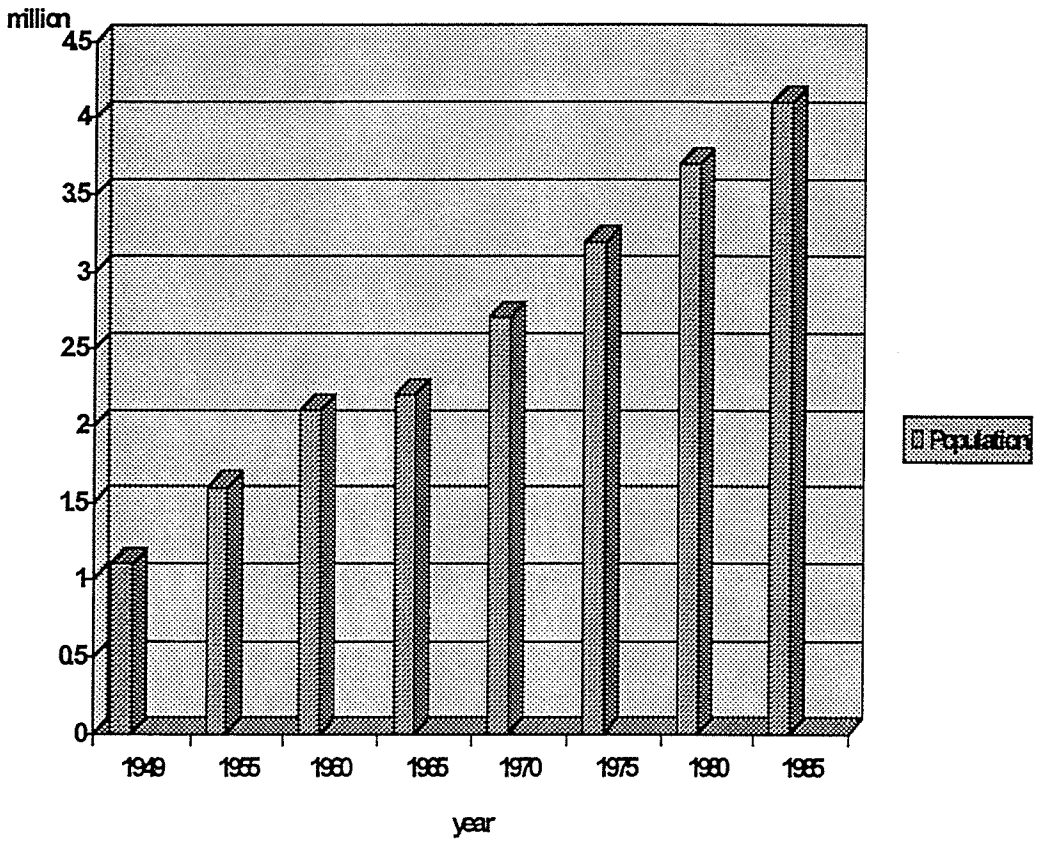
The Ningxia Hui Autonomous Region, administratively equal to a province, is located in northwest China. The whole area of Ningxia covers 66,400 km^2. Generally, the geographic area of northwest China consists of three autonomous regions and four provinces (see figure 2.1). As a result of a mixture of arid and semi-arid climates, large-scale canal irrigation has had a long history in northwest China, and this will be discussed in chapter 3. During the 1970s, 1980s and 1990s, the rapid expansion of local population led to the establishment of new irrigation networks. In particular, contemporary canal irrigation systems are set up across northern part of Ningxia and are crucial for local agriculture. In 1988 Ningxia had a population of 4,146,215 with a density of 62.4 person/km^2. As indicated in figure 2.2, from 1949 to 1985, the annual average growth rate of population in Ningxia was 3.67%, which includes natural growth as well as the increase resulting from immigration (Editorial Board 1988:66). Ningxia is a province receiving a large number of immigrants from other parts of China, of all the population increasing from 1949 to 1985,

Figure 2.1 Provinces of The People's Republic of China



Northwest China includes: Ningxia, Gansu, Shaanxi, Xinjiang, Qinghai and the western part of Nei Mongolia

Figure 2.2 Growth of Population in Ningxia (1949 - 1985)

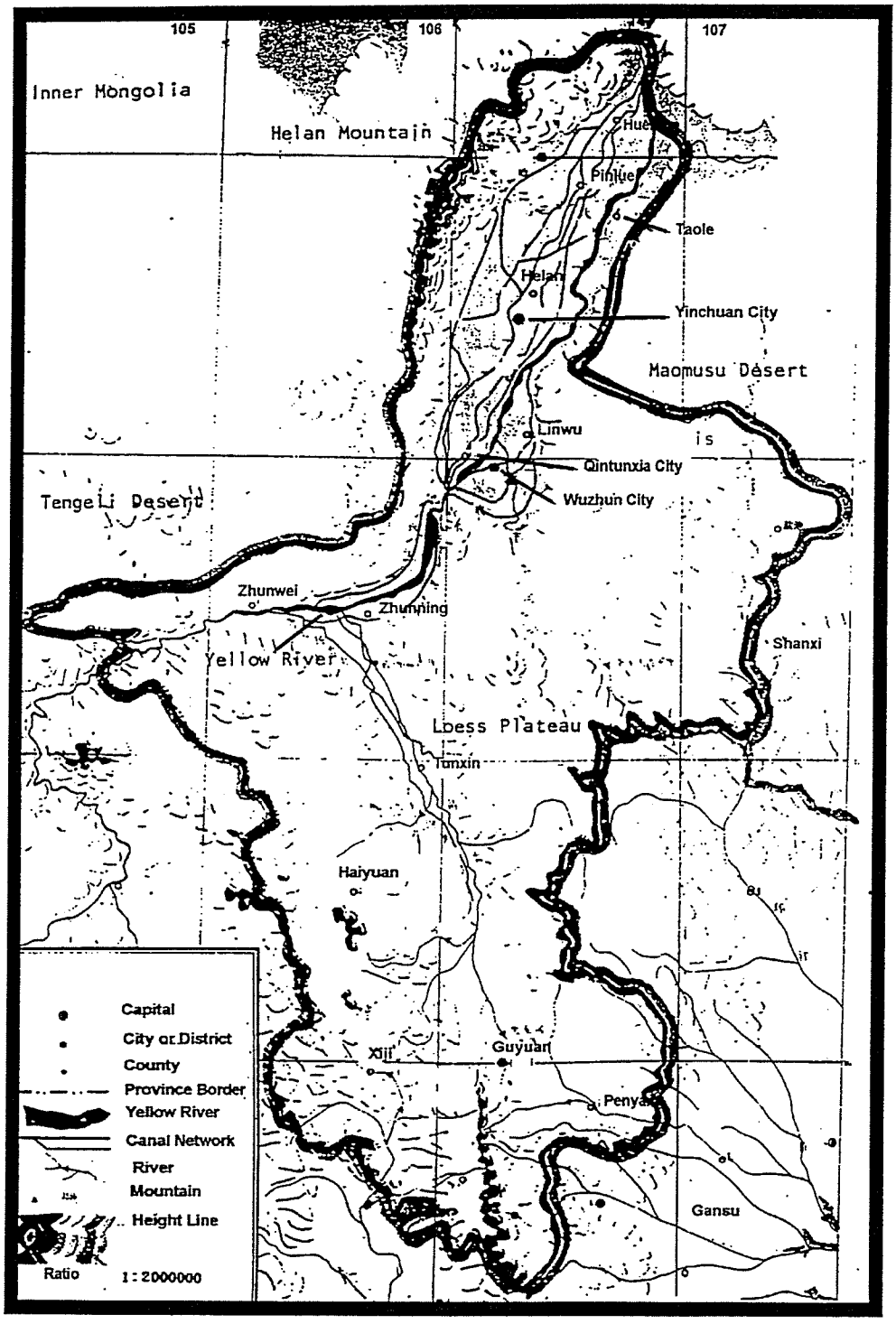


Source: Ningxia Population, (Editorial Board 1988).

natural growth accounts for 78.91%, the increase due to immigration accounts for 21.09% (Editorial Board 1988:66). The rapid population expansion and resultant population pressure on local ecosystems are significant factors that push Ningxia Provincial government to continuously develop new irrigation systems.

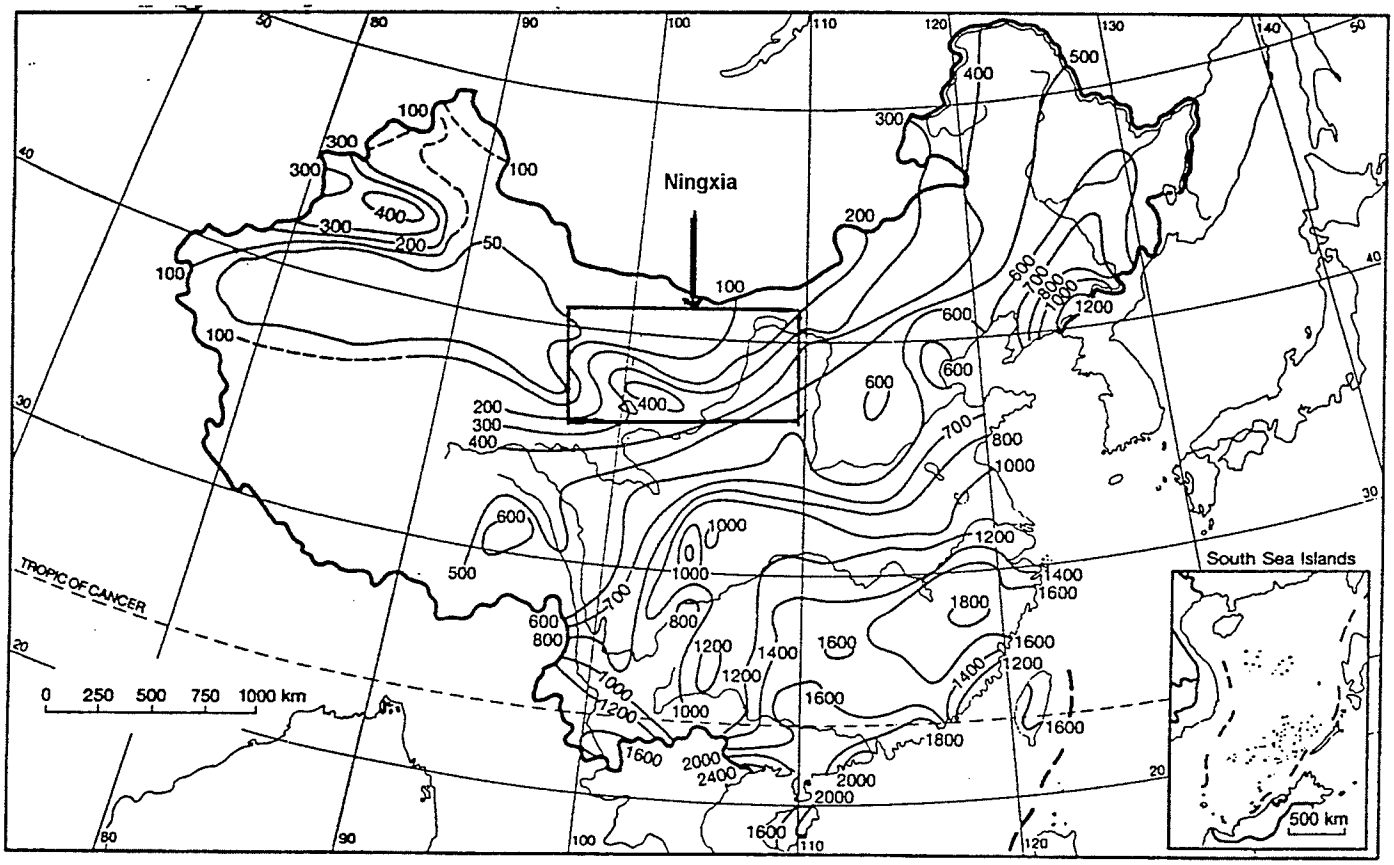
In terms of topographic features, the region of Ningxia is surrounded by Mongolia and Loess Plateaus. The northern part of Ningxia is a north-south plain located in the Yellow River valley, where most ancient and contemporary canal irrigation systems are concentrated (see figure 2.3). The Yellow River, the largest river in north China, is 397 km long across northern Ningxia with an annual average flow of 2.4 billion m^3 (Regional Planning Office 1988). The area of northern Ningxia accounts for approximately 69.8% of the entire Ningxia region. Within this north-south plain, there is a population of approximately 2.5 million, and the population density is 144.7 person/km^2 (Regional Planning Office 1988). The forthcoming analysis of local irrigation management will be focusing upon northern Ningxia, or the so-called Yellow River valley.

Figure 2.3 Map of Ningxia



Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office 1988)

Figure 2.4 The Mean Annual Rainfall of China



Source: Fundamentals of Physical Regionalization of China (Xi Chengfan 1984)

2.2 Water Resources[4]

Ningxia is located in arid northwest China, where the annual average rainfall ranges from 100 mm to 400 mm, but the annual average evaporation is from 1355.1 mm to 1511.3 mm (Editorial Board 1984). This is shown in figure 2.4. According to the Nationally-owned Land Resources of Ningxia (Regional Planning Office 1988), the annual average rainfall in northern Ningxia is around 200 mm. Summer periods account for 51-65% of the annual precipitation; winter is the opposite, contributing 1-2%. Figure 2.5 shows the monthly changes of rainfall in Yinchuan region, which is the central part of northern Ningxia. Rainfall reaches its peak usually in July and August. The rainfall of August can account for 30% of the yearly rainfall. On the other hand, the annual evaporation of northern Ningxia is from 2000 mm to 2200 mm. Therefore, the water supply from rainfall (annually 200 mm) cannot provide enough water for the growth of wheat and rice, the two major crops produced in northern Ningxia (see table 2.10). As a result, irrigation systems are crucial for the existence and development of local agriculture given that northern Ningxia is currently one of the major grain producers in northwest China. In 1984 northern Ningxia supplied 1,130.5 million kg of grain while its cultivated land only occupied 24.2 of the

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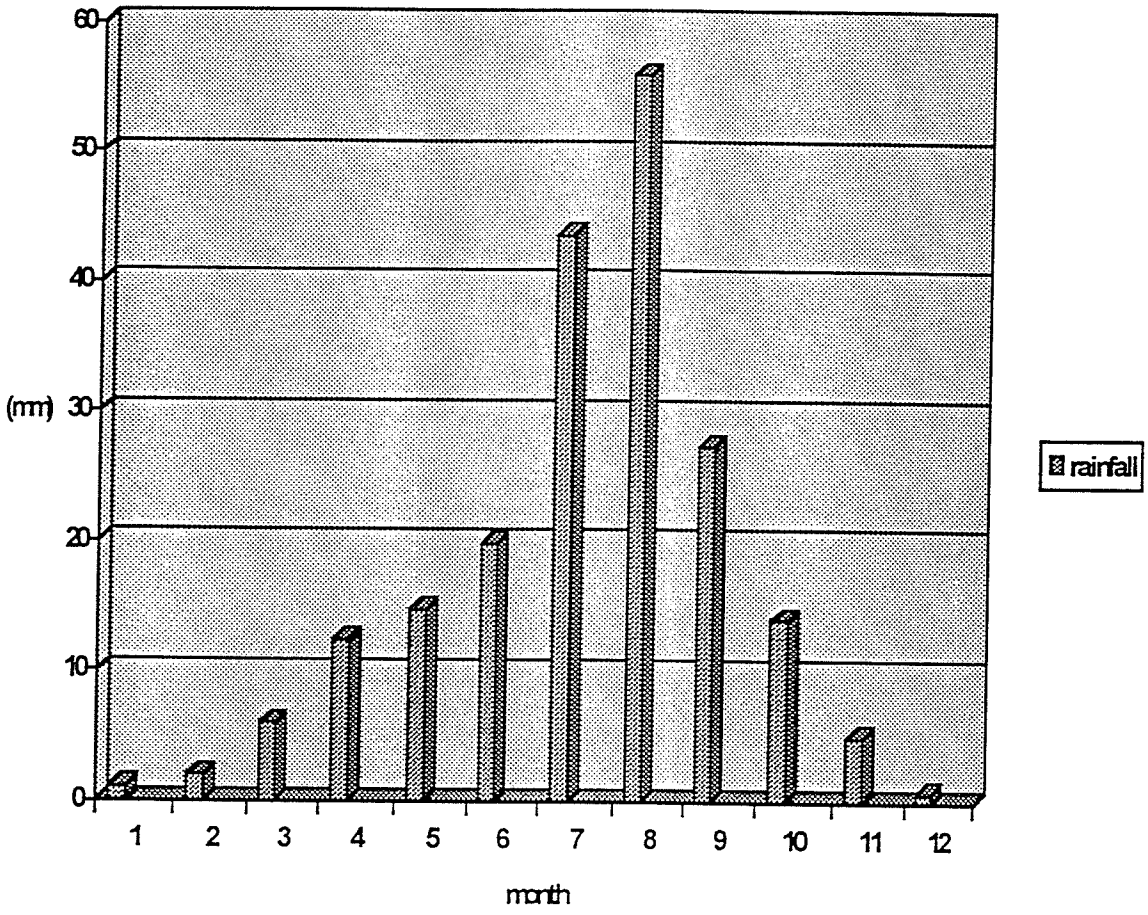
[4]. The data on water resources is from the Nationally-owned Land Resources of Ningxia, chapter 4 (Regional Planning Office, Ningxia Provincial Planning Commission 1988).

Figure 2.5 Monthly Changes of Rainfall in Yinchuan Region



Source: Nationally-owned Land Resources of Ningxia, (Regional Planning Office1988).

whole province (Liu et al. 1986).

The annual average water accumulation from rainfall in Ningxia is 15.7 billion m^3; the amount of natural surface water aside from the supply from the Yellow River is 889 million m^3, and the underground water supply, 2.37 billion m^3. Table 2.1 describes the situation of water resources in northern Ningxia, where large-scale irrigation systems are concentrated.

Table 2.1 Natural Water Resources in Northern Ningxia

Region	Area (km^2)	Surface water (one hundred million m^3)	Underground water (one hundred million m^3)
Ningxia	51,800	8.89	26.0
Northern Ningxia	6,573	0.123	21.3

Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office, Ningxia Provincial Planning Commission 1988).

The canal irrigation systems in northern Ningxia exclusively receive their surface water supply from the Yellow River. Thus, the flow of the Yellow River is understandably the major water resource for local agricultural production. The annual average yearly flow of the Yellow River across Ningxia is 32.5 billion m^3. An important hydrologic feature of this large river is its abundance of sand, amounting to 3.12 kg/m^3 in its passage through Ningxia. Because of large-scale intensified canal irrigation initiated around 127 BC, this

rich silt from the Yellow River has been accumulating as an "artificial" layer of soil across the plains area of northern Ningxia. Currently, there are 4.18 million *mu* land (1 *mu* = 1/15 ha) covered by this soil layer, which is favourable for grain production. Table 2.2 lists some major hydrological characters of the Yellow River within Ningxia.

Table 2.2. Major Hydrological Features of the Yellow River within Ningxia

Test station	Annual flow (1956-1979) (billion m^3)	Maximum flow (s/m^3)	Annual weight of sand (1967-1982) (million tone)	Averagee annual density of sand (1967-1982) (kg/m^3)
Xiaheyan	32.5	6050 (1964)	125	3.74
Qintunxia	32.0	6230 (1946)	98	3.12
Shizhueishan	30.1	5830 (1946)	103	3.26

Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office, Ningxia Provincial Planning Commission 1988).

The quota of water supply available from the Yellow River is determined by the Chinese National Commission for the Yellow River (CNCYR), a national agency responsible for coordinating the administrative and technological management of the Yellow River. According to the plan made by CNCYR in 1986, The quota of the annual water supply from the Yellow

River for Ningxia is 4,000 million m^3 (see table 2.3). According to Liu (1992), the irrigation in Ningxia alone consumed 7,000 million m^3 of water from the Yellow River in 1986, which is far beyond its quota. This figure also means that the water supply available for local irrigation in Ningxia is actually determined by local usage, rather than by a plan set up by a central governmental agency above the level of the province.

Table 2.3 1986 Plan for Distributing Water Supply from the Upper Part of the Yellow River

Province	Qinhai	Gansu	Ningxia	Inner Mon-golia	Shaanxi
Water supply (million m^3)	1,410	3,040	4,000	5,860	3,900

Source: "Water Scarcity in the Middle and Lower Parts of the Yellow River and the Problems of Large-scale Drain" (Liu 1992).

Floods and droughts are two major natural disasters heavily influencing Ningxia's irrigated farming. When the flow of the Yellow River is beyond 4000 m^3/s, major canals along the river, nearby villages, and farmland usually face the danger of being destroyed. The major flooding periods of the Yellow River in Ningxia are in July and September. When the flow of the Yellow River is below 800 m^3/s, there is a possibility of water shortages for irrigation canals which usually depend on the natural flow from the river (Editorial Board 1992). The major periods of water shortage include Jan-

uary-March, as well as April and May.

Table 2.4 Floods and Droughts of the Yellow River within Ningxia (1939-1985)

Year	Date (day/month)	Period (days)	Flow above 5000m^3/s	Flow below 500m^3/s
1941	8/5	1		/
1942	24/5	27		/
1943	10/7	3	/	
1944	4/5	5		/
1946	16/9	9	/	
1953	19/6	54		/
1954	3/5	13		/
1956	16/5	12		/
1957	1/5	4		/
1958	7/5	12		/
1959	11/5	9		/
1960	27/5	25		/
1963	11/5	2		/
1964	29/7	5	/	
1966	3/5	22		/
1967	13/9	6	/	
1968	5/6	2		/
1979	3/7	16		/
1980	7/6	7		/
1981	17/9	6	/	
1984	1/5	2		/
1985	3/5	2		/

Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

For instance, from May 1st to June 21st, 1953, the flow of the Yellow River was around 40 to 300 m^3/s. Drought resulting from water shortage from the Yellow River is a major threat to the growth of crops in northern Ningxia during the Spring, a crucial period for local irrigation when the growth of wheat requires much water. On the other hand, drought due to lack of rainfall is only relevant to farming in southern Ningxia where no large-scale irrigation systems are available.

Table 2.4 gives some detailed information on floods and droughts of the Yellow River from 1941 to 1985. More recently (in the late 1970s and 1980s), drought occurred more frequently than flooding. For example, in March of 1979, the flow of the Yellow River was around 378 m^3/s for 16 days; from 1984 to 1986, there were 5 days of flow below 500 m^3/s.

Generally, the water supply from the Yellow River in northern Ningxia is used for irrigation, rural residents and herds, urban population, and industry.

1) Irrigation[5]

In northern Ningxia (the "plain area") the utility index of canal irrigation is 0.44, which means that approximately 44% of transferred water can end up on farming land. Another 56% is lost as a result of leakage and water retreat from sub-

[5]. The data for sections 1), 2) and 3) is from chapter 2 of a special report prepared by the Regional Planning Office of Ningxia Provincial Planning Commission (NPPC), and published by NPPC in 1990.

canals. The major crops for local agricultural production are wheat and rice. Rice occupies approximately one-third of local cultivated land. The estimated volume of water consumed by crops per *mu* (1 *mu* = 1/15 ha) in northern Ningxia are: rice, 1000 m^3, and wheat, 300-400 m^3. Table 2.5 shows the water usage for irrigation of northern Ningxia in 1990.

Table 2.5 Water Usage for Irrigation in Northern Ningxia (1990)

Region	Area of irrigated land (10,000 *mu*)	Index for irrigation per *mu* (m^3/*mu*)	Quantity of water for irrigation (million m^3)
Northern Ningxia	544.7	586.7	3,193

Source: The Report of Efficiency Analysis of Watered Areas in Ningxia (Regional Planning Office, Ningxia Provincial Planning Commission 1990).

According to a research presented in a report prepared by the Ningxia Provincial Planning Commission (1990), the use of irrigation water for northern Ningxia in 1990 was 3,193 million m^3 (see table 2.5), but by the year 2000 it is projected to reach 3,565 million m^3 due to an increase in cultivated land.

2) Rural residents and Animal herds

In 1990 (see table 2.6), the rural residents of northern Ningxia consumed 19.21 million m^3 of water. Pigs and sheep

raised by local farmers respectively consumed 2.44 and 2.3 million m3 of water. Other animal herds including horses, cows and other livestock used 2.91 million m^3 of water.

By the year 2000, the overall water usage for rural residents and animal herds in northern Ningxia is expected to increase to 38,74 million m^3.

Table 2.6 Water Usage for Rural Residents and Herds in Northern Ningxia (1990)

	Residents	Pig	Sheep	Other herds	Overall
Population (10,000)	131.6	44.63	125.94	26.60	
Water usage (10,000 m^3)	1921	244	230	291	2,686

Source: The Report on Efficiency Analysis of Watered Areas in Ningxia (Regional Planning Office, Ningxia Provincial Planning Commission 1990).

3) Urban domestic and industrial usage

Most towns and cities are concentrated in northern Ningxia since the plains region favours urban development and the establishment of industry. In 1990 there was a population of 1.7 million living in cities of northern Ningxia which consumed 74.62 million m^3 of water for domestic usage. By the year 2000 this figure will reach 88.56 million m^3 when the urban population is more than two million. Local industries such as coal mining and electrical power stations consumed 256

million m^3 of water, and this may be increased to 438 million m^3 by the year 2000.

2.3 Land Resources[6]

Major plains of Ningxia

In Ningxia, mountainous regions cover 27,900 km^2 accounting for 53.8% of the whole provincial area. Plain regions account for 26.8 % of the provincial area, or 13900 km^2. Southern Ningxia is a mountainous area. The major irrigated land is mainly concentrated in the plains region of northern Ningxia including Yinchuan and Weining plains (see figure 2.3). Of them, Yinchuan plain is the largest one with an area of 7977.66 km^2.

Table 2.7 Areas of Major Plains in Ningxia

Plain	Yinchuan	Weining	Qinshueihe valley	Xinren	Weizho	Hunsibao
Area (km^2)	7,977.66	1,719.8	1,849.58	451.37	1,288	610.18

Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office Ningxia Provincial Planning Commission 1988).

The Qinshueihe valley is located in the border areas between northern and southern Ningxia. During the late 1980s, land within this valley has been irrigated with the help of electric pumping technology.

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[6]. The data on land resources of Ningxia is from Nationally-owned Land Resources of Ningxia (Regional Planning Office, Ningxia Provincial Planning Commission 1988).

Major soil types related to local agriculture

1) Black soil

Black soil is mainly distributed in southern Ningxia with an area of 491,700 *mu* accounting for 6.33% of the whole provincial area. This type of soil contains rich organic materials in a layer ranging from 50-100 cm thick. These soil layers have been heavily eroded due to recent deforestation. The irrigated farming of northern Ningxia does not occur in areas of black soil.

2) Grey soil

Grey soil is primarily distributed in the plains of central and northern Ningxia with semi-arid or arid climate. The total area of grey soil is 8,575,000 *mu* (23.91% of the entire province's area). The organic layer in grey soil is around 30 cm thick. The surface of this type of soil usually appears to be semi-desert or grassland depending on the transition of the percentage of vegetation cover (10-50%). In Ningxia most irrigation farming is pursued in lands covered with grey soil.

3) "Artificial" soil

The "artificial" soil is the result of the accumulation of silt from the Yellow River through long-term irrigation. With its richness in organic materials and other chemical elements (e.g., N (0.07-0.09%), S (0.05-0.10%) and K (1.0-1.87%)), it is exclusively concentrated in northern Ningxia and is quite

favourable for agricultural production. There are 4,183,000 *mu* of "artificial" soil, accounting for 5.38% of the provincial land.

Land utilization for agriculture

According to the statistics of 1984, there are 17,767,000 *mu* of cultivated land in Ningxia, accounting for 22.9% of all land. Of 77.7 million *mu* of land in Ningxia, 5,383,000 *mu* are irrigated land (6.9% of the whole); 5,211,000 *mu* of grassland (58.2%); 5,578,000 *mu* of forestland (7.2%); 120,000 *mu* for plantations (0.1%); and 4,270,600 *mu* for other uses (5.5%) (urban development, industry, transportation etc.). It is obvious that agriculture dominates local land utilization.

Table 2.8 Regionall Distribution of Land, cultivated Land and Grassland in northern Ningxia

County	land		Cultivated Land		Irrigated land		Grassland	
	Overall (10,000 mu)	Per capita	Overall (10,000 mu)	Per capita	Overall (10,000 mu)	Per capita	Overall (10,000 mu)	Per capita
Province	7.770	18.74	1.193	2.88	365.6	0.88	4.521	10.9
Yinchuan	191.4	4.82	31.7	0.80	31.7	0.80	88.2	2.22
Shuzuishan	223.8	7.05	20.3	0.64	20.2	0.64	144.1	4.54
Wuzhun	147.6	6.58	22.9	0.87	22.9	0.87	71.0	2.69
Qintunxia	283	14.55	32.1	1.65	32.1	1.65	180.3	9.27
Yunning	151.7	9.48	33.6	2.10	33.6	2.09	70.2	4.39
Helan	181.2	11.9	37.4	2.31	37.4	2.31	73.1	4.51
Pinlue	308.0	12,87	46.2	1.93	46.2	1.93	146.7	6.13
Taole	136.3	71.06	6.1	3.18	6.1	3.18	98	51.09
Linwu	552.8	28.85	31.3	1.63	26.7	1.39	427.8	22.32
Zhunningg	325.3	17.44	21.9	1.17	21.9	1.17	233.9	12.54
Zhunwui	700.6	26.77	35.3	1.35	27.3	1.04	462.9	17.69

Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office, Ningxia Provincial Planning commission 1988).

Table 2.8 outlines the distribution of land, cultivated land, and grassland in northern Ningxia. Unlike Zhunwei and Linwu counties, the other eight counties in northern Ningxia have approximately 100% of their cultivated land irrigated. For example, in Yunning county, all of its 336,000 *mu* of cultivated land is irrigated.

Since the socialist revolution of 1949, the area of cultivated land in Ningxia has experienced three periods of significant change (see figure 2.6). As a result of the expansion of local farming between 1949 and 1956 land grew by 496,000 *mu* per year with an accumulation of 3,472,000 *mu* within seven years. From 1957 to 1980 there was a fluctuation of from 13,000,000 to 14,000,000 *mu*, but after 1981 there occurred a reduction to 1,927,000 *mu* in 1985, demonstrating that part of the cultivated land has been transferred to forestry or grassland. From 1981 to 1985, 1,509,000 *mu* of cultivated land had been so transformed. However, as shown in figure 2.6, the per capita area of cultivated land as well as of irrigated land have basically decreased from 1949 to 1985.

In 1985 cultivated land for rice was 747,351 *mu*; and for wheat, 4,235,366 *mu*[7]. The period for the growth of wheat is from March to September; for rice, from July to October. The precipitation during the major growth period of rice is approximately 140 mm, while only 4.5 mm of precipitation falls

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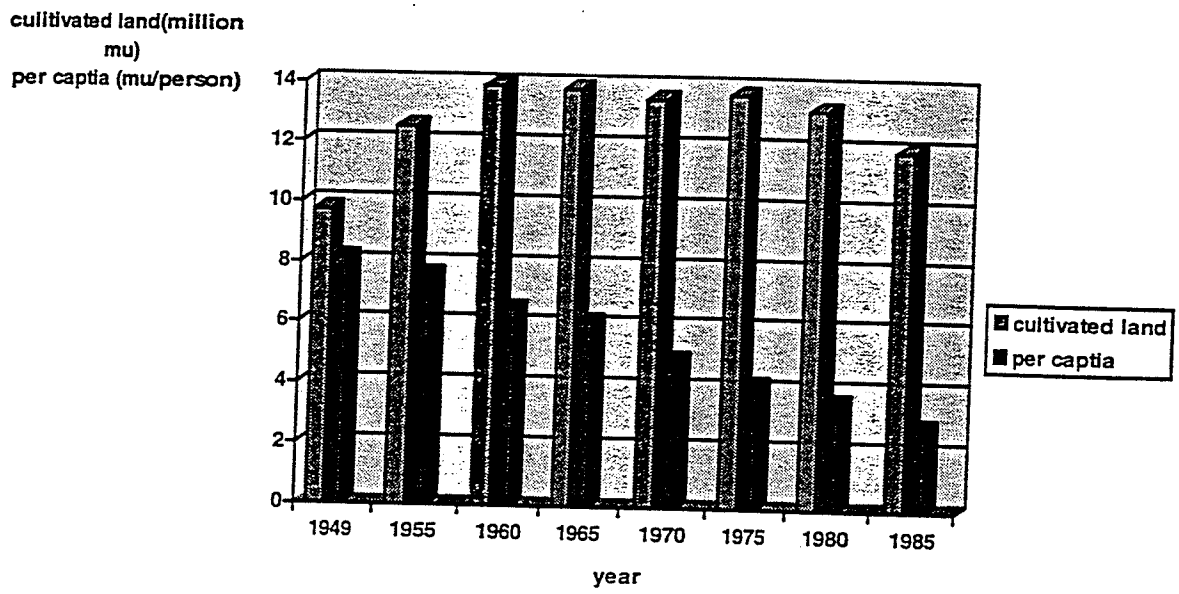
[7]. The data on cultivated land for wheat is that of the whole province.

Figure 2.6 Historical Change of Cultivated Land in Ningxia (1949-1985)



Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office 1988)

during the major growth period of wheat (Liu et al. 1986). Thus, irrigation is crucial for the growth of these major grain crops. As indicated in table 2.9, the yearly growth of rice in northern Ningxia needs 1,350 - 1,450 mm of irrigation water.

Table 2.9 Yearly Irrigation Water Requirements for Major Crops in Northern Ningxia

Crop	Water Required for Growth (mm)	Irrigation Water Required (mm)
Wheat	400 - 500	350 - 450
Corn	300 - 400	250 - 350
Rice	1,500 - 1,600	1,350 - 1,450

Source: "Micro-management of Irrigation & Drainage in Ningxia" (Liu et al. 1986).

The agricultural activities last for approximately 250 days across northern Ningxia each year. The yearly period of irrigation begins in April and ends at the end of December. However, irrigation is employed for approximately 180 days. The irrigation periods for local major crops are as follows:

a) Wheat (planted in Spring)

Three periods of irrigation

(1) winter irrigation, water requirement is 80-130 m^3/mu;

(2) growth period, irrigated two to seven times, water requirement is 180-400 m^3/mu;

(3) washing salt and watering soil, 70-130 m^3/mu.

b) Rice (planted in Summer)

Irrigated seven to 30 times depending on the changes of local temperature, water requirement is 640-2000 m^3/mu.

2.4 Irrigation Systems[8]

According to the ways of obtaining irrigation water from the Yellow River, there are two types of irrigation systems across Ningxia. The first one is called "automatic flow" (gravity-flow) irrigation system which takes advantage of natural water flow as consequence of gravity. The second is called the "electrical pump" irrigation system which only appeared in the 1980s with the help of electrical pump stations. The first system, "gravity-flow" irrigation with a long history dating back to 125 BC (see chapter 3), is still the dominant local irrigation system. It is crucial for local agriculture especially in northern Ningxia. The second type, the "electrical pump" irrigation, has been built in northern, central, and southern Ningxia where land available for cultivation is distributed in relatively high elevations. As discussed in chapter 3, gravity-flow irrigation systems in northern Ningxia have a long history of both centralized and township and village-based institutional management. Due to the limited availability of data, the case studies discussed

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[8]. The data on irrigation systems is from Documents of Ningxia's Irrigation (Editorial Board 1992).

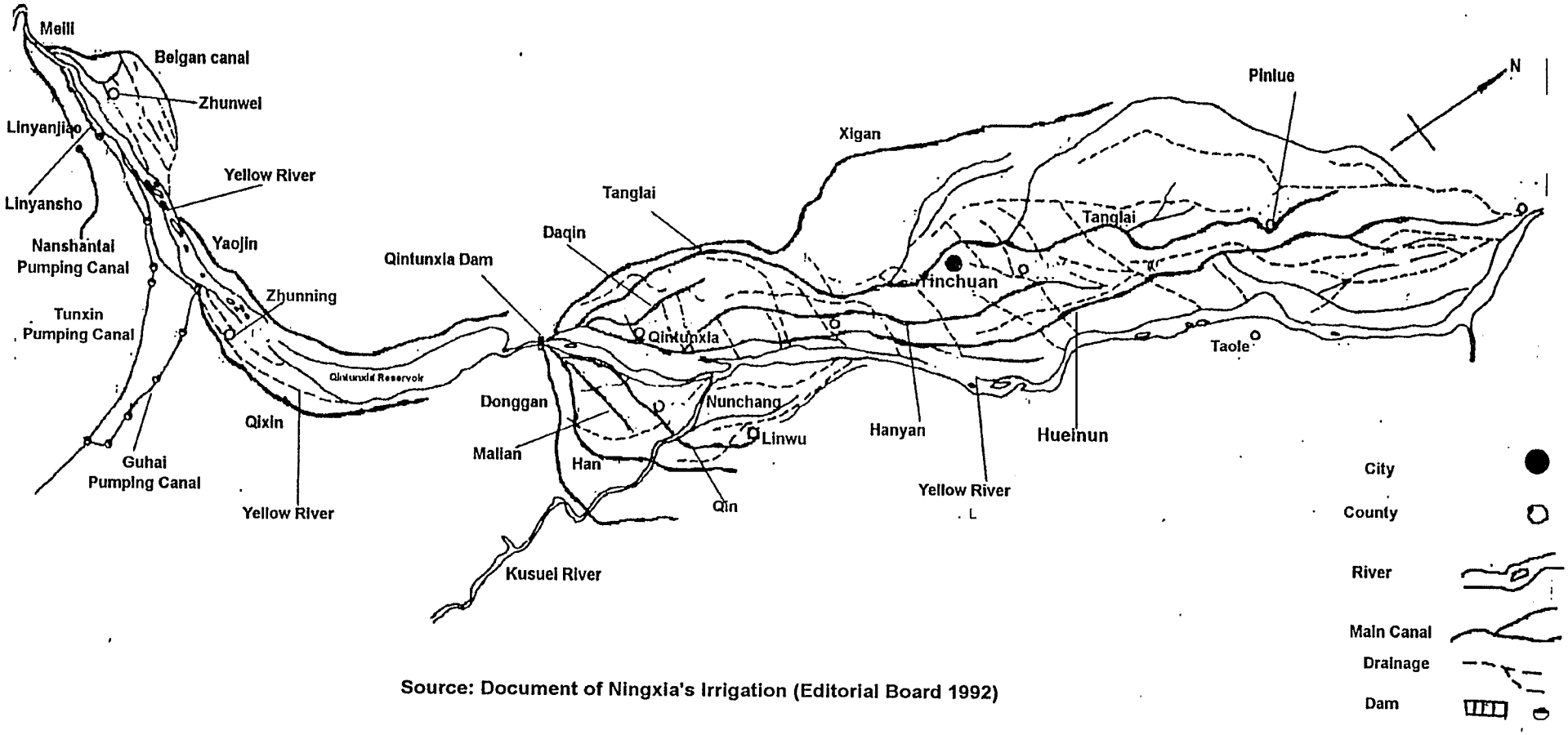
in this thesis will deal mainly with gravity-flow irrigation.

The "gravity-flow" canal irrigation systems in Ningxia are primarily concentrated in northern plain regions along the Yellow River valley. This valley runs south-north, given that the Yellow River is flowing from south to north (see figure 2.3). In terms of altitude above sea level the southern part of the Yellow River valley is relatively higher than its northern part. The incline ratio is 1/4000 which means that the surface of land declines one metre every 40,000 m. Thus, in order to get water from the Yellow River through taking advantage of the south-north incline, entrances of all the major canals of northern Ningxia are set up at the southern passage of the river (see figure 2.7). As shown in figure 2.8, the incline of one major canal (such as the Hanyan canal with a length of 88.6 km) ranges from 1130 m to 1110 m above sea level. Compatible with the flow direction of the Yellow River, the south-north incline of the Yellow River valley actually has a number of important consequences:

(1) The requirement of large major canals

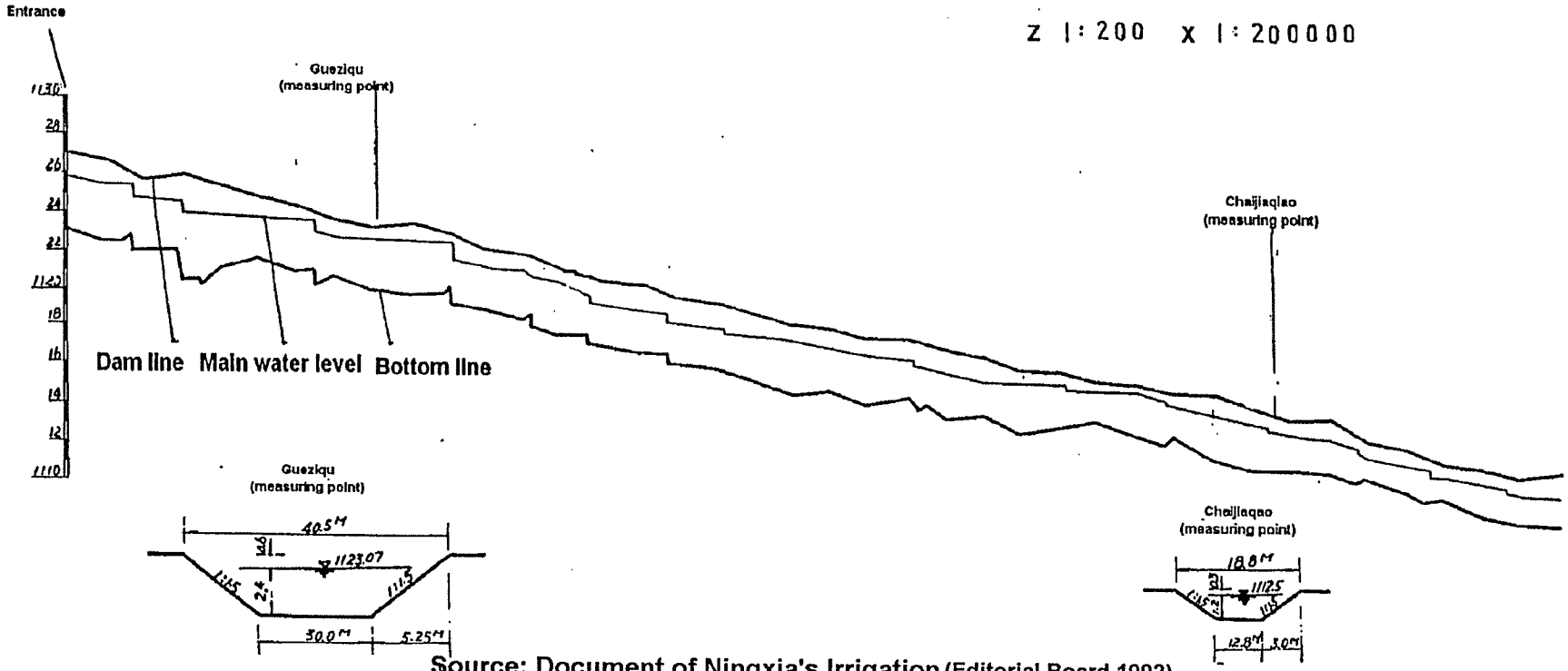
Northern plain areas can only get their irrigation water through the large main canals ("Ganqu"), whose entrances for irrigation water must be built at southern parts of the valley, usually around 100 km away from the northern irrigated land. As a result, all the main canals are constructed from south to north across the Yellow River valley. For example,

Figure 2.7 Irrigation System of Northern Ningxia



Source: Document of Ningxia's Irrigation (Editorial Board 1992)

Figure 2.8 Section of the Hanyan Main Canal



Source: Document of Ningxia's Irrigation (Editorial Board 1992)

the Hanyan canal (88.6 km long) irrigates the Yinchuan plain, the largest plain located in the northern part of the valley. As shown in figure 2.8, the entrance to the Hanyan canal is 1130 m above sea level; its terminus, 1110 m above sea level. The incline along the Hanyan canal is 20 m. From south to north the width of Hanyan canal changes from 40.5 m at its entrance to 33.m of its midpoint, and to 18.8 m at its end. The Hanyan canal alone irrigates approximately 720,000 *mu* of land.

Currently, there are 15 main canals in northern Ningxia with a total length of 1099.2 km. Table 2.10 gives the detailed information on main canals in northern Ningxia. Together, these major canals irrigate 4500,000 *mu* of cultivated land with the annual transportation of 7 billion m^3 of irrigation water. Corresponding to these canals there are 41 drainage systems which are 842 km long. Annually, they can drain 3 billion m^3 of water from approximately 6,700,000 *mu* of irrigated land. Of all these 15 main canals, seven are directly managed by the Ningxia Provincial Ministry of Water and Irrigation through seven specialized bureaus for main canals (see chapter 4). Others are under the control of county bureaus of electricity and irrigation. The seven main canals are: Tanglai, Hueinun, Hanyan, Qi and Han, Yaojin, Qixin and Xigan (as marked by "*" in table 2.10).

Table 2.10 Major Canals of Irrigation Systems of Northern Ningxia (1985)

Major canals	length (km)	Capacity (m^3/s)	Volume of water (million m^3)	Irrigated land (1000 mu)
Meili	21.6	40	519	245.3
Linyanjiao	14.3	1	12	8.4
Limyansho	32.8	12	104	58.4
Yaojin*	85	30	287	92
Qixin*	87.6	65	543	250
Qin*	60	70	658	400
Han*	44.3	40	268	200
Malian	16	18	168	70
Donggan	54.3	54	256	220
Hanyan*	88.6	90	791	500
Tanglai*	154.6	160	1540	1100
Daqin	25	23	230	100
Hueinun*	175	85	945	750
Xigan*	112.6	45	372	330
Qinming	47	20	155	67

Source: Documents of Ningxia's Irrigation (Editorial Board 1992).
* Main canals directly managed by Ningxia Provincial Ministry of Water and Irrigation.

(2) The establishment of numerous branch-canals

In order to get irrigation water from large major canals, it is necessary to connect numerous branch canals ("Zhiqu") to the major ones, usually at a 90° angle. Following those branch canals are sub-branch canals ("Doqu"). For instance, the Qin canal has eleven branch canals irrigating 400,000 *mu* of

cultivated land (see table 2.11). Across this major canal, there are 145 entrances for sub-branch canals. The cultivated lands of ten townships are irrigated by the entire canal network. Usually, one main canal may cross the territories of several counties. For example, the Tanglai canal (the longest major canal in Ningxia) passes by five counties and one city. There is a special agency set up for the management of the Tanglai canal, which is controlled directly by the Provincial Ministry of Water and Irrigation.

Similarly, a branch-canal may irrigate lands of several townships[9]. For instance, Zhaoqu, the branch-canal of Qin canal, irrigates 4,206 *mu* of land belonging to three different townships. The maintenance of this branch-canal is coordinated by management personnel from these three townships. Basically, governmental agencies at provincial, districts and county levels are responsible for the management of major canals and their branches, while management personnel at rural community-levels (township and village) may be in charge of sub-branch canals. However, peasants who directly benefit from main canals and their branches must contribute labour or money to their maintenance.

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[9]. In the People's Republic of China the administrative areas follows: province, city or district, county, township and village. Townships and villages are the lowest-level administrative units in rural areas. Each township, usually composed of several villages, is administrated by a township government. Every village has a village council in charge of administrative affairs.

Table 2.11 Branch Canals of the Qin Canal (Irrigating 3000 *mu* of Land or More)

Branch-canals	Capacity (m^3/s)	Irrigated land (mu)
Waqu	1.55	4,488
Xidaiqu	1.31	4,803
Zhunqu	2.01	7,650
Chai	1.22	3,868
Xinqu	3.87	15,093
Zhaoqu	2.01	4.206
Xuqiao	2.00	4,594
#35 canal	1.50	3,003
Diqu	1.39	3,447
Garden #1	1.24	3,512
Henshan	2.5	4,000

Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

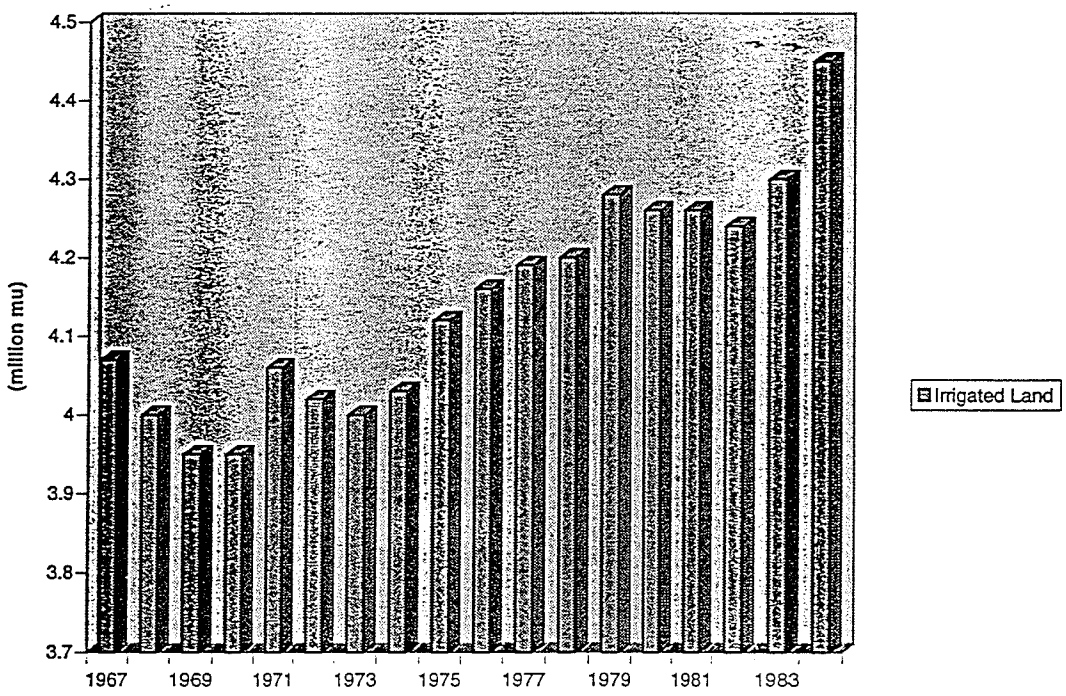
Before 1949, major maintenance of main canals in Ningxia involved the clearance of silt in main canals, and the annual repair of water gates through which water from the Yellow River was transferred into main canals. In 1960, the Qintunxia Reservoir was established to raise the water level of the Yellow River by 18 m (see figure 2.7). The main dam of the reservoir is 697 m long and 42 m high. Despite the fact that it is a hydraulic power station, the Qintunxia Reservoir has increased water supply to all the main canals, and dramatically decreased silt within these canals because high level water can clear silt through its gravity. The reservoir

also eliminated the annual repairing of water entrances for main canals and reduced intensive labour for silt clearance (Shang 1992).

During the 1960s, 1970s, and 1980s, irrigation systems in northern Ningxia have been expanded in order to deal with the growing population. Figure 2.9 shows the expansion of irrigation in northern Ningxia from 1967 to 1984. For instance, in 1967, the irrigated land was 4.07 million *mu*; in 1984, the amount of irrigated land had increased to 4.48 million *mu* (Liu et al. 1986).

The spatial structure of a large-scale irrigation system can be heavily influenced by the type of water supply and by the topographical features of land it irrigates. This is especially true with regard to the arid ecosystems of northwest China. In Ningxia, local irrigation systems are concentrated within a south-north plain, where the Yellow River flows. All of the main canals receive their water supply exclusively from the Yellow River, and most of them get water through several main water entrances located at the Qintunxia Dam. As discussed in chapter 4, those large hydraulic facilities at levels of main and branch canals are directly controlled by the Ningxia Provincial Ministry of Water and Irrigation and its special agencies. In addition, below branch canal level are sub-branch canals and ditches, which can be managed by township and village-based organizations. These two layers of local irrigation systems correspond to two types of

Figure 2.9 Expansion of Irrigated Land in Northern Ningxia (1967-1984)



Source: "Micro-management of Irrigation & Drainage in Ningxia" (Liu Bezhang et. al 1986).

institutional management: centralized and localized.

In this chapter, I have described some important characteristics of the local climate, topography and water or land resources which have close relations with irrigation systems. In northern Ningxia it is obvious that to a degree, the structures and functions of institutional management of local irrigation systems are related to the described features of local ecosystems, especially through the physical requirements for a large-scale irrigation network.

Chapter Three

History of Canal Irrigation Management in Ningxia

3.1 Management of Canal Irrigation in Northwest China during Imperial Times (221 BC - 1911 AD)[10]

Ancient agrarian state societies once prospered in the regions along the Nile, the Indus, the Yellow River and the Tigris & Euphrates rivers. As noted by Wittfogel (1955, 1957), all of these societies were associated with large-scale, complicated irrigation systems. In these agrarian state societies large-scale irrigation systems require a group of centralized management institutions, which existed in ancient northwest China as well. Wittfogel used the term "hydraulic societies" to emphasize the significance of large-scale hydraulic projects in the formation and transition of ancient state societies in China, Egypt, and India. Yet, he almost completely ignored the existence of rural community-level control of irrigation water and hydraulic works in "hydraulic societies".

There is a long history of collective or village-based management of natural resources in imperial China. According

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[10]. A detailed description of the dynasties of Imperial China can be found in appendix 1.

to Menzies's study on rural areas in southern China during the 1900s (1994), several villages could jointly manage forest and land for forest, and had a complex system of rotating supervisory committees. These villages each selected one officer to the management body. The members were then divided into a number of groups with several officers in each group. Each group was responsible for supervising forest management for at least one year on a rotating basis. Usually, clans and lineage groups might devise and enforce their own regulations concerning lineage lands without reference to the state legal structure.

China has a long history of large-scale hydraulic construction, and much of it was sponsored by the state. However, as argued by Nickum (1982), with the exception of major flood control and navigation works and a small number of large irrigation districts relying on river diversion, water management before 1949 was most commonly in the hands of families, or of villages, or clan organizations. These management bodies were one of the few instances of an institutional structure independent of direct governmental administration in traditional Chinese society. This functional separation from mainline political and economic systems has persisted into the period of the People's Republic of China. In fact, the management of various irrigation systems in ancient China was so complicated that a general conclusion would be improper concerning its long history and a variety of

ecosystems in a territory of 9.6 million km^2. However a case study of a region like Ningxia, with long history of large-scale canal irrigation systems, will help us analyze some historical features of irrigation management in imperial China.

Historical development of canal irrigation in Ningxia

During imperial times (221 BC-1911 AD), the management of canal irrigation in Ningxia and other areas of northwest China was, to a degree, different from the general situation of other parts of China as discussed by Nickum (1982). As a result of its arid climate and frontier history (Lattimore 1951), large-scale canal irrigation systems dominated northwest China, where the major river, the Yellow River, provided irrigation water. The coordination from a state authority in the construction and maintenance of hydraulic facilities was not only necessary, but also overwhelming .

Northwest China, including Ningxia, was at one time the frontier between the Mongolian Plateau and the north China plain during the time that military confrontation between nomads and the Chinese dominated the history of north China. Most dynasties of Imperial China established their control over the frontier regions in northwest China, which Lattimore described as "the Inner Asian Frontier of China" (1951:409). Usually, after having militarily defeated the nomads, the Chinese imperial government organized a large number of

immigrants from other parts of north China to resettle in northwest China as farmers and soldiers (Zhang 1994). These immigrants were from north or central China where irrigation agriculture had been developed earlier than in northwest China. In particular, during the Han dynasty (206 BC-220 AD) the number of settlers from north China was so great that the Chinese imperial government had to set up new counties and provinces to control the new sedentary population. For example, from 127 BC to 119 BC, approximately 1,460,000 immigrants resettled in Ningxia and other regions of northwest China. A new province called "Shuefang"[11] was established for them, and special governmental officials organized more than 600,000 settlers and soldiers to construct canals and to pursue irrigation farming in four frontier provinces (Zhang 1994). In addition, new state officials, specializing in the management of irrigation farming, were appointed in these frontier provinces. It was during the period of the Han dynasty that most of the earliest hydraulic works were set up along the Yellow River valley in Ningxia and other areas of northwest China.

Several ancient Chinese books published by the imperial governments, such as Shiji and Ashisishi, are still available today and give detailed descriptions of the ancient hydraulic

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[11]. The English spelling of Chinese-pronounced names (e.g., the name of a province or county, and of a person) adopts the Pinying system, which is officially used in the People's Republic of China.

works in Ningxia. For instance, in 444 AD the governor of a frontier province (including Ningxia) ordered the construction of a 60 km major canal that irrigated land of more than 40,000 *qin* (1 qin =6.6 ha) (Lu 1989). However, more detailed descriptions come from a series of special books documenting local history, demography, social life, and administration. These books were usually published by the provincial government during the late imperial dynasties of the Ming (1368 -1644) and the Qin (1644-1911). According to one of these: Jiajingningxiaxingzhi (Guan Liu 1982), from 1522 to 1566 there were 18 major canals and sub-canals built across Ningxia. In all, these were 700 km long irrigating land of 1.56 million *mu*. During the 18th century, there were 23 main canals connected to the Yellow River, which extended more than 1000 km, irrigating land of 2.1 million *mu*. Before the socialist revolution of 1949, 39 main canals were functioning in Ningxia with a coverage of 1.92 million *mu* (Editorial Board 1992). Table 3.1 gives a detailed description of the historical development of irrigation in Ningxia during the imperial times.

The purposes of this type of state-sponsored hydraulic construction and sedentary resettlement were obviously political: they served (1) to colonize the frontier with sedentary settlers, and (2) to strengthen the imperial army which was already stationed there for reasons of military security.

Table 3.1 Historical Development of Irrigation in Ningxia

Dynasty	Major canals	irrigated land (mu)
Han (206 BC-220 AD)	unclear	unclear
Beiwei (461-530 AD)	one 60 km canal, others unclear	40,000 qin*, others unclear
Tang (618-907 AD)	10 (estimated)	unclear
Xia (1038-1227)	12	90,000 qin*
Ming (1368-1644)	18	1,560,000
Qin (1644-1911)	23	2,100,000

* 1 qin =6.6 ha
Source: "History and Lessons of the Yellow River Irrigation in Ningxia" (Lu Deming 1989).

Other goals, typically economic, include developing irrigation farming in order to provide enough food for the imperial frontier army and sedentary settlers. Otherwise, the imperial government would have had to transfer large amounts of food from north China to the frontier in northwest China. This kind of transportation was usually extremely costly because of the long distances and the large amounts of intensive labour required.

Distinct from those in north, central and south China, most canal irrigation systems in northwest China are the result of the colonial expansion of the Chinese empire. The

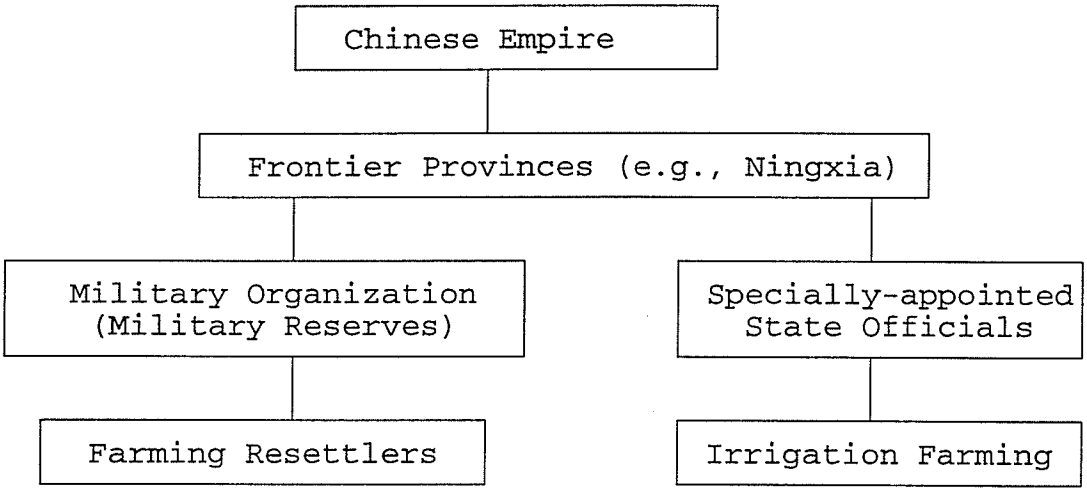
proper functioning of these hydraulic works was not only crucial for the survival of the frontier army and sedentary settlers, but also crucial for the national security of Imperial China (Zhang 1994). Therefore, it is not surprising that in Ningxia and other areas of northwest China there is a long history of centralized management of irrigation.

Centralized irrigation management during imperial times

During the imperial period, the state sponsored and organized all the hydraulic works in Ningxia and other regions of northwest China. In fact, the earlier settlers were organized as military units although they kept their civilian status (military reserves). Thus, during the earlier period of the Han dynasty (206 BC-220 AD), when irrigation was initiated in northwest China, the social organization in those frontier provinces was exclusively military so that settlers could be recruited immediately if war against the neighbouring nomads (such as the Hunnish) broke out. As shown in figure 3.1, during imperial times, management of local irrigation systems can be characterized as being centralized and was facilitated by officials who were especially appointed for managing irrigation farming.

According to Lu (1989), a special regional (provincial or cross-provincial) agency was established which was in charge of the management of irrigation and farming in Ningxia during the Xia, Yuan, Ming, and Qin dynasties.

Figure 3.1 Ningxia's Irrigation Management during the Han Dynasty (206 BC-220 AD)



Source: Immigration and Ningxia Regional Culture (Zhang 1994).

Special regulations were issued for the maintenance of hydraulic facilities and the allocation of water. For instance, during the Ming dynasty the official policy required that in March of every year the governor of Ningxia had to assign his soldiers to repairing dams and water gates or cleaning silt in major canals. Table 3.2 lists the governmental agencies at a variety of levels which were responsible for managing irrigation in Ningxia during imperial times.

Table 3.2 Governmental Agencies for Managing Irrigation in Ningxia (1038-1911 AD)

Dynasty	Agencies	Administrative level
Xia (1038-1227 AD)	Farming agency	The central government
Yuan (1271-1368 AD)	Farming agency (1289)*, river & canal agency (1309)	Provincial
Ming (1368-1644 AD)	River & canal agency (1431), farming agency (1551)	Provincial
Qin (1644-1911 AD)	Irrigation agency	Provincial

* The years indicate when the agencies were first officially established.
Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

Note that table 3.2 only lists the agencies described in the imperial governmental documents; the same agencies might have existed during other dynasties, but are not recorded in the available documents. Actually, all of these provincial agencies of Imperial China still find their contemporary counterparts in today's Ningxia provincial government: the Ministry of Water and Irrigation with 3,723 officials, technicians, and workers in charges of seven major canals and other hydraulic facilities (see Documents of Ningxia's Irrigation (Editorial Board 1992)).

Some Chinese scholars (e.g., Lu 1989, Chen Maoling 1991) have studied the irrigation regulations issued by the imperial government. According to Chen (1991), during the Tang dynasty

(618-907 AD) the central government issued national legislation governing irrigation systems across districts and counties in China. For example, the first article of this legislation called "*Shueibushi*" ("Legislation for Irrigation Administration") declared that: governments of districts and counties are entitled to manufacture and install water gates along major canals for water allocation; it is illegal for any individual to manufacture or install these facilities.

In Ningxia, the construction of all major canals was sponsored and organized by the state authority, usually at provincial or county levels. Across Ningxia 12 major canals were built during imperial times. Table 3.4 lists their construction years and irrigation coverage. Seven of these cross counties. Therefore, the provincial government had to coordinate their construction and maintenance. The longest major canal, named "Tanglaiqu" (212 km), covered five counties. During the Yuan, Ming, and Qing dynasties, the provincial governments were completely in charge of the maintenance of this major canal. It used to irrigate land of 467,000 *mu* across five counties. For instance, in 1709 AD, the provincial minister of irrigation ordered the construction of a dam at the head of Tanglaiqu in order to increase water supply from the Yellow River (see Documents of Ningxia's Irrigation 1992 (Editorial Board 1992)).

Table 3.4 Major Canals in Ningxia during Imperial Times

Major canal	Construction year	Irrigation coverage (title, number of counties)
Qinqu	214 BC	Qintunxia, Wuzhun, Linwu (three counties)
Hanyanqu	211 BC	Qintunxia, Yunning, Yinchuan, Helan (four counties)
Hanqu	119 BC	Qintunxia, Wuzhun, Linwu (three counties)
Tanglaiqu	102 BC	Qintunxia, Yunning, Yinchuan, Helan, Pinlue (five counties)
Meiliqu	100 BC	Zhunwei (one county)
Qixinqu	100 BC	Zhunwei (one county)
Hueinunqu	1726 AD	Yunning, Yinchuan, Helan, Pinlue, Shcueishan (five counties)
Linyanshuoqu*	The Qing dynasty (1644-1911)	Zhunwei (one county)
Linyangjiaqu	1767 AD	Zhunwei (one county)
Daqinqu*	The Qing Dynasty (1644-1911)	Qintunxia (one county)
Changrunqu*	The Qing dynasty (1644-1911)	Pinlue, Shzueishan (two counties)
Tainingqu*	The Qing dynasty (1644-1911)	Qintunxia, Zhuntan (two counties)

* The exact building year is unclear.
Source: "Macro-management of Irrigation & Drainage in Ningxia (The Yellow River)" (Liu Paizhang et al. 1986).

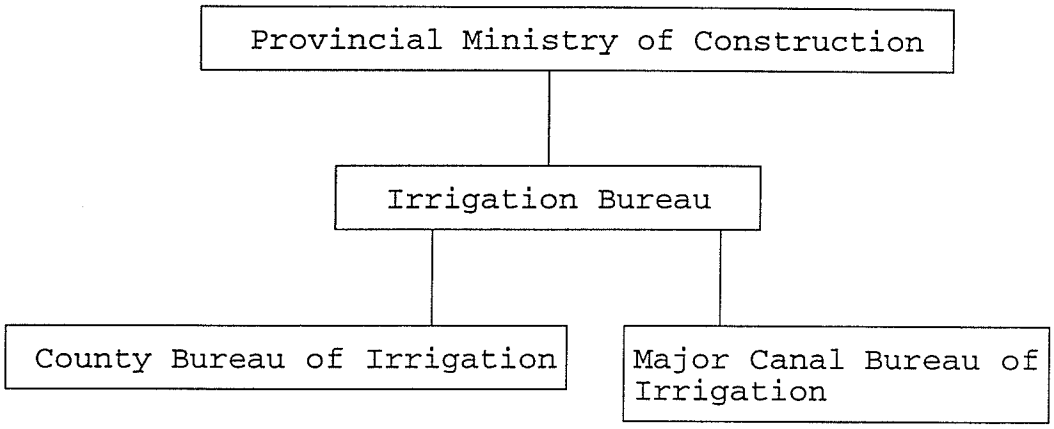
For those major canals within the territory of one county, the provincial government usually provided financial and technical assistance through direct administrative control. One example is a major canal called "Meiliqu" (77 km) in Zhunwei county. In 1562 (during the Ming dynasty), the provincial governor ordered officials from Zhunwei county to build a new water entrance for Meiliqu. By 1701 (during the Qin dynasty), with the financial support from the province, the officials of Zhunwei county organized local farmers to construct a stone dam in order to raise the water level of the Yellow River because the bed of the Meiliqu canal had been raised as a result of accumulation of silt (Editorial Board 1990).

Governmental agencies for irrigation before the socialist revolution of 1949

During the time of the Democratic Republic of China (1911-1949), management agencies at both provincial and county levels were still efficiently controlling the maintenance of most main canals (Editorial Board 1992). When compared with imperial times, it is particularly worthy of note that more sub-agencies were set up in counties, where irrigation farming dominated local agriculture. Another difference is evident in the establishment of agencies specialized in managing main canals. Before 1949 there were five main canal agencies. In addition, these relatively powerful governmental agencies had to cooperate with township or village-based institutions.

These institutions, as discussed later, were very influential before the socialist revolution.

Figure 3.2 Governmental Agencies for Irrigation Management in Ningxia in 1943



Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

Figure 3.2 shows the governmental agencies, both at provincial and county levels, which were specialized in managing irrigation during the period of the Democratic Republic of China (1911-1949). This model was adopted after 1949 by the socialist government without any dramatic change. The detailed situation of governmental agencies on irrigation after 1949 is discussed in chapter 4.

3.2 Rural Community-based Management of Irrigation (17th century -1949)

Emergence of township-based irrigation during the 17th and 18th centuries

According to the County History of Zhunwei (Editorial Board 1990), which was first published in the 18th century, the earliest documented township-built and managed irrigation system appeared in the 17th century in Zhunwei county of north Ningxia. In 1625, a township ("Pu") named "Zhaoyuanpu" built two branch canals within its territory[12]. The first branch canal was 35 km long, and the second one was 10 km long. In all, they irrigated more than 15,200 *mu* of farmland. There were eleven water gates along these two canals. The leader of the township was in charge of managing the canals; the book even lists his name and the person who led the construction.

As noted by Zhang (1994), the gradual dissolution of military social organizations during the later imperial times led to the emergence of rural civilian society in Ningxia and other regions of northwest China. The typical periods involve the late Ming dynasty and Qin dynasty (1644-1911). The transition of local social structure from military to civilian

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[12]. During the Ming Dynasty, the largest rural community in Ningxia was called a "Pu" meaning a "fort." A "Pu," equal to one township, was derived from a former military fort built by the Chinese imperial front army. Usually, the residents of a "Pu" were former soldiers and their families. During the 15th and 16th centuries, a peace agreement between the Chinese empire and the Mongolians allowed a large portion of the imperial army to become farmers in Ningxia (Zhang 1994).

societies made possible the establishment of community-based irrigation systems. On the other hand, this kind of transition was conditioned by the political changes of the frontier regions in northwest China. During long periods of peace between the nomads and the Chinese, civilian society could survive at levels of the rural community in Ningxia. Obviously, more sophisticated studies are required to deal with those intriguing connections, which are beyond the current focus of this thesis.

During the Qin dynasty (1644-1911) when China had transformed itself into a multi-ethnic society, the Mongolians and other nomadic groups signed permanent peace agreements with the central government. This is the first time in its long history that Ningxia was no longer a military frontier. According to the County History of Zhenwei (Editorial Board 1990), most of its township-based irrigation canals were built during the Qin dynasty. The book recorded twelve canals built by rural townships (see table 3.5)

The building and maintenance of these canals might sometimes require the administrative assistance from the county government, particularly when conflicts among townships occurred. One example concerns the maintenance of the canal of Tietunpu township. In 1758 more than 2km of the canal's water entrance collapsed. The township could not afford to repair it and thus turned to the mayor of Zhuenwei county for help. The mayor, Huang Enyi, suggested building a new entrance.

Table 3.5 Township-based Canals in Zhunwei County during the Qin Dynasty (1644-1911)

Township	Canal length (Km)	Irrigation coverage (mu)
Zhenqinpu	15	8,740
Zhenluepu	20	15,600
Yunxinpu	12.5	7,260
Shikunsipu	35	16,900
Zhangyipu	7.5	3,600
Zhueyuanpu	45	12,000
Tietunpu	12.5	2,500
Guangwupu	30	7,900
Changlepu	14	1,100
Yunkanpu	20	7,800
Xuanhepu	20	15,300
Juoninganpu	20	29,200

Source: County History of Zhuenwei (Editorial Board 1990).

The Tietunpu township subsequently bought four *mu* of land next to the Yellow River from a local farmer. However, when the construction of new water entrance started, farmers from a nearby township tried to stop it because they were worried that the path of new entrance would occupy their land. As the highest official in the county, the mayor finally declared the construction was legal. He himself even participated in the labour to symbolize his authority (Editorial Board 1990).

As shown in the historical document above, townships in north Ningxia could build their own canals if financial and labour resources allowed them to do so. Generally, the leaders

of a township dominated the decision-making process of construction and maintenance. Many details about the institutional management of these township-based canals remain unclear due to the lack of relevant detailed historical documents. For example, how was irrigation water allocated among users of a township? Were there any regulations collectively agreed upon by water users to protect their rights? These questions may require further study in order to provide a more complete picture of irrigation management in rural townships of northwest China during late imperial times (e.g., the Qin dynasty).

Township and Village-based management of irrigation before the socialist revolution of 1949

Few documents are available concerning particular irrigation systems which were directly managed by villages or townships in Ningxia before the socialist revolution of 1949. However, according to Documents of Ningxia's Irrigation (Editorial Board 1992), township and village-based management became relatively popular after the collapse of the Manchu Empire in 1911. The centralized institutions in charge of financial and technical assistance maintained a cooperation with rural

communities[13]. Some information from Documents of Ningxia's Irrigation (Editorial Board 1992) provides a relatively general description of the situation at that time.

In rural areas of north Ningxia before 1949 there was an executive director for each branch canal who could be elected by local users. Alternatively, the position rotated among local landlords. The primary duties of an executive director involved the allocation of irrigation water and the maintenance of canals. Usually, the maintenance of canals, such as the clearing of silt, required labour as well as financial input from local users. Each township had a canal director, who was usually elected by users. A canal director was in charge of collecting the water fee, as well as of organizing labour and construction materials in his township. It is notable that it was the duty of a canal director to organize the labour and construction materials, and even to collect money for the construction of a new major canal or the maintenance of the old ones.

On the other hand, it was the provincial or county governmental agencies which coordinated the construction and maintenance of these major canals that ultimately benefitted the users of the township and others as well. As a result,

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[13]. According to an interview with the former chief engineer of Ningxia Provincial Ministry of Irrigation, community-based management used to dominate local irrigation systems before 1949, while governmental agencies were powerful regarding sponsoring or coordinating the construction of new major canals or the maintenance of old ones.

there was cooperation between township and village-based institutions and governmental agencies. The possible reasons behind this type of cooperation are: (1) branch or sub-branch canals in townships or villages received water from the major canal managed by a governmental agency, or (2) a government agency in charge of irrigation management needed the assistance of irrigation officials from villages or townships, whose expertise and experience were important for the normal functioning of canal networks.

Since 1937, this type of cooperation had been strengthened through the establishment of a special executive council for each major canal and county. Local users were entitled to select the members of each council, who were usually experienced in the management of irrigation in their villages and townships. The emphasis on cooperation, however, did not mean the elimination of conflict between these rural townships or villages and the government. These conflicts usually manifested themselves in disputes concerning labour contributions by townships and villages, and the maintenance of a major canal, the supply of irrigation water, and taxation.

When discussing the general situation across China, Nickum (1981:3) suggests that:

> With a few notable exceptions, however, the historical Chinese state concerned itself primarily with manipulating water for purposes other than irrigation, especially flood control and navigation.

Nickum's caution is justified, as one notices that the management of irrigation systems in Ningxia just falls into his "few notable exceptions". In the arid regions of northwest China large-scale irrigation systems were mainly manipulated by the Chinese imperial government at the provincial level. This legacy can still be observed in today's irrigation management of Ningxia, as exemplified by a group of centralized management institutions ranging from county to provincial levels (see chapter 4). As later indicated in chapter 4, from the period of the Republic of China (1911-1949) to that of the People's Republic of China (1949-), few changes occurred to the basic structure and functions of the centralized management institutions at a variety of administrative levels in Ningxia.

In his analysis of local organizations for irrigation management, Nickum (1981: 4) explains:

> On-farm application and removal of water was left in the hand of local village or intervillage organizations. These bodies varied in form from place to place and from time to time. Sometimes they were built and run by families separate from landholding. At other times, especially in recent centuries, they were operated by landlord or other farmer association, usually with full-time managers. This was one of the few instances of professional, task-oriented management independent of direct village administration in traditional Chinese society.

The township and village-based management of irrigation in Ningxia is compatible with the general situation of China as described by Nickum (1981). Since the socialist revolution of 1949, however, some dramatic changes have occurred in the

Chinese rural society. In particular, collective ownership replaced private landholdings across China during the socialist revolution. In this context, the structures and functions of township and village-based management institutions have undergone certain changes, which will be discussed in chapter 4.

Chapter Four

Management of Irrigation in Ningxia after 1949

4.1 1949-1978: People's Commune and Rural Community-based Management

Prior to the socialist revolution of 1949, there was an executive director for each sub-canal in rural Ningxia. He was elected by local users, or the position rotated among local landlords. The duties of an executive director mainly involved the allocation of irrigation water and the maintenance of canals. In Ningxia this type of community-based (township and village), task-oriented management was independent of the local government administration before the revolution of 1949 (Wu 1992). For instance, in the spring of 1929 when civil war broke out in northern Ningxia a local warlord's army occupied the capital city (Yinchuan), and the executive provincial government collapsed. However, the annual maintenance of canals continued as usual with coordination from managers selected by local farmers (Wu 1992).

After the revolution of 1949, and especially since the mid-1950s, township and village-based water management across the People's Republic of China has operated within dramatically different political and social structures.

Besides the direct control of the communist party at the village level, the collectivization of land-ownership and the establishment of the People's Communes had weakened the previously active institutions responsible for irrigation management in villages or townships. A brief history of land reform and the People's Communes in rural China would be helpful for the understanding of this whole process.

In the earlier period of the People's Republic of China (1950-1952) land reform was a popular way for the Communist government to gain wide support from landless peasants, who represented 70% of the rural population (Zhou 1992). From 1950 to 1952, large landlords across China were forced to give up their lands without any financial compensation. A special peasant committee was set up in each village or township and was responsible for reassigning land to landless peasants. In 1950 the "Legislation of Land Reform in the People's Republic of China" legalized land ownership by individual peasants. At that time, land reform was intended to eliminate the concentration of land in the hands of landlords, which had usually led to most of the peasant rebellions in the Chinese history. However, by 1956 the communist government initiated another round of land reform in order to force peasants into "Co-operative Farming Teams". As a member of a "Co-operative Farming Team", a peasant gave up the ownership of his land which was then collectively owned by the entire farming team. By the end of 1956, 87.8 % of peasants across the country

joined a "Co-operative Farming Team" (Zhou 1992).

As the collectivisation of landholding continued, Chairman Mao decided to use "People's Communes" to replace "Co-operative Farming Teams". In August of 1958 the Central Committee of The Communist Party issued "A Decision on Establishing Rural People's Communes". According to this decision: "in general, one commune can include several villages and households ranging from 2,000 to 6,000 or 7,000, or even more than 20,000" (People's Daily Sept. 10, 1958). The decision declares that, "A People's Commune adopts collective ownership (of land and other resources), which can be transferred into all-people ownership" (People's Daily Sept. 18, 1958). By September 1958, 23,284 People's Communes had been established involving 90.4 % of the rural households in China (Zhou 1992). By 1962, the basic social and political structures of the Chinese countryside had been drastically changed into the three-layered rural People's commune system: (1) commune (township), (2) production brigade or large farming team (large villages or across several small villages), and (3) production team (villages). This situation remained unchanged until 1978 when the rural economic reform happened. A commune was the lowest state administrative unit in the 1950s, 1960s, and 1970s. Many of its administrative personnel ("cadres") were paid out of the unified state budget.

During the period of the People's Commune (mainly from the 1960s to 1970s), as analyzed by Nickum (1982), the management of village-wide or intervillage water facilities was placed in the hands of specialized management personnel or bodies belonging to a commune or state. Water rights (user rights and ownership) belonged to either the state or the collective commune. Within a given irrigation project, rights of use and allocation might be centralized in the management institutions based on state agencies or the People's Communes. For instance, at the Yeyuan Reservoir (Shangdong province), according to the resolution of a local irrigation district congress, management was under the unified leadership of the People's Commune Party committee and was handled in a unified manner by the Yeyuan Reservoir Management Bureau; no other institutions or individual farmers had the right of transferring or allocating water (Nickum 1982:31). In principle, any water project which benefited or affected a single commune, brigade or team was the separate management responsibility of that commune, brigade or team. The higher level administration was responsible for the management of any water project which benefited more than one commune, brigade, or team. Usually, the management institutions (e.g., county) above the level of the commune were operated by the state agencies which employed a group of full-time staff including management professionals, engineers or technicians, and party officials.

Before the revolution, the traditional forms of village-level water management, while varied across China, had all been grounded in private or clan ownership of water rights or land (Nickum 1981). The land reforms of the late 1950s eliminated this private or clan ownership, but at the same time they collectivized landholding with the establishment of the People's Communes. The People's Communes, incorporating production brigades and teams, provided new community-based water management organizations which had earlier been integrated within a multilevel management systems. These systems were rapidly centralized in the late 1950s and 1960s through the Communist Party's control at the village level, as well as through the collectization of ownership of land and water resources. The secretary of a village Communist Party Committee was not only a top political official but also the most powerful administrator in his or her village. Yet this type of top-down political control in rural China did not lead to the total dissolution of village and township-based institutions for irrigation management. On the contrary, these institutions, such as special village committee of users or sub-branch canal management committees, continued their daily function, although within a new political structure.

According to Documents of Ningxia's Irrigation (Editorial Board 1992), management committees of irrigation were set up as rural community-based institutions in Ningxia during the time of the People's Communes. Generally, officials from

communes or brigades which benefited from a branch canal constituted a management committee for that canal, while several communes or brigades might select a peasant as its director. However, his appointment had to be approved by the county bureau of irrigation. Before the revolution of 1949, the director of a branch or sub-branch canal could be elected by local water users or rotated among local landlords. Obviously, the communist government allowed the form of rural, community-based institutions for management to survive, but the process of selecting personnel of these institutions as well as of decision making had been centralized. One example is that the governmental agencies at the county level reserved the privilege of approving the appointment of a branch canal director. Another example was that the annual plan for water use drafted by a branch canal committee had to be approved by a management bureau of the major canal, which was directly controlled by the Provincial Ministry of Water and Irrigation. In addition, officials constituting management committees of irrigation at village levels were usually leaders of communes or brigades who were directly appointed by the state government. There is no doubt that they were the most powerful figures within these committees.

Nickum (1982) studied the irrigation management of Shaoshan in Hunan province. In 1970 there were three levels of management institutions involving local government and communes in Shaoshan. The highest was the irrigation district

congress, which was primarily composed of representatives from communes and brigades. In spite of some members being selected from among peasants, major participants of a irrigation district congress included principal members of the party committees of communes as well as representatives from the provincial government. The irrigation district congress was headed by a chief official from the district government[14]. The second-level management institution was the irrigation district management committee under which there were several management committees at the level of the commune, or section management committees along canal or branch canal systems. All the members of both committees were composed of top officials from communes as well as of some governmental agents in charge of canal maintenance. Similar to the situation in Ningxia, the lowest management institution involving villages in Shaoshan was a section management committee of a branch or sub-branch canal.

Concerning the control of these institutions, a regulation authorized by the local government in Shaoshan emphasized the leadership of top officials from the state government and communes. The same regulation mentions that some members of management committees may be "selected" among

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[14]. A district is an administrative unit above county level in China. One district usually includes several counties.

local farmers[15]. A similar regulation issued by the provincial Communist government in Ningxia (1962) characterizes village-related management structure as an appropriate form of "democratic management and mass participation" (Editorial Board 1992:243). However, the regulations make it very clear that the bottom line for the normal functioning of these village-based institutions is that governmental agencies at the county level (e.g., a county bureau of electricity and irrigation) reserve the right to deny or approve the appointment of leaders and members of those institutions.

With the introduction of liberal policies in 1978, villages, townships and households in rural China have exercised significantly increased decision-making powers over the use of land and water resources. By the 1980s, the People's Commune system as a political structure had disappeared across the country. Townships and villages have re-emerged as administrative units in the countryside. However, the form and functions of water management organizations developed during the late 1950s and early 1960s have remained essentially the same since that time. New changes did happen, but most of these occurred in the process of decision-making and in the formation of management institutions and the selection of their members. Most changes

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[15]. In Irrigation Management in China" A Review of the Literature (Nickum 1982), an English translation of the regulations issued by local government in Shaoshan is attached (e.g., pp. 28).

took place at the levels of township and village-based institutions. They include the decentralization of decision-making and a village-based process of organizing management institutions, as well as for the selection of their members. Most recently, village officials in rural China are elected directly by farmers to form a village council, which is in charge of the administration of each village. In rural Ningxia it is a village council which selects village-based irrigation officials, such as a ditch water releaser.

4.2 Centralized Management Institutions after 1978[16]

During the 1950s, 1960s and 1970s, there were few apparent changes in the basic structure and functions of centralized management institutions in Ningxia as well as in other parts of China. In spite of some changes in their official titles, the Ningxia governmental agencies responsible for irrigation management have remained similar to those existing before 1949, which have been described in figure 3.2. But an irrigation bureau affiliated with the provincial ministry of construction before 1949 was replaced by a provincial ministry of water and irrigation, which resulted from the dramatic expansion of irrigation systems after 1949 in the province (see chapter 2). During the times of economic reform and the

[16]. The data is from Documents of Ningxia's Irrigation (Editorial Board 1992). Otherwise, references are given.

open policies of the 1980s, the centralized institutions for irrigation management in Ningxia experienced few dramatic changes, although peasants and their villages were starting to challenge the powerful governmental control. By the 1990s, some of these challenges have been recognized by governmental agencies at the county level. However, as described later, the whole process is still underway.

As noted by Nickum (1982), water resources across China were officially owned by the state during the times of the People's Commune. Since the economic reform of 1978, however, water resources in rural China have been respectively owned by the state and villages or townships. Water resources located in rivers, lakes and reservoirs, which are built through investment from the state, are the property of the state. On the other hand, water in ponds owned by villages or townships and in reservoirs built and owned by villages or townships is the collective property of these rural communities (Wang et al. 1988). Concerning the property-rights regimes of irrigation water and facilities in rural China, table 4.1 lists a relatively simplified situation during the late 1980s. It should be noticed that the irrigation systems in table 4.1 refer to large-scale surface irrigation utilizing water from a major river or reservoir. If a small-scale irrigation system gets its water directly from a pond or reservoir which belongs to a village or township, irrigation water and facilities are both usually the collective property of this village or

township.

Table 4.1 Property-rights Regimes of Irrigation Systems in Rural China (1988)

	State property	Collective property (township & village)
Irrigation water	\	
Irrigation facilities	\	\

Sources: Knowledge Handbook of the Legislation of Water (Wang et al. 1988).

As described in Chapter 2, irrigation systems in Ningxia consist of lengthy major canals transferring water from the Yellow River. The main canals and most branch canals in northern Ningxia are owned by the state. The government agencies of province, district or county invested in the construction and maintenance of these hydraulic facilities. However, most sub-branch canals and their ditches are the collective property of townships or villages, although the situation might be very complex due to the different locations of these canals. For instance, a sub-branch canal may be located in the territory of a township but cross the territories of several villages. Normally, the township that administratively controls these villages is responsible for building this canal and subsequently owns it although the canal might have to obtain its water from a government-owned major canal. If a village built a sub-branch (or sublateral)

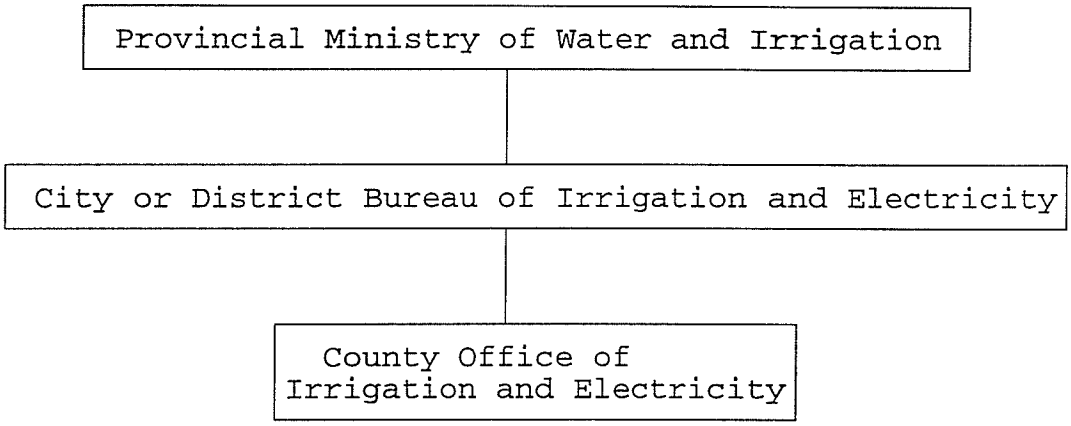
canal within its territory, it would hold the ownership of this canal. In both cases, irrigation water flowing from major canals is still the property of the state, and local farmers have to pay for its usage (Shang, 1992).

The national government of the People's Republic of China and its representatives at a variety of administrative levels are perceived as the "owners" of water as well as of other natural resources. These are named as "state property" according to the Chinese Constitution and the Legislation of Water (first issued in 1988). In the case of Ningxia governmental agencies centralize the management of major canals since irrigation water is exclusively from the Yellow River and is strictly the property of the state. In addition, all the major feeder canals directly transferring water from the Yellow River are owned by the state. They are operated and maintained by a variety of governmental agencies (see figure 4.3). As indicated in figure 4.1, the current governmental agencies for irrigation management in Ningxia can be divided into three administrative layers: (1) provincial ministry of water and irrigation, (2) city or district bureau of irrigation and electricity, and (3) county bureau (office) of irrigation and electricity[17]. It should be noted that this top-down administrative structure remains similar to the one

[17]. In order to reduce the staff and cost of administration, at the level of county or district, an integrated bureau is set up to manage both irrigation and electricity supply.

existing during the times of the Republic of China (1911-1949) (see figure 3.2).

Figure 4.1 Three Administrative Layers of Governmental Agencies for Managing Irrigation in Ningxia (1992)



Source: Document of Ningxia's Irrigation (Editorial Board 1992).

A county bureau of irrigation and electricity (CBIE) plays an active role in managing irrigation systems within its territory. In rural China a county is usually a direct administrative unit above villages and townships. The main functions of a CBIE involve the coordination of technical maintenance of main or branch canals within the county and the allocation of financial resources for irrigation facilities maintenance among townships and villages. In Ningxia a management station specialized in irrigation has been set up at the level of townships since 1982. A township management station

for irrigation is not only a localized institution but also an official representative of a county bureau of irrigation and electricity. The reason behind this dual role of a township station is that the governmental agency at the county level would like to keep its powerful influence over those townships. For instance, through the appointment of a head official for a township management station, a county bureau is able to heavily influence the decision-making process of water allocation and canal maintenances at that level.

One example comes from the case of Taole county (see figure 4.2), the smallest county located in northern Ningxia (Ye 1993). With a population of 22,000, Taole county has five townships that own 63,000 *mu* of irrigated land. Since the late 1980s, a special management institute for water management has been established within the county bureau of irrigation and electricity. There are four professional agents within the institute in charge of managing irrigation facilities and conflict resolution. Five township management stations have been created across the county. Each station has one or two canal inspectors who are responsible for monitoring branch or sub-branch canals. A new contract system is applied to managing irrigation facilities at the level of the village[18].

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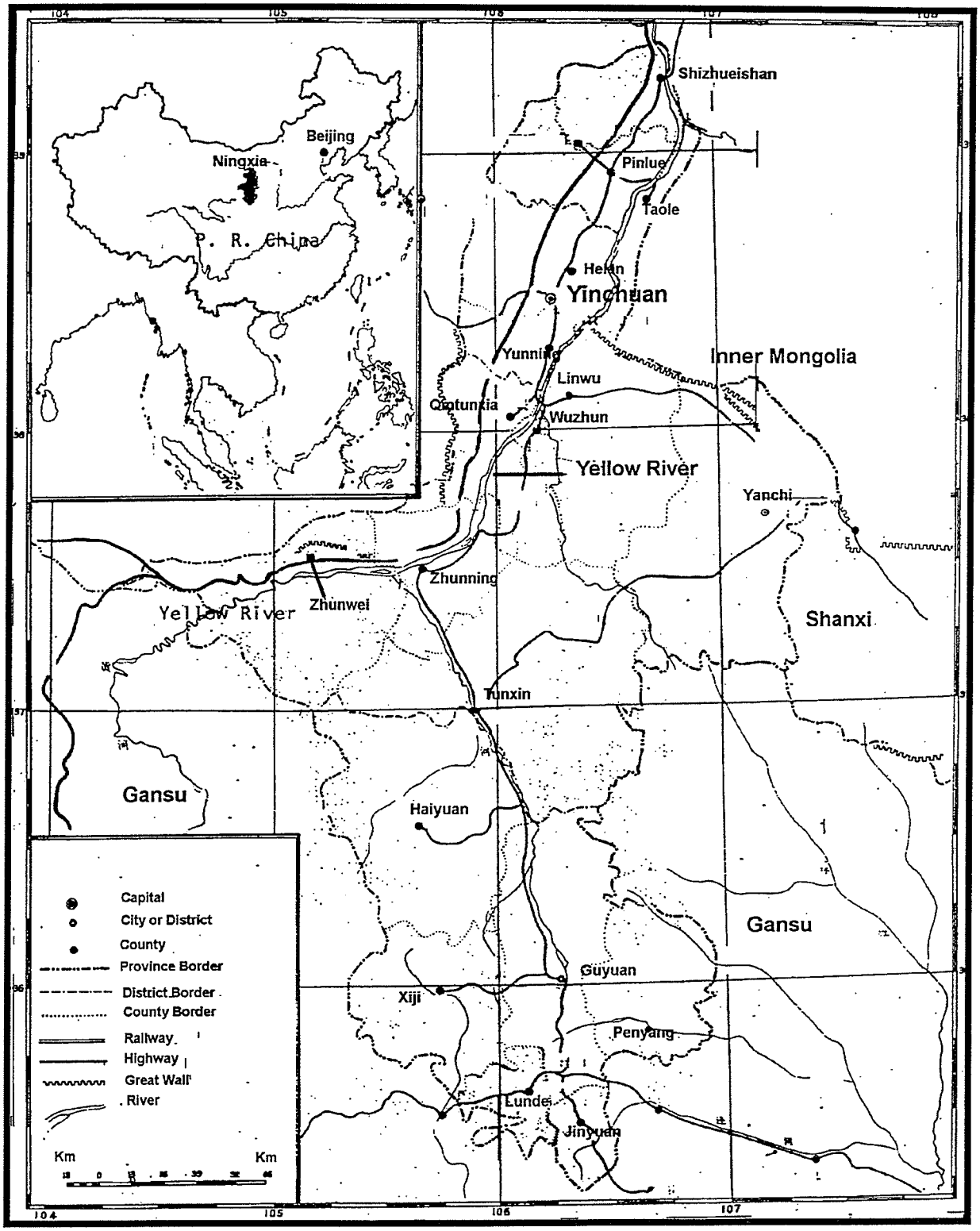
[18]. A contract system was introduced in rural China in 1978. It allows individual peasants to have contracted duties and benefits with regard to hydraulic facilities, land, and other natural resources which are still owned collectively by townships and villages. For further details, please see the third part of this chapter.

Figure 4.2 Counties and Cities of Ningxia



Source: Nationally-owned Land Resources of Ningxia (Regional Planning Office 1988)

Under this new system, the user rights and maintenance duties of each branch canal and its corresponding facilities are contracted out to villages or individual farmers. As argued by the author of the report (Ye 1993), who is also an agent of the CBIE of Taole county, the new management system involving the cooperation among townships, villages, and farmers was first initiated by the CBIE. It is the CBIE, together with the Taole county government, that designed the whole plan and ordered its township representatives (township station for irrigation management) to implement this policy. It is very clear that the CBIE is an influential governmental agency, especially for village irrigation users who have to face its direct control. This type of control appears to be more powerful when assisted by the administrative power of a county government.

Bureaus of Irrigation and Electricity are set up in two cities and one district in northern Ningxia. As the mediator between the province and its counties, a city or district bureau has the power to coordinate management activities at the county level. Usually these activities involve the allocation of financial resources for yearly canal maintenance and the transfer of management personnel. In some cases a city or district bureau may provide technical support to a county or even management institutions at the village or township level if requested to do so. As an administrative unit between the county and the province, a district is sometimes

overlapped with a city. Agencies at the levels of city and district sometimes create bureaucratic barriers between province and county. However, such a mediating agency at city or district levels is not usually very active and influential in the process of managing irrigation, particularly when involving townships and villages.

Currently, the National Ministry of Water and Irrigation coordinates the management of state-owned irrigation and other hydraulic facilities across China[19]. At the provincial level, this coordination is mainly pursued through a provincial ministry of water and irrigation. As the highest governmental agency for irrigation management in Ningxia, the Provincial Ministry of Water and Irrigation (PMWI) is responsible for the coordination of the management activities of city, district, and county agencies. The major functions of the PMWI include:

(1) Management of seven main canals across counties in Ningxia In northern Ningxia, there are seven special main canals directly transferring water from the Yellow River (see table 2.10). Correspondingly, the PMWI sets up seven bureaus

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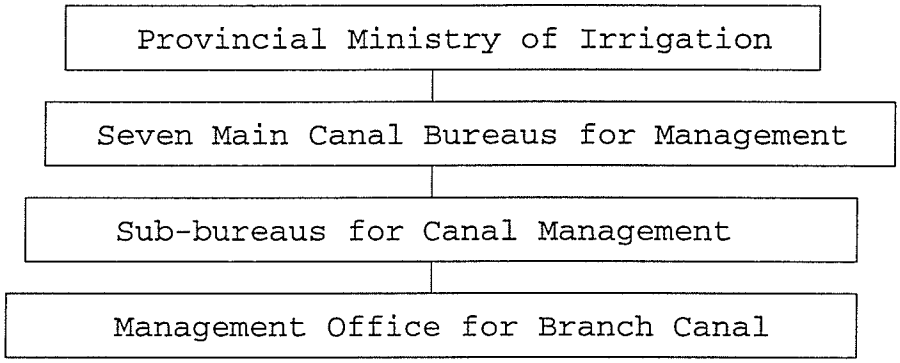
[19]. During the early 1980s, the former National Ministry of Water and Electricity was divided into the National Ministry of Water and Irrigation (NMWI) and the Ministry of Electricity (NME). As a coordinating agency of the central government, most recently the NMWI is mainly in charge of planning hydraulic projects across provinces and distributing special national funds for the maintenance and construction of large-scale hydraulic projects for agriculture. The NME is a national agency specialized in managing the power industry, including large hydro-power stations.

specialized in the management of these main canals (see figure 4.3). Consequently four layers of management institutions exist: the provincial ministry of water and irrigation, a main canal bureau for management, sub-bureaus for management, and management offices for branch canal management. The PMWI itself is in charge of the appointment of top officials for these canal agencies, and it financially supports them through staff salaries. In addition, every year the Provincial Government allocates certain amounts of money for the maintenance of canals.

Figure 4.3 Governmental Agencies for Main Canals Management in Ningxia



Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

It is the duty of the PMWI to distribute this special fund among the seven canal agencies. A main canal bureau, together with its sub-bureaus and management offices as the management representative of the PMWI, is responsible for water

allocation along the main canal and its branch canals. It is also responsible for the regular maintenance of canals. Table 4.2 gives the statistics on management staff of those seven bureaus for main canal.

For example, the Management Bureau for the Tanglai canal has 11 sub-bureaus which control 44 offices for branch canal management. These 44 offices are in charge of 726 branch canals (Shang 1992). For the convenience of management, the Tanglai canal, which is 154.6 km long, is divided into 11 sections. Each sub-bureau is responsible for one section.

Table 4.2 Management Staff of Seven Bureaus for Main Canals (1985)

Bureau	Staff number	Officials*	Workers*
Qixinqu	81	27	54
Yaojinqu	50	17	33
Qinhanqu	215	64	151
Hanyanqu	134	43	92
Hueinunqu	179	53	126
Tanglai	238	65	173
Xiganqu	127	/	/

"/"The number is not available
*In China the staff of a governmental agency for irrigation management can usually be divided into officials and workers. Officials include management personnel, engineers, and party officials. They are government employees. Workers refer to personnel who are hired by a governmental agency, but do not have the benefits enjoyed by government employees. They usually do manual or less-skilled jobs.
Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

Within each section that feeds several branch canals, several management offices are in charge of these branch canals. Each management office usually controls a group of branch canals. For the Tanglai canal, each sub-bureau has, on average, four management offices. One management office is responsible for daily maintenance and water allocation for more than 16 branch canals. As a whole, the Tanglia main canal, including its 725 branch canals, irrigates approximately 1.1 million *mu* of farmland (see table 2.10).

According to Shang (1992), at the level of the branch canal, a governmental agency such as a management office for a branch canal should be set up, although it might be directly controlled by the provincial ministry of irrigation. On the other hand, the management of sub-branch canals and their ditches is controlled by township or village-based institutions. But township or village-based institutions are partially involved in the management of branch canals as well although most of branch canals cross villages or townships and sometimes counties. As discussed later, most cooperation and conflict between governmental agencies and township and village-based institutions occur at the branch canal level.

This type of centralized management structure, which focuses on main canals, is not totally independent of another set of administrative structures (see figure 4.1). Since these seven main canals cross two or more counties, it is necessary for main canal bureaus to cooperate with their counterparts at

the county or city level. This cooperation is usually intended to increase efficient use of irrigation water or to improve water transfer at the level of the branch canal within individual counties. In 1991, for instance, the Management Bureau of the Qinhan Canal provided a subsidy of more than 20,000 *Yuan* (1 US $ = 8.9 Yuan) to the bureau of irrigation and electricity of Wuzhun City to repair 87 water gates along a the Malian branch canal. The maintenance has enabled an appropriate amount of irrigation water from the Qinhan Canal to reach the end users along the Malian branch canal (Shang 1992). Meanwhile, county bureaus must submit their yearly maintenance plans for branch and sub-branch canals to the PMWI for approval. In addition, the PMWI usually partly finances these maintenance activities operated by a county. Branch canals across northern Ningxia have to receive irrigation water from the seven main canals. Through seven specialized bureaus for canal management, the Ningxia Provincial Ministry of Water and Irrigation is able to manipulate water supply for the whole irrigation system across northern Ningxia. This manipulation has, in return, become a significant source of the PMWI's dominance over the process of centralized irrigation management in Ningxia

(2) Allocation of water for irrigation

During the 1950s, instruments to measure water were installed in the watergates of main canals. Governmental agents for

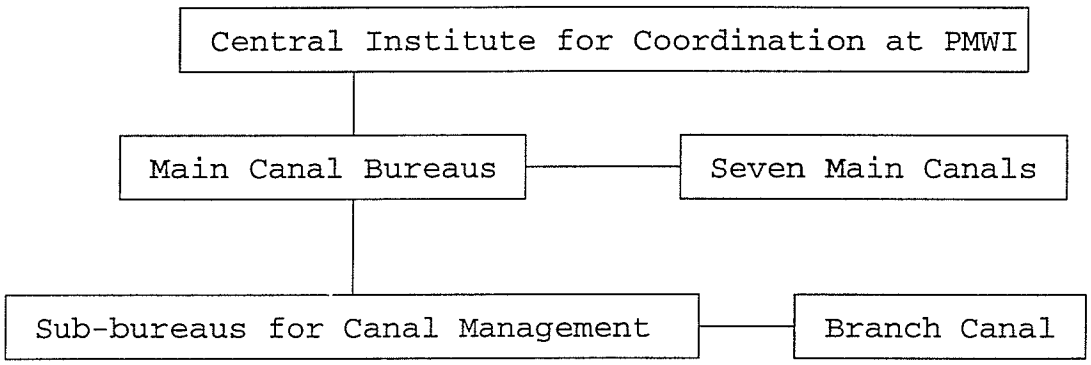
managing main canals were in charge of measuring water transferred into these canals. Several sections of one main canal and their branch canals received water the volume of which was set by these officials. In the annual meetings for irrigation agents responsible for different sections of main canals discussed the standards for measuring water which used to be based on actual water consumption. In 1953 from the middle of May to June 20th the water flow of the Yellow River was the lowest in recent decades. For a period of 33 days, the water flow was around 320 m^3/s; and the water transferred into main canals was less than half of that allocated during previous years. Around May 16th, most fields of wheat, the local major crop in Spring, had not been irrigated. Some farmers even tried to get water from the upper parts of main canals. The usual order for allocating water: end users first, upper user later, did not function as it had before. The vice-governor of Ningxia had to order top officials of counties to direct the allocation of water in person. With the strong backing of the administrative power of governments at the provincial and county levels, the first round of irrigation for wheat had been almost completed by the end of May. This crisis demonstrates that under circumstances of water shortage, governmental agencies come to totally control water allocation using the administrative assistance of governments from the province to the county.

Since the late 1980s specialized governmental agencies (see figure 4.4) have been in charge of distributing quotas of irrigation water which usually are based on reports prepared by village irrigation officials. In fact, the Provincial Ministry of Water and Irrigation, management bureaus for main canals, and county bureau for electricity and irrigation hold the right of the final approval over most plans related to irrigation management even at village or township levels. On the other hand, the dominant governmental agencies in Ningxia still need cooperation from township and village-based institutions such as the township management stations of irrigation, in order to maintain canals and to allocate irrigation water.

According to the Ningxia Provincial Legislation for Irrigation Management (first issued in 1962, revised in 1983, see appendix 2), the PMWI is directly in charge of water allocation of seven main canals across counties through its yearly water plan. The yearly use plan for the irrigation water allocated to branch canals must be approved by the PMWI as well. In addition, sub-branch canals managed by villages or townships should submit their plans for water use to management bureaus and offices of the PMWI. Through this unilinear top-down control, the PMWI tries to balance water allocation across the whole irrigation region of northern Ningxia in order to minimize potential conflicts among counties, townships, and villages. Figure 4.4 shows the PMWI's

affiliated agents in charge of water allocation. As the highest organization for irrigation water allocation in Ningxia, the Central Institute for Coordination (CIC) of PMWI is directly responsible for how much water should be transferred from the Yellow River to the seven main canals.

Figure 4.4 Provincial Ministry of Water and Irrigation and Its Agents for Water Allocation



Source: Management Regulations for Ningxia Irrigation (1988), Ningxia Provincial Ministry for Water and Irrigation.

According to the amount of water available, each main canal bureau will decide how much irrigation water should be distributed among a group of branch canals. When this allocated water reaches a branch canal, sub-bureaus and their management offices redistribute irrigation water along a certain number of sub-branch canals and their corresponding ditches.

On the other hand, each year village and township management organizations have to submit their plan for water use to the management offices for branch canals. The non-official representative, the director of a sub-branch canal, will collect detailed data on water consumption for each individual sub-branch and its ditches, and this is the basis for the yearly water use plan. Then a management office for the branch canal will make its yearly plan for water use according to the plans submitted by the directors of each sub-branch canal. Subsequently, it forwards its plan to a main canal bureau which then drafts a yearly plan and submits it to the Central Institute for Coordination of the PMWI. Through the process of allocating irrigation water from a main canal to its branch canals, it is obvious that management organizations in villages and township are powerless and are subordinated to a group of centralized governmental agencies.

In addition, one important duty of the PMWI is to deal with inter-provincial conflicts over water supply from the Yellow River. Because all irrigation water in Ningxia comes from the Yellow River, which flows across northern China, the Chinese National Council sets up a quota for overall water use in Ningxia. The quota is proposed by the National Commission for the Yellow River. In 1986 the water quota for Ningxia was 4,000 million m^3 (see table 2.3). The Ningxia Provincial Ministry of Water and Irrigation, as the provincial subordinator to the central government, has to balance the

possible inter-provincial conflicts through its tight control of water use within the province.

(3) Cooperation with the Provincial Committee for Irrigation Management

Northern Ningxia produces 80 % of the grain grown in the entire province. Irrigation is vital for local agriculture. In 1988 the province established a management committee for irrigation, which was chaired by a vice-governor of the province. The committee members included top administrative officials of districts and counties who were in charge of local irrigation. The provincial committee for irrigation management, as a consulting institution, checks working plans of the governmental institutions for irrigation and drafts or reviews official regulations regarding irrigation management. The PMWI has to consider the advice and suggestions presented to it by this committee concerning water allocation, canal maintenance, financing, and conflict resolution. Since all members of the Provincial Committee for Irrigation Management are governmental officials, the organization itself function only when an administrative order from one governmental agency fails to influence the decision-making of its counterparts, or when two governmental agencies conflict with each other over the distribution of water or land for building new canals. For instance, a main canal bureau affiliated with the Provincial Ministry of Water and Irrigation may disagree with the yearly

maintenance plan for one section of a branch canal proposed by a county bureau for irrigation and electricity. The argument usually involves the distribution of special funds. At this time, it is the Provincial Committee for Irrigation Management together with the PMWI that plays a mediating role.

4.3 Township and Village-based Management Institutions after 1978[20]

During the late 1970s and early 1980s, dramatic changes occurred in the political and economic structures of rural China. The most significant and influential changes were the introduction of the Household Responsibility System and the establishment of the Contract System. The Household Responsibility System allows individual farmers to have user rights over land which is still collectively owned by each village or township[21]. These user rights are legalized through a contract between a farmer and his or her village or township. Therefore, the contract system which flows from the Household Responsibility System works to define user rights on land, and

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[20]. The data is from Documents of Ningxia's Irrigation (Editorial Board 1992). Otherwise, references are given.

[21]. In 1994 the People's Congress of China voted for several revisions of the Chinese Constitution. One important revision involves the Rural Household Responsibility System and other forms of collective economy involving production, supply and selling, as well as loan or credit (Outlook Weekly (Beijing), March 8, 1994; vol. 10, pp.6). Yet, the Chinese leaders failed to allow the privatization of land in rural China because socialism as an national ideology is still their major concern.

has been extended to other natural resources such as forests. By the late 1980s, the contract system had created a special legal institution in rural China by means of which ownership and user rights over land and other resources are deliberately separated in order to provide villages, townships, and individual peasants with secured access to key resources that are essential to their livelihoods. The valid period of contracted user rights ranges from several years to decades depending on the types of resources involved: for example, 30 years for land[22], and 3 years for water for fish farming (Zhou ed. 1992).

In addition, according to the Ningxia Provincial Legislation (1983) and Regulation for Irrigation Management (1988), "the state owns and is responsible for managing irrigation facilities constructed through the investment by the state; the facilities constructed through the investment by villages or townships are collectively owned and managed by these groups" (Editorial Board 1992: 383). This regulation, compatible with the Chinese National Legislation for Water Resources, has empowered village and township-based management organizations for collective-owned irrigation facilities (see table 4.1). In Ningxia water for irrigation is owned by the state while a variety of official agencies are in charge of

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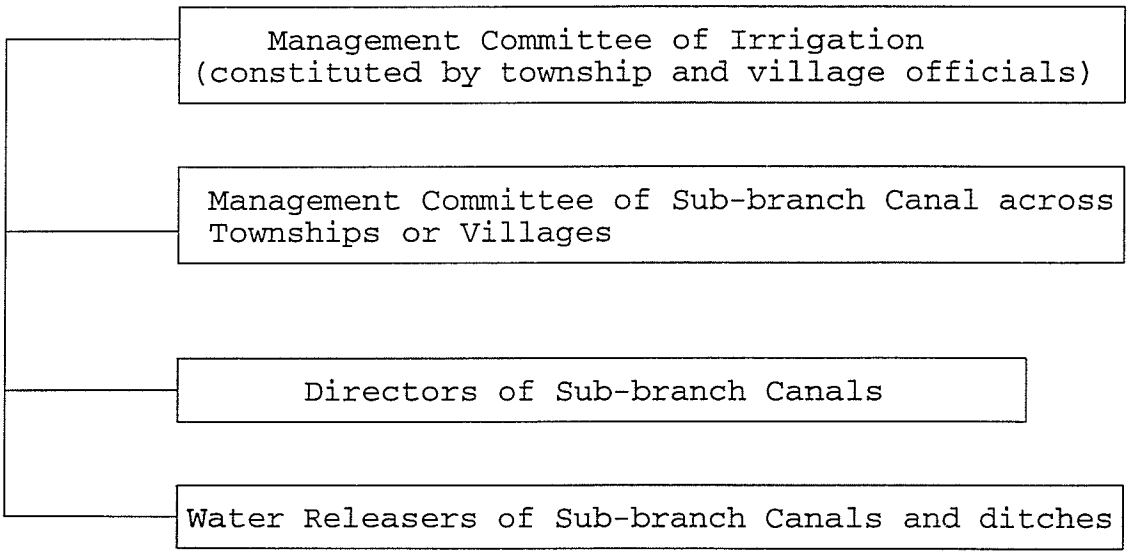
[22]. Recently, the State Council, China's cabinet, has approved a renewal of land contracts held by farmers across the country, extending them for thirty years, while collective ownership remains unchanged.

water allocation. But at the levels of sub-branch canal and ditch, villages or townships are able to set up management institutions of their own. These institutions are usually in charge of regular maintenance of sub-branch canals within the territory of a township or village, and they distribute irrigation water or solve conflicts among users. A simplified model of township and village-based management institutions in Ningxia is shown in figure 4.5. A management committee of irrigation is usually constituted by officials from townships and villages.

Figure 4.5 Village and Township-based Management Institutions for Irrigation in Ningxia



Source: Documents of Ningxia's Irrigation (Editorial Board 1992).

Since a main canal provides water to branch canals across a group of townships, officials from a management bureau for a main canal are included in this committee as well. Due to its extension across townships and villages, the major functions of a management committee for irrigation are conflict mediation and drafting an annual plan for irrigation. It may advise a main canal bureau to improve its work performance with respect to canal maintenance and water transfer. During the periods of maintenance (usually in Spring) for a main canal and its branch canals, individual villages must contribute their labour as part of the requirements for getting irrigation water. It is the duty of a management committee of irrigation to monitor the distribution of labour among villages. In terms of administrative power, a management committee for irrigation is not as influential as it appears to be. Instead, most of its functions have been recently taken over by a township management station, which usually acts as the executive agency of a management committee of irrigation (Shang 1992).

Normally, a sub-branch canal may cross several townships or villages. A director and vice director for each sub-branch canal are selected among users by a township or village, but their appointment must by approved by a county or city bureau of irrigation and electricity. A director of a sub-branch canal, together with officials from these townships and villages, makes up a management committee for that sub-branch

canal (MCSC). The major duty of a MCSC is to supervise the job of the director of a sub-branch canal and his assistants, and to mediate conflicts concerning water allocation along the canal. Actually, a management committee of irrigation and a management committee for a sub-branch canal are both in charge of mediating conflicts among water users. However, until now no official legislation supports the authority assumed by these two committees. In practice, individual users often turn to the administrative agency for help. The influence of a management committee has been dramatically weakened as a result of a lack of legal and administrative support. In other words, as a non-governmental organization, a management committee for irrigation or for a sub-branch canal is dominated by the currently powerful governmental agencies. According to the Ningxia Provincial Regulation for Irrigation Management, even a director of a sub-branch canal selected by a village council remains subordinate to the leadership of a main canal bureau. The director of sub-branch canal has to maintain cooperation with a governmental agency such as a main canal bureau. This is similar to the dual role of a township management station.

The normal duties of a director of a sub-branch canal are:

(1) collection of data on water consumption and the drafting of an annual plan for irrigation water use which must be submitted to a main canal bureau,

(2) monitoring the water consumption of the sub-branch canal and its ditches according to the approved plan for water use, (3) supervising water releasers and planning annual maintenance of the sub-branch and its ditches.

Water releasers are selected among village members; they are in charge of releasing water from a sub-branch canal to a number of ditches. These positions are part-time, and have the following general duties:

(1) according to the assigned water gates, releasing irrigation water as planned by a director of sub-branch canal, (2) maintaining the operation of ditches.

All these duties are accomplished on the basis of rotation among a group of defined personnel. They are paid by their village, and receive a certain subsidy from a governmental agency of a county or its representative in a township (e.g., a township management station for irrigation).

It is obvious that the bottom line for the effective function of these township and village-based institutions is that governmental agencies at the county level reserve the right to approve the appointment of township and village-based management personnel or officials. Yet, this reflection on the political reality in rural China should not lead to a conclusion that centralized institutions directly control the entire process of township and village-based management of irrigation. It is true that the political power of the Chinese centralized government can touch every village and township,

basically through the ruling party--the Communist Party. For instance, a county Communist Party Committee (CPC) can appoint a party secretary for a township; and a township CPC may appoint the party secretary of a small village. At the village level a party secretary, as a top official, is administratively powerful as well. There is no doubt that this type of top-down political control does limit the autonomous functions of local user organizations in charge of irrigation management. It might be appropriate to describe the situation in Ningxia as being characterized by township and village-based institutions controlled by an elite representing the state authority of both ruling party and government.

To a degree, village and township-based management organizations and their management personnel remain subordinate to governmental agencies such as a main canal bureau. More recently, they have become powerful and are able to make management regulations that might be approved by councils of villages or governments of townships. Especially since the successful practice of the Contract System during the 1980s, farmers have been empowered to manage the land from which they have contracted use rights. In return, peasants are more assertive in their management of irrigation water, which is understandably crucial for the economic gains of their agricultural land. A typical case is from Lixin township,

Qintunxia city[23]. Since 1991 local farmers have practised self-organized management of irrigation. Lixin township is located in the southern part of northern Ningxia. It has an area of 103.21 km^2 (see figure 4.6), of which 27.7 km^2 are irrigated land (21,000 *mu*). The township controls six villages with a population of 7,100. The irrigation systems include: 18 sub-branch canals (29 km) connected with 18 ditches (14.4 km) and 260 sub-ditches (176.6 km). There are three management institutions in Lixin township. Each will be considered in sequence.

1) Management organizations

a. Township management committee for irrigation and management station for irrigation

The government of Lixin township sets up a special management committee for irrigation, although it is not clear how its members are selected. As described earlier, such a township-based management committee is usually composed of officials from the township and its villages. Local farmers as irrigation users are not very active in this organization with regard to decision-making. There is a township management station for irrigation in Lixin, which mainly functions as an executive agency of the township management committee. The

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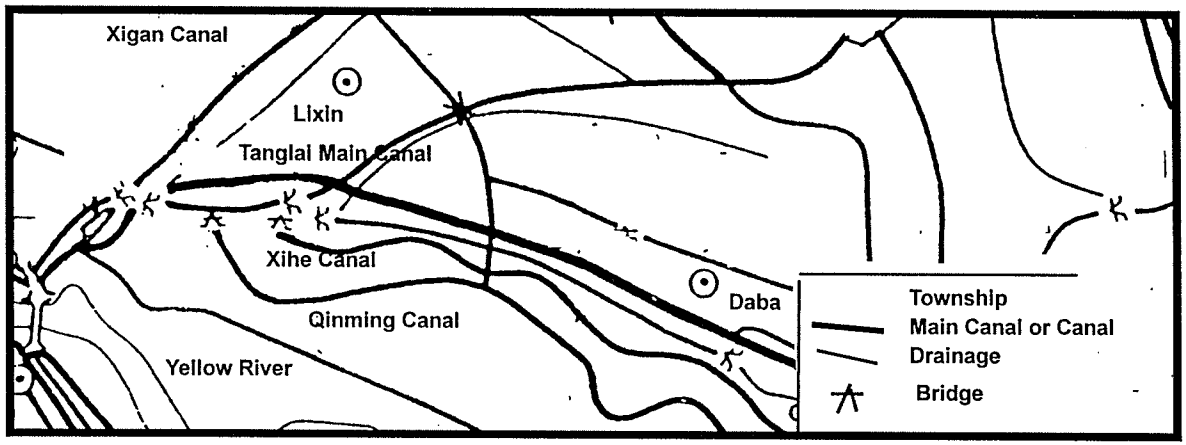
[23]. This case study is based on an investigation report entitled "Management Situation of Irrigation in Lixin Township," published by Ningxia Provincial Ministry of Water and Irrigation, Yinchuan, 1996.

Figure 4.6 Lixin Township



Source: Document of Ningxia's Irrigation (Editorial Board 1992)

station has two regular staff and one full-time manager for canals. Despite being controlled by the township government, the management station is administrated as well by the Qintunqia City Bureau of Irrigation and Electricity.

This dual role of a township-based management organization is popular as well in other townships across the province. One major reason for Lixin township to maintain such an administrative connection between its management organization and a governmental agency is probably financial. Each year the provincial government allocates a certain amount of money as 'special funds' for irrigation maintenance and construction. The Provincial Ministry of Water and Irrigation is then in charge of reassigning this special fund to its agencies such as a county or main canal bureau. A portion of this fund is set aside for financial subsidies to maintain and build irrigation facilities collectively owned by townships or villages. Thus a direct administrative connection allows Lixin township management station to be able to obtain some of its operational money from the Qintunxia city bureau, which is in charge of assigning the special fund for canal maintenance allocated by the PMWI.

b. Village "management group" for irrigation

In Lixin township, each village has its own "management group" in charge of irrigation within its territory. There is a director of sub-branch canal in each group, whose duty is

specialized in water allocation and technical maintenance. A village "management group" is usually headed by a village official, who at the same time must work as a part-time ditch manager. A ditch manager should be responsible for water allocation and maintenance of a group of ditches. The money for the operating budget of a "management group" is collected by the village council. The council, usually elected by villagers, is the highest governing agency of a village. It collects the money directly from users.

2) Contract responsibility system for users

Individual users may have contracted duties for managing sub-ditches and their extensions. The contract should be signed between a farmer and his or her village council since it is the village that collectively owns these small irrigation facilities. The contracted duties include clearance of silt and the prevention of draining water into ditches. A contracted duty involves a corresponding economic return for a contractor. For instance, looking after 100 m of sub-ditch is equal to two working days paid by the village council. On the other hand, a contract involves obligations as well. These obligations are actually associated with the fact that efficient operation of irrigation is crucial for the economic gain of a contractor's land, over which he or she has obtained a long-term contract for use rights. A farmer's concern for his economic gain from irrigated land tend to obligate him to

a contract for irrigation management.

3) Rules and regulation

Since the 1980s the Household Responsibility System has divided large parts of land in rural Ningxia into small portions, increasing the possibility of conflict among irrigation users. Since the property ownership of irrigation facilities at levels of the township and village is still collective, individual farmers are not heavily obligated to maintain cooperation with each other when operating their contracted irrigation system. Common problems are the destruction of others' ditches, the occupation of a public road when digging a ditch, draining excess water to others' ditches, and digging an un-authorized water gate along a branch or sub-branch canal. In order to deal with these problems and conflicts, Lixin township and its villages have established a group of rules and regulations. Most of them are drafted and approved by the village council. They include penalty regulations for draining water into ditches and fines for canal collapse and destruction of irrigation facilities.

For example, if a section of a sub-ditch collapses it is the responsibility of the person who has signed a contract with his village to repair it himself or pay a certain amount of money for the labour required for its repair. The penalty also includes payment for the provision of construction materials. Usually, every one m^3 of soil is equal to 5 *Yuan*;

for stone pieces each m^3 cost 100 *Yuan*. With respect to the loss of water, the loss of one m^3 will result in a fine of o.2 Yuan. There are also regulations concerning financial return to part-time management personnel. The salary of a director of a sub-branch canal is paid according to the area of land irrigated by his canal. Usually, if a canal irrigates more than 2,000 *mu*, one *mu* yields o.4 Yuan; if a canal irrigates less than 2,000 *mu*, one *mu* yields 0.55 Yuan. Individual users should pay these fees. The salary of a ditch manager hired by a village is paid according to the length of the ditches he maintains. Generally, every 100 m of ditch yields 4 yuan, which is collected from users according to the area of their irrigated land. Although monies earned may be small, fines can be heavy depending on the amount of damage incurred.

4.4 A comparison of governmental and township and village-based organizations before and after 1949

According to the available historical documents, the earliest governmental organizations managing irrigation systems in Ningxia and other parts of northwest China appeared during the Han dynasty (206 BC -220 AD). At that time the colonial expansion of the Chinese empire led to the establishment of large irrigation systems in the Yellow River valley in Ningxia. However, until the seventh century governmental agencies manipulated the whole process of managing local irrigation systems. During the late periods of imperial times

(the Ming and Qin dynasties), township-based organizations emerged in Ningxia and could be assisted by county-level government to build local canals for irrigation. The structure of the imperial governmental organizations were not clearly defined for the special management of irrigation, although some officials were appointed to be in charge of irrigation management. As early as the 17th century, some townships in Ningxia could select their leaders to manage local irrigation systems.

Before the socialist revolution of 1949, governmental agencies from the province to the county controlled all the major canals. Special agencies were set up not only provincially, but also at the level of the county. In addition, special bureaus for major canals were established during the period of the Republic of China (1911-1949). After 1949 few dramatic changes occurred to the entire structure and functions of governmental organizations although they had been put into a new political framework. With the expansion of irrigation systems, more bureaus for main canals were set up after the establishment of the People's Republic of China. For instance, before 1949 there were only five bureaus for main canals; after 1949, there were seven bureaus.

On the other hand, some minor changes did occur to the centralized management structure after 1949. The socialist government expanded the earlier structure into a two-layered management structure. At the top administrative layer there

are the Provincial Ministry of Water and Irrigation, City or District Bureaus of Irrigation and Electricity, and County Offices of Irrigation and Electricity. At the canal layer, there exist the Provincial Ministry of Water and Irrigation, Main Canal Bureaus for Management, Sub-bureaus for Canal Management and Management Offices for Branch Canals. As far as new governmental agencies after 1949 are concerned, it seems that their management functions have been specialized in water allocation and maintenance or construction of canals. By 1978, when the new liberal policy was adopted by the Chinese government, the governmental agencies managing irrigation as a whole had retained their original top-down and two-layered structures, as well as holding on to their major functions of allocating water and coordinating maintenance of canals.

During the period of the Republic of China (1911-1949), township and village-based organizations were very active in managing irrigation systems. Township and village-based organizations were task-oriented and relatively independent of governmental agencies. It seems that there was cooperation between governmental and township and village-based organizations. This cooperation was needed mainly for the maintenance of canal networks. After the establishment of the People's Republic of China, especially during the 1950s and 1960s, the collectivization of landholding and dominance of the People's Communes dramatically changed the political and social structures of rural China. But these changes did not lead to

the dissolution of traditional township and village-based organizations for irrigation management. The forms of those township and village-based organizations, such as village committees of users, are still allowed to exist, but within a centralized management structure. For example, the appointment of officials for township and village-based organizations had to be approved by governmental agencies at least the county level. However, the township or village-based irrigation officials such as the director of a branch canal or a water releaser continued their duties of allocating water among local users.

After 1978, the Household Responsibility System led to the collapse of the People's Communes in rural China. Individual farmers and their villages exercised significantly increased decision-making power over the use of land and water resources. By the 1980s, townships and villages re-emerged as basic administrative units in rural China. In Ningxia, however, the overall structure of township and village-based organizations for irrigation management, established during the period of the People's Communes, remained essentially the same. It includes management committees of irrigation (across villages or townships), management committees of sub-branch canals, directors of sub-branch canals and water releasers. Governmental agencies in charge of irrigation were still very influential over these township and village-based organizations and their officials.

Since the introduction of contract systems during the 1980s, townships and villages in Ningxia have had more power to self-manage the marginal parts of irrigation systems within their territories. As indicated by the example of Lixin township of northern Ningxia, the most recent management organizations at the level of the village are more complete in order to perform relatively sophisticated tasks. In Lixin township there are two kinds of management organizations: (1) a township management committee for irrigation and a management station for irrigation, 2) a village "management group" for irrigation, composed of a director of sub-branch canals and a ditch manager.

Compared with the centralized organizations, township and village-based organizations are very vulnerable to recent political and social changes occurring in rural China. Of those changes, the socialist revolution of 1949 and subsequent collectivization of landholding did most to transform the structure of township and village-based organizations for irrigation management. But some similarities have endured and are shared both by township and village-based organizations before and after 1949. For instance, part-time irrigation officials like directors of sub-branch canals are active in villages. Marginal parts of a large irrigation system (sub-branch canals and ditches) are usually self-managed by township and village-based organizations, while governmental agencies are in charge of main or branch canals.

The current challenge faced by township and village-based management of irrigation systems in Ningxia, as well as in other parts of China, is that irrigation water is legally owned by the state, but used mainly by farmers whose agricultural activities are based on individual households or associations of households established after the dissolution of the People's Communes in the late 1970s. Socially or culturally, there is no traditional base in China for this type of contracted use rights of cultivated land. Currently, local farmers get their quota of irrigation water through direct payment (water fees), and are still dependent on a group of powerful governmental agencies to distribute water among them.

Chapter Five

Cooperation between Governmental and Township and Village-based Management Organizations

5.1 Cooperation[24]

In some parts of China management systems of irrigation during the latest period of the People's Commune times (the late 1970s) was reformed in favour of more "reliance on the masses[25] " (Nickum 1982). Although initiated by the government, this type of reform intended to improve the cooperation between governmental and rural community-based management organizations. One example comes from Shaoshan in Hunan province where a number of arrangements were adopted in 1979 (Nickum 1982).

The local main canals and small-scale hydraulic facilities are divided among the communes, each of which is responsible for managing one part of the irrigation system. Large-scale hydraulic facilities are still managed by governmental agencies, which are entrusted with the provision of necessary financial support for the building materials and

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[24]. The data is from Documents of Ningxia's Irrigation (1992). Otherwise, references are given.

[25]. In the People's Republic of China the term "mass," often appearing in governmental media and documents, generally refers to a group of people at grass-roots levels, for example, peasants of a village or township.

equipment needed to maintain main canals. Canal systems at the branch level and below, as well as electrical pumping stations, ponds, small reservoirs, etc., are managed by the management committees of communes and their brigades or teams. Each year a winter maintenance plan for a section of the main canals is proposed by communes and bridges or teams. Commune (or municipal) management committees decide on a plan for the year's winter maintenance. Before July of each year the Irrigation District Project Management Bureau and its subordinates (for example, a management institute) will investigate the plans prepared by commune, and report them to the Irrigation District Management Committee for approval. Then, the winter maintenance of the main canals is carried out from governmental agencies and communes to the lowest levels of production teams. Regular maintenance of canal systems at the branch level and below is handled by individual communes, brigades, or teams.

As argued by Nickum (1982), an essential ingredient of this cooperation between governmental and user-based management is the strengthening of the role of the non-professional coordinating agencies, such as rural community-based management organizations and Party committees of communes, brigades and production teams. It should be noted that the governmental agencies at a variety of levels (e.g., province, district or county) initiate and push the whole process of co-operation, as indicated by the case of Shaoshan. The emphasis on cooper-

ation is a top-down process of implementing official policies (e.g., yearly maintenance of canals) relevant to irrigation management. There is no doubt that governmental agencies expect that township and village-based institutions would cooperate to strengthen their authority. As discussed later, the recent cooperation between township and village-based organizations and governmental agencies in Ningxia shares similar characteristics, although some recent changes such as the introduction of the Contract System have occurred.

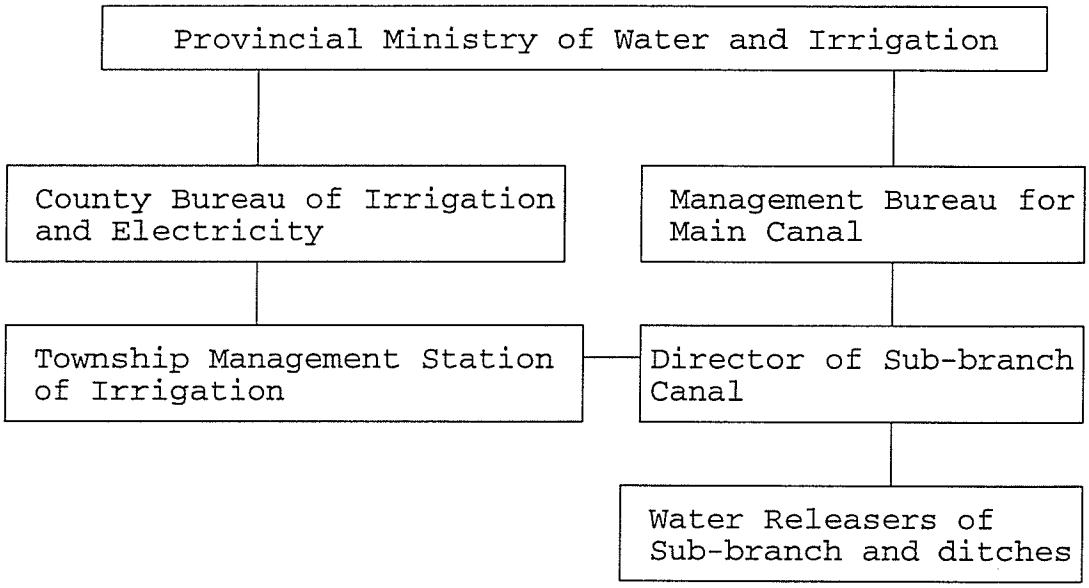
As noted by Ostrom et al. (1994), it is often believed that in poor countries national governments are the only agencies that should or could invest in constructing and managing irrigation systems. This belief in the necessity of a centralized authority is intensified by a second presumption that large-scale irrigation requires considerable technical expertise, which is unlikely to be found locally. The presumed inability of individual users to undertake their own collective action is perceived as justifying the need for state-based or centralized management. The situation of Ningxia is somewhat different from the above viewpoint. It is true that local governmental organizations from province to county dominate the management of integrated large-scale irrigation systems. On other hand, it is obvious that below the level of the branch canal, rural communities such as townships or villages are able to take their own collective action to manage local irrigation networks.

In Ningxia, as shown in Figure 4.1 and 4.3, Provincial and county governmental agencies are mainly responsible for the management of main canals. Chapter 4 described the major functions of these governmental organizations. They include irrigation water allocation and the maintenance of canals. But the normal practice of these functions requires the cooperation of township and village-based organizations. Here cooperation should be defined as the process of co-managing irrigation systems by a group of specialized organizational entities. These organizations, either governmental or township and village-based, have to work together in order to operate the large-scale irrigation system, which is crucial for agriculture in arid regions such as Ningxia. But, as will be discussed later, in Ningxia the process of cooperation for allocating irrigation water and maintaining canals has been dominated by powerful governmental organizations. As a result, this dominance has unbalanced the whole process of cooperation.

As shown in figure 5.1, this type of cooperation for irrigation management in Ningxia is based on the institutional connections between governmental and township and village-based organizations for management. There are two types of connections. The first one is administrative involving the Provincial Ministry of Water and Irrigation (PMWI), the county bureau of electricity and irrigation, and township management station for irrigation. The second is canal-centred,

consisting of the PMWI, the management bureaus for main canals, the directors of sub-branch canals, and water releasers of sub-branch canals and ditches. However both are headed by the PMWI, the highest governmental agency in Ningxia which controls county bureaus of electricity and irrigation. In addition, the PMWI is in charge of implementing provincial legislation and regulations for irrigation management (see appendix 2).

Figure 5.1 Connections between Governmental and Township and Village-based Management Organizations in Ningxia



The analysis below will follow these two institutional connections and explain them in detail. It is noted that figure 5.1 is a simplified model of the actual situation and is presented here for the convenience of analysis.

Cooperation in irrigation water allocation: canal-centred connection

During the 1950s water measurers were installed at the watergates of main canals in northern Ningxia. The governmental agents for managing main canals were in charge of measuring the volume of water transferred into these canals. Several sections of one main canal and their branch canals received water, the volume of which was set by water measurers. In the annual meetings for irrigation governmental agents from different sections of main canals discussed the standards for measuring the volume of water, which used to be based on the agencies' estimation of actual water consumption. Usually, the estimate was based on data of water consumption of previous years. During the process of assigning irrigation water, farmers and their communes or production teams received the water allocated by governmental agencies.

After 1960, a new institution for water allocation was set up and remains in effect today. As described in Chapter 4, governmental agencies (see figure 4.4), such as main canal bureaus, are in charge of distributing irrigation water. For each main canal, the amount of water that should be released is based on an annual plan. Yet, the accomplishment of the plan for allocating water needs the assistance of township and village-based organizations. This cooperation is, in fact, facilitated by the canal-centred connection between governmental agencies and township and village-based

organizations (see figure 5.1). First, the annual allocation plan for each main canal, which is submitted by bureaus for main canals to the PMWI, is based on reports prepared by sub-bureaus for branch canals. These reports are actually completed according to the annual reports submitted by directors of sub-branch canals who, as village and township irrigation officials, are directly selected among local users. Furthermore, it is the water releasers of sub-branch canals and their ditches who collect the most basic data on water consumption by local users. This data is usually collected according to the actual volume of water consumed on the farming land of individual farmers. It is calculated according to the area of irrigated land.

In the case of Lixin township[26] (see figure 4.6), the actual situation is somewhat complicated at the level of the village, but it is still illustrative of the general process. Linxin township receives its irrigation water mainly from the Tanglai main canal. In Lixin, each village has a "management group" for which there is a director of a sub-branch canal who is in charge of water allocation among local users and of collecting data on water consumption. On the other hand, a village "management group" is usually headed by a village official who works as a part-time ditch manager as well. A

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[26]. The case study is based on a special report entitled "Management Situation of Irrigation in Lixin Township," published by the Ningxia Provincial Ministry of Water and Irrigation. Yinchuan, 1996.

ditch manager, similar to a water releaser, should be responsible for water allocation among a group of ditches. In Lixin both directors of sub-branch canals and ditch managers gather information about water usage directly from local users. By means of the institutional channel, based on the canal-centred connection described in figure 5.1, this information about the annual water usage of six villages in Lixin is presented to the Management Bureau for the Tanglai Main Canal. Each year the Management Bureau for the Tanglai Main Canal incorporates the information from Lixin together with that from other townships into its annual report, which is then submitted to the PMWI for the final approval.

When the plan for annual water allocation along the Tanglai main canal is approved by the PMWI during late April of each year, a measured volume of water is transferred from the Yellow River to the Tanglai canal. Through one of its branch canals[27], water then flows into the 18 sub-branch canals at Lixin, which are connected with 260 sub-ditches. In 1991 the irrigation water allocated for Lixin was 45 million m^3; in 1994, it was 26.7 million m^3. When water arrives at sub-branch canals, the directors of sub-branch canals allocate water among ditches and sub-ditches by supervising watergates along the canals. Then, ditch managers allocate water once again to the farming land of local farmers. As indicated by

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[27]. According the data available, it is not clear which branch canal of Tanglai main canal irrigates the farmland in Lixin township.

the case of Lixin, it is obvious that from a management bureau for a main canal to a township and its villages water allocation is centralized by means of a top-down process. But it should be pointed out that at levels of the township and village, local irrigation officials, such as a director of sub-branch canal, are important for the operation of this centralized cooperation. Their work of reallocating water among local users helps to maintain the normal function of the above unequal cooperation.

Across northern Ningxia, the cropping activities last approximately 250 days each year. The yearly period of irrigation begins in late April, and concludes by the end of December. The actual time of irrigation is around 180 days. The irrigation requirements for local major crops are:

a. Wheat (planted in Spring)

Three periods of irrigation: (1) winter irrigation, (2) growth period, irrigated two to seven times; (3) washing salt and watering soil.

b. Rice (planted in Summer)

irrigated seven to thirty times depending on changes in local temperature.

These requirements are not set up by any governmental agencies or any township and village-based institution but reflect the influence of the local climate on the growth of crops. In the area of Lixin township yearly irrigation requirements for crops are three to four times for wheat,

three to four times and ten to thirty times for rice. The variety of irrigation times depends on changes in local temperature and precipitation. Every year, directors of sub-branch canals and ditch managers at Lixin township and its six villages must work together with the Management Bureau of the Tanglai main canal to ensure an appropriate water supply for local farmers. It is understandable that during the process of allocating water from a main canal to sub-branch canals and ditches at the level of the village, cooperation has been heavily unbalanced by the dominance of governmental agencies.

It should be noted that there are two kinds of interactions involved in the process of this cooperation for water allocation. The first one extends from the village to the management bureau of the main canal to the Provincial Ministry of Water and Irrigation. It involves the collection of data on water usage from local users. During this down-up process, farmers, as users, can present their estimates of how much water they would like to use to irrigate their lands. But these individual requirements must be balanced by the second top-down interaction. In the second type of interaction a director of a sub-branch canal should incorporate the individual farmers' requirements for irrigation water into his annual report. Then a management bureau for a main canal and its subordinates (e.g., management offices for branch canals) will balance a group of water plans presented by directors of sub-branch canals. Finally, the provincial ministry of water and

irrigation also has to balance water requirements among individual main canals, and to ensure that the amount of water needed in these plans submitted by management bureaus for main canals is not beyond the annual quota of water transferred from the Yellow River[28]. The last step involves interaction between the Ningxia Provincial Ministry of Water and Irrigation and the Central Government in Beijing (the Chinese National Council), as well as with Ningxia's neighbouring provinces which share water from the Yellow River[29].

During the second type of top-down process of water allocation, at the levels of the township and village, the directors of sub-branch canal assign irrigation water among a group of ditches according to the plan approved by a management bureau for main canal. It is obvious that the execution of plan for water allocation set up by governmental agencies needs the cooperation of the management personnel selected by villages. Through both top-down and down-up processes, the directors of sub-branch canals who are supervising water releasers (ditch managers in Lixin) play a key role in maintaining the cooperation between village

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[28]. Sometimes in Ningxia, the actual usage of water from the Yellow River exceeds the yearly quota set up by the central government. For example, in 1986 the quota for Ningxia was 4,000 million m^3; but the actual usage was 7,000 million m^3. It is still not clear if the Ningxia Provincial Ministry of Water and Irrigation deliberately failed to obey the quota, since involved as well are other elements such as inaccuracy in measuring water available from the Yellow River.

[29]. These provinces include Gansu and Inner Mongolia (see figure 2.1).

organizations and governmental agencies. This top-down co-operation allows irrigation water from the Yellow River to go through state-owned main and branch canals to reach township and village-owned sub-branch canals and ditches, and ultimately farmers' land.

Correspondingly, when allocating water there exists a process of centralization to ensure the dominance of governmental agencies. This centralized process can be described as follows: directors of sub-branch canals submit a plan for water usage to bureaus of main canals for its approval, and the Provincial Ministry of Water and Irrigation reserves the right of the final approval for plans presented by the bureaus for main canals. However, there is a process of "decentralization" at work when the PMWI and its bureaus of main canals finally balance and approve plans for water allocation submitted by villages or townships. During this "decentralization," the directors of sub-branch canals and water releasers at township and village levels are in charge of re-allocating the available water among local users. In fact, in Lixin township the management station sets a quota of irrigation water for each village according to the annual plan approved by the Management Bureau of the Tanglai Main Canal. The "management group " of each village then contracts the quota to its directors of sub-branch canals and ditch managers. In order to encourage efficient allocation of water, the Lixin township government allows each "management group"

and its irrigation officials to get a bonus in cash if a certain amount of irrigation water is saved. For instance, for each m^3 of water saved, 0.0012 yuan should be paid as a bonus. Of the bonus, 20 % belongs to members of the "management group"; 25 % is paid to directors of sub-branch canals. Ditch managers can receive their bonus from fines for overuse of water by users.

However, it should be noted here that during the process of water allocation, centralization exceeds "decentralization". One example can be found in the fact that the plan for irrigation water use at Lixin must be first approved by the Management Bureau of the Tanglai Main Canal. Under this officially approved plan, Lixin township may re-assign the quota for each of its six villages, and each village can re-allocate the water among local users through its "management group". In addition, the decentralization from main canal to sub-branch canal is only tolerated by governmental agencies under one important pre-condition: the authority and dominance of the PMWI, bureaus for main canals and county bureaus for irrigation must be respected. In fact, the Ningxia Provincial Regulation for Irrigation Management (issued in 1988) makes it clear by stating that:

> Users should report their plans for water use to governmental agencies for managing irrigation. These governmental agencies will balance the plans and submit them to the highest agency (The Provincial Ministry of Water and Irrigation) for approval. When there is a shortage of water resources, governmental agencies will concentrate the volume of water available, and distribute it proportionally, and supply it to users on the basis of

rotation (see appendix 2).

When daily water flow from the Yellow River is less than 800 m^3/s, gravity-flow main canals face a water shortage. There is very limited data on how the above institutional cooperation between governmental and rural community-based institutions deals with crisis situations as exemplified by water shortage in the Yellow River. It is understandable that even in the available official documents the role of governmental organizations is exaggerated. However, two incidents may provide a perspective on crisis situations.

From the middle of May to June 20th, 1953, the water flow of the Yellow River reached its recorded minimum in recent decades. Over a period of 33 days, the water flow was around 320 m^3/s; and the water transferred into main canals was less than half of that during the previous years. Around May 16th, most fields of wheat, the local major crop in spring, had not been irrigated. Some farmers as end users even tried to get water from the upper parts of main canals. The usual order: end users first, upper user later, did not function as it had before. The vice-governor of Ningxia had to order top officials of counties to direct the allocation of water in person. With the strong backing of the administrative power of provincial and county governments, the first round of irrigation for wheat had been almost completed by the end of May.

A more recent incident occurred in 1980 when for a period of 7 days the daily flow of the Yellow River had been around 451 m^3/s. In early June, the daily flow from the Yellow river declined to 300 m^3/s. The Provincial Government had to call for an emergency telephone meeting on May 21. The governor, together with top officials from the Ministry of Water and Irrigation, initiated a special plan which allowed main canals to get irrigation water in rotation. During such a period of water shortage, normal plans for allocating water no longer worked. It was up to the Provincial Government to decide which area should have priority for irrigation. One main canal, Yaojin, only received half of its normal water supply. It is not clear how management institutions of villages and townships along the Yaojin main canal dealt with water shortage. They might have adopted more efficient ways of irrigation when the management bureau for the Yaojin main canal had to cut the water supply to their villages.

These two crises indicate that under circumstances of water shortage governmental agencies for irrigation, with the assistance of provincial and county governments, usually overwhelm process of water allocation. But there is no doubt that the assistance from directors of sub-branch canals and water releasers from villages is necessary for allowing limited irrigation water to reach local users. It is possible that during times of severe drought the administrative power of government would ensure the legal authority of these vil-

lage-based irrigation officials when the normal order of allocating water is threatened.

User fees for irrigation have been charged even since 1956 when the Ningxia Provincial Government issued the first regulation on irrigation fees. Since 1983 water fees have been charged according to the volume of irrigation water consumed. At branch canals and above, fees are charged according to the volume of water measured at watergates; at sub-branch canals and below, fees are charged according to the area of irrigated land. In northern Ningxia in 1994, one m^3 of water through gravity-flow irrigation was charged 0.006 yuan; water supplied by electrical-pumping was charged 0.05 *yuan*. But there is no data available on how government agencies work together with irrigation organizations of village and township to collect water fees from local farmers. According to provincial legislation on irrigation management, it is generally the township management station that should assist the governmental agencies in collecting water fees from users.

Cooperation in canal maintenance: administrative connection

From imperial times to the 1950s repairing watergates and dams of main canals and clearance of silt used to dominate canal maintenance in Ningxia. Without machines these maintenance activities were extremely labour-intensive. For example, the annual clearance of silt of sand along canals across northern Ningxia required approximately 0.7 or 0.8 million labour days.

Local farmers had to contribute their labour and money to the maintenance of main canals and their branches. In 1938 during the period of the Democratic Republic of China, the Ningxia Provincial Government ordered that every 60 *mu* of land to the west of the Yellow River should contribute one labourer, and one labourer should be provided for every 100 *mu* of land to the east of the Yellow River. The working period for maintenance was 30 days. But after the establishment of the Qintunxia Dam along the Yellow River in 1960, the water level of the Yellow River was raised by 18 m and most main canals did not need the annual repairing of watergates and dams, and the clearance of silt. Currently, the major activities needed to maintain main and branch canals involve repairing canals and watergates along canals, or the construction of new branch canals.

Since main and branch canals are owned and managed by the state, maintenance activities in Ningxia are mainly coordinated along the administrative connection: the PMWI, the county bureau of irrigation and electricity, and the township management station of irrigation, although sometimes bureaus for main canals might be involved as well (see figure 5.1). At the levels of sub-branch canals and their extensions, which are collectively owned by townships and villages, maintenance of these irrigation canals is managed independently by township and village-based organizations with occasional financial assistance from county bureaus of irrigation and

electricity. In Lixin township the management station for irrigation can apply to a special governmental fund for canal maintenance through its administrative connection with the Qintunxia City Bureau of Irrigation and Electricity. But the Lixin township government provides the bulk of financial support. At the village level, money for maintaining canals owned by villages is usually collected by each village council.

To maintain main and branch canals, or to build new canals, local users from townships must contribute a certain amount of labour which is calculated according to the number of working (labour) days. For instance, at Lixin township, the yearly labour contribution has been around 15,000 to 20,000 working days since 1991. It remains unclear how these labour days are divided up between the maintenance of state-owned main or branch canals and township or village-owned sub-branch canals. Usually, the labour for maintaining main and branch canals is organized by each township government through assistance provided by its management station for irrigation. Furthermore, a county bureau of irrigation and electricity is in charge of coordinating labourers for repairing a section of one main canal or building new canals, which should be located in the territory of the county.

One example involves the construction of the Baima canal network in Zhunning county. The project included six branch canals with a length of 9600 m. The construction lasted from

March of 1985 to September of 1987 with the input of 99,981 labour days (Statistics on Irrigation of Ningxia 1987). Most of labourers came from Baima township, of which 4000 *mu* of cultivated land are irrigated by the new canal network. Actually, a county bureau of irrigation and electricity plays a very active role in coordinating maintenance cooperation with townships and villages, although the provincial ministry of water and irrigation may provide some financial assistance.

In Zhuning county, in 1987, the county itself invested 190,000 yuan in extending a branch canal while it received 240,000 yuan from the province for annual flood protection (Statistics on Irrigation of Ningxia 1987). To maintain state-owned canal networks, a county bureau of irrigation and electricity may directly acquire labour assistance from townships because township governments are administratively controlled by a county government.The maintenance of those main canals which cross two or more counties requires labour input from local farmers as well. But the situation seems to be complicated by the administrative gap between bureaus for main canals and county governments. It is probably more difficult for bureaus of main canal and the PMWI to get the labour needed to repair main canals or to build new ones, although the Provincial Legislation for Irrigation Management authorizes the PMWI and its bureaus to obtain labour from local users if necessary. In fact, according to a recent report prepared by the PMWI (Anonymous 1995), 1,327 km of main

and branch canals across northern Ningxia are threatened by a lack of necessary maintenance. In spite of a proclaimed financial difficulty, the lack of labour might be a major factor.

Cooperation between governmental and township and village-based organizations is channelled through the administrative connection among special organizations for irrigation management: the PMWI, a county (city) bureau, and township management stations (see figure 5.1). In addition, the administrative connection itself and associated governmental agencies for irrigation management have been strongly assisted by the administrative power of provincial and county governments[30]. County and provincial governments can be very influential especially when dealing with crisis situations such as floods or the collapse of canals.

One incident involves the collapse of the Han main canal on May 15th, 1977 when a 20 metres long and 5 metres deep gap was formed. With the help of 300 local farmers, the Wuzhun county bureau for irrigation coordinated the repair, which lasted only 24 hours. During September of 1981, heavy rain allowed the daily flow of the Yellow River along northern

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[30]. In China the administrative structure of the state government at levels of province, city and county can be divided into two parts. The first is a "core government" composed of top administrative officials (e.g., a governor), their staff and special offices. The second includes some special agencies in charge of irrigation, transportation and industry. The term "government" here refer to the first, which administratively controls the second.

Ningxia to reach 5780 m^3/s. Normally, when the daily flow of the Yellow River is beyond 4000 m^3/s, main canals, land and villages along the river may be flooded. In the summer of 1981 the Ningxia Provincial Government issued two special orders for flood emergency while the Provincial Ministry of Water and Irrigation was responsible for drafting the emergency plan. Nearly 200,000 people across northern Ningxia were organized to maintain 275 km of protective dams and to build 85 km of new ones. When the Yellow River reached its highest level, 20 metres of a protective dam collapsed in Zhuenning county. The Provincial Governor had to come to the site of the dam and personally directed 2,300 farmers and soldiers in the building of a new dam. It is obvious that during a crisis situation involving the entire region of northern Ningxia, the provincial government is in charge of emergency coordination. Meanwhile, both township and village-based organizations for irrigation management may provide some assistance, such as coordinating labour contributions from local farmers.

5.2 Conflicts and Problems

The above discussion of cooperation does not imply that conflicts between governmental and township and village-based institutions has been eliminated. Although they obtain very limited power through their cooperation with governmental agencies, township and village-based organizations are still trapped in the centralized political structure of China. The

selection and appointment of officials and personnel of these organizations does happen at township and village levels, but governmental agencies have the right to approve these appointments. Such control can be used to push management groups of townships and villages to cooperate with government agencies. Obviously, the co-operation discussed here is not a process of strengthening local management organizations or of balancing management power between governmental and local organizations. Actually, to a degree its priority might be to maintain order and balance among irrigation users through a very powerful administrative institution. In fact, the cooperation involves conflicts and problems resulting from a powerful centralized institution. On the other hand, management organizations at the levels of township and village have to serve the interests of local users. Under the political control and subject to administrative interventions from government, these irrigation officials from townships and villages sometimes find that it is very difficult to please both government officials and local users.

In an official report (Shang 1992), the author complains that farmers in Ningxia do not actually use irrigation water as planned by governmental agencies. He claims that the practice of irrigation in rural Ningxia is not pursued according to official regulations. If the conflict between local users and governmental agencies continues, as claimed by this report (Shang 1992), it is obvious that some irrigation

officials from townships and villages might be blamed by either a county bureau of irrigation and electricity or by a bureau for main canal. It seems that these irrigation officials, who are selected from among local farmers, tend to defend the interests of those village or township especially when they have signed a contract for management with their villages or townships. Some government officials are worried that the current contract system tends to decentralize the management of irrigation, and that it may further destabilize the existing centralized institutions for water allocation and maintenance[31]. It might be normal that these officials, benefitting from a centralized institution, are afraid to lose their power if this institution was to be dissolved by the emergence of grass-roots democracy in rural China[32]. Actually, two other official reports (Liu et al. 1986, Ye 1993) argue that provincial and county governmental agencies should increase their control of irrigation management at the

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[31]. In personal correspondence with the Chief Engineer of the Territory Office, the Ningxia Provincial Planning Commission, it was indicated that some officials from the Provincial Ministry of Water and Irrigation think that the current situation of irrigation management in Ningxia is characterized by "disorder and problems" ever since the practice of family responsibility and contract systems began.

[32]. Since the 1980s the introduction of the Household Responsibility System and the Contract System has changed the political structure of rural China. Peasants have been empowered to manage land and other natural resources over which user rights are contracted. In 1995 the Communist government allowed farmers to directly elect their village officials. This grass-roots democracy, totally new in modern China, enables villagers to vote for candidates who are not selected by the government as was previously the case.

township and village levels by drafting new policies and monitoring the process of selecting township and village-based irrigation officials.

In Ningxia the current dominance of governmental agencies has been maintained at a heavy cost: low water fees based on centralized allocation (Shang 1992). One official report indicates that many special governmental agencies for irrigation are almost bankrupt due to the low fees and high costs of administration and technical maintenance of large canals (Anonymous 1995). According to Shang (1992), the present water fee charged by governmental agencies is only one-third of the actual cost. At the same time, the low water fees, which are regulated by government, may be partially responsible for creating conflict between township and village-based organizations and local users. In spite of the centralized allocation of water among townships, villages have to reallocate the assigned water among local users through directors of sub-branch canals or water releasers.

However, regardless of the authority of those township or village-based irrigation officials, local users may sometimes irrigate their land with amounts of water which are far beyond the actual requirements for crop growth. The reason is that due to low water fee, they do not have to pay high costs for the extra usage. Certainly, the new contract system has improved the efficiency of water usage as indicated in the case of Lixin township. Villages at Lixin had to write special

regulations to punish those individuals who overuse or waste water. The penalties include fines and extra contributions of labour for canal maintenance. But low water fees still encourage farmers to give up efforts to use water more efficiently. In fact, this problem has a history dating back to the times of the People's Communes when water fees were only symbolic. For example, in 1956 one *mu* of irrigated land for rice was charged 0.5 *yuan* for irrigation fees. The same water fee system continued until 1981.

Normally, the volume of water available from the Yellow River is set by the Chinese State Council. In 1986 the quota for Ningxia was 4,000 million m^3. Yet the actual usage was 7,000 million m^3 (Liu 1992:57). As noted by one Chinese scholar (Liu 1992), lower water fees and inefficient use of irrigation water might be attributed to this overuse. Recently, long periods of drought continuously hit northern China, where the Yellow River provides seven provinces with water for irrigation and domestic use. In the summer of 1995 months of drought have dried up a 385-mile stretch of the lower part of the Yellow River[33]. The overuse of water by Ningxia and other provinces along the Yellow River might further worsen the situation. Actually, these provinces do not trust each other in terms of water distribution. For example,

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[33]. According to the Chinese official news agency, the Xinhua news agency, the shortage of water in the lower part of the Yellow River caused great difficulty for the local people and affected agricultural production.

the Qintunxia Dam (see figure 2.7), which is located in northern Ningxia, is used to control irrigation water released into seven main canals of northern Ningxia. Each summer during periods of irrigation, officials from Inner Mongolia, which is located in the lower part of the Yellow river next to Ningxia, have to come to the Qintunxia Dam in order to monitor the operation of water allocation by the Ningxia Provincial Ministry of Water and irrigation. It is not clear if the central government would like to act as a mediator to deal with the potential conflict between provinces over water distribution from the Yellow River.

Conflicts among up-canal and end-canal users usually take place in northern Ningxia. According to the Ningxia Provincial Regulation of Irrigation Management, it is the duty of the management committee of irrigation and the management committees of sub-branch canals (see figure 4.5) to resolve conflicts among users from different townships or villages. Although some officials from townships and villages are members of these committees, no administrative institutions support these coordinating organizations. Most recently, the coordinating role of these committees has been taken over by a special agency, the Institute for Irrigation Management, affiliated with a County Bureau of Electricity and Irrigation (Ye 1993). It is not yet clear if there exists a cooperative mechanism between township and village-based and governmental organizations which will work to resolve conflicts among users

from different villages, townships, or even counties in Ningxia. Further study will be necessary to reveal the whole process.

Chapter Six

Conclusion

6.1 A Comparative Study

As discussed in Chapter 1, there are several poor countries such as Egypt, India and Nepal where national governments own water resources, and are responsible for the construction and management of large-scale irrigation systems. But user-based organizations at the level of the village are still active in these countries. A brief study of the management experiences from those countries and a comparison with the case of Ningxia would help further our understanding of the systems of institutional management in Ningxia.

Large-scale irrigation systems still operate in modern Egypt and are important for local agriculture. According to Hunt (1986), during the 1970s and 1980s the supply of irrigation water in Egypt was dominated by the national government. The Egyptian Ministry of Irrigation (MOI) received water from the major dams and distributed it through the government-built canals. Below these major canals are sub-canals owned and managed by local farmer groups. Two local user-based groups of irrigation management are visible in Egypt: one is associated with the *mesqa* (ditch) and the other one with the *saqia* (the wheel). The irrigation water that local farmers acquire from

the MOI canal system is allocated among them. For instance, the *mesqa* is a sub-canal collectively owned by local groups of farmers. The farmers who draw water from it are responsible for operating and maintaining the *mesqa*. There is a formally organized institution at each *mesqa* with a group of irrigation officials who are responsible for administering allocation turns. Membership in the *mesqa* group is a function of owning land watered by the *mesqa*.

In a pattern similar to the situation of China before 1978, every Egyptian farmer belongs to an agricultural cooperative. The People's Communes in China could control almost every economic, social, and political aspect of a farmer's life. But according to Hunt (1986), an agricultural cooperative in Egypt only administers the plan for agricultural production. Crop discipline in Egypt is officially imposed by the national government in order to ensure that there is a good fit between the timing and the distribution of irrigation water. In Egypt this centralized control of agricultural production and irrigation is associated with management of irrigation by local groups. These groups, associated with the *mesqa* and *saqia*, have been formally structured and have successfully managed irrigation water for a long period of time. However, water for irrigation is taken from the Nile by the Egyptian National Ministry of Irrigation and is the property of the state, even when it arrives at the ditches managed by local farmers. It is very interesting to

note that management groups of local farmers are actually allocating water resource belonging to the national government.

As indicated by Hunt's study of Egypt (1986), farmers could be organized in small groups (e.g., village-based or ditch-based) to manage the marginal parts (e.g., sub-branch canals or ditches) of a large-scale irrigation system which is controlled by a central authority and its agencies. Usually, user-managed branch or sub-branch canals receive irrigation water from the state-owned main canals. Hunt referred to these groups as "water users associations" (WUA) or "irrigation communities". He argued that a WUA could control the irrigation water and decide how it would be allocated among users once it is delivered to canals managed by a WUA. It can not be ignored that such groups are attached to larger bureaucratic organizations.

In the case of Ningxia, according to the Ningxia provincial regulations for irrigation management, "the state owns and is responsible for managing irrigation facilities built through the investment by the state, the facilities in which villages or townships invested are collectively owned and managed by these groups" (Document of Ningxia's Irrigation 1992:383). This regulation, compatible with the Chinese National Legislation of Water Resources, empowers and rationalizes local-level organizations for the management of collectively-owned irrigation facilities, although top-down govern-

mental intervention is very influential when assisted by a centralized administrative structure in charge of irrigation management. As in the case of Egypt, however, governmental agencies in China play a leading role when supplying water from one major large river through state-owned main canals. In Ningxia water for irrigation is supplied and assigned by the Provincial Ministry of Water and Irrigation and its special bureaus for main or branch canals. In order to allow water to arrive at the land of local farmers, the cooperation from township and village-based organizations is needed. As noticed by Hunt (1986), recent studies on poor countries have largely ignored how local user-based organizations interact with a centralized authority which provides irrigation water to farmers through state-owned facilities. The study of Ningxia indicates that this type of interaction could be presented as a cooperation relationship between governmental and local organizations. Yet, the dominance by a group of powerful governmental agencies has heavily unbalanced the process of this co-operation. For example, the Ningxia Provincial Ministry of Water and Irrigation sets up the annual plan for irrigation water usage, and its special bureaus for main canal are in charge of allocating water to farmers.

It should be noted here that local organizations for irrigation management in Ningxia are not formed as "water users associations" as exemplified by Egypt and other poor countries. Rather, they are referred to as "township and

village-based organizations". The difference is that in Ningxia, a township government or a village council controls sub-branch canals and ditches, and village officials are usually appointed to be irrigation officials in charge of management groups. For instance, an official of a village council can work as a part-time ditch-water releaser. The difference between "water user associations " and "township and village-based organizations" means that in Ningxia there is an institutional layer between a village and its farmers which somewhat limits the participation of farmers in the process of decision-making.

Similar village-based organizations exist in other poor countries as well. In his study of irrigation water in southern India, Wade (1986) describes a "public realm" within local peasant groups for irrigation management. The "public realm" consists of four main village-based institutions: (1) a village council, (2) a village standing fund, (3) a work group of village field guards employed by the village council, and (4) a work group of "common irrigators" employed by the village council to distribute water through the government-run irrigation canals. Wade indicated that these village-based institutions operate with the money collected from local farmers. In rural Ningxia extra fees are collected as well from farmers by village councils to pay part-time village-based irrigation officials. Obviously, because of their institutional structure and administration functions with

regular staff, township and village-based organizations need funds in order to operate.

Most recently in Ningxia, villages or townships have been able to set up regulations of their own which can govern water allocation among local users and maintain of sub-branch canals within the boundaries of a village or township. However, in Ningxia as well as in other parts of China, farmers do not own the land they are able to use through the Contract System. The legal separation of ownership and user rights of land in China makes township and village-based organizations less powerful than management groups of users in Egypt, who own the land irrigated by the water from the governmental canals.

According to Cruz (1989), the most popular water user-based organizations in the Philippines during the 1980s are called *zanjeras*, which were formed by groups of farmers who offered to construct irrigation facilities in exchange for the right to cultivate a portion of land. The *zanjeras* have existed for many years with minimal government interference. However, in 1976, the government of the Philippines issued a Water Code which required that the traditional claims of all *zanjeras* for the use of water should be registered with the government's National Water Resources Council. At present in the Philippines, all water resources belong to the state, which issues a water permit to guarantee its administrative authority (Cruz 1989). In the Philippines user-based organizations (*zanjeras*) for irrigation management usually have three

levels of institutional management. The first consists of a board of directors, which applies for water permits from the government on behalf of the organization and supervises the follow-up of the application. This board also coordinates the distribution of water with other user groups along the same river. The second level focuses on a supervisor, who controls the activities of "working groups". Each "working group" is composed of four to ten farmers sharing a canal. Its members clean silt or repair canals. The third level of a *zanjeras* involves an institution for mediating conflicts among users.

As noted by Cruz (1989), the interaction between water user-based organizations and governmental agencies could be performed through a very simple legal channel. In the case of the Philippines, which does not have large-scale irrigation systems, the national government issued the Water code (1976) to regulate management powers of both governmental and user-based organizations. The National Water Resources Council was set up to grant water permits to local organizations for irrigation management. This legal basis enables the government to protect the water resources owned by the state while granting local farmers use rights over water. On the other hand, governmental agencies in Ningxia not only have legal influence, but also administrative control over township and village-based organizations. However, governmental agencies and township or village-based organizations have to work together in order to allocate irrigation water among local

farmers and to maintain canals. In order to maintain this interaction, there are two institutional channels which connect township and village-based organizations together with governmental agencies in Ningxia. The first one is canal-centred: the Provincial Ministry of Water and Irrigation, bureaus of main canals, offices for branch canals, directors of sub-branch canals, and ditch water releasers. The second one is administrative: the Provincial Ministry of Water and Irrigation, county bureaus of electricity and irrigation, and township management stations. In Ningxia the Provincial Legislation for Irrigation Management (issued in 1988) requires that water allocation should be implemented through the canal-centred connections. But the second connection, the administrative connection, is not mentioned in the same legislation. In fact, most maintenance of canals in Ningxia is accomplished through the administrative connection, which can coordinate financial support from governmental agencies and labour contribution from local farmers.

The situation of Ningxia is different from that of the Philippines. In Ningxia, the legal authority only justifies one institutional connection between governmental and local organizations, while another institutional connection tends to work independently through its administrative structure (e.g., province, county, township, and village). Obviously, township and village-based organizations in Ningxia have to work with governmental agencies at a variety of administrative levels.

This type of interaction tends to marginalize township and village-based organizations. The sophisticated nature of these connections seems favourable for the maintenance by governmental bureaucrats of their powerful position. On the contrary, in the Philippines the institutional connection between user groups and governmental agencies appears to be relatively simple. Local organizations apply for their water permit which can be granted by the National Water Resources Council. The legal basis for granting a water permit is the Water Code issued by the Philippinese Government in 1976. But it has to be pointed out that most irrigation systems in the Philippines are small-scale, and that they have been owned and managed independently by water user-based associations for a long period of time. The Philippinese government does not directly interfere with the process of local management. In Ningxia, state-owned main canals are integrated with township or village-owned small canals into a large-scale irrigation system which receives water from one major river. The government provides state-owned water to townships and villages. It is reasonable to expect that a sophisticated hydraulic network is operated by a complicated and centralized institution, which not only legally influences township and village-based organizations, but also administratively controls these organizations.

In modern Nepal governmental agencies (e.g., the National Department of Irrigation) are responsible for the construction

and management of most irrigation systems. The state owns water resources (Ostrom et al. 1994). However, according to Ostrom and Gardner (1993), two types of localized organizations for irrigation management are still active in Nepal. The first one consists of "self-governing" organizations. For example, all farmers served by one canal are organized as a water users group and should provide the necessary labour for canal repair. Each users group has its own leader who is generally responsible for the timely organization of seasonal repair, and for collecting fines as well as for the supervision of water distribution. In addition, one or more members can be appointed by each group as water guards. They are usually paid in grain by the group. The second type of localized organization can be found on some of the state-owned and managed irrigation systems, where farmers have organized themselves and participate in a marginal level of the management process. They are described as "farmer-managed" organizations by Ostrom et al. (1993).

More recently, the role of these farmer-managed organizations has been gradually strengthened as they are accepted by the governmental agencies. For instance, the Pithuwa Irrigation Project was developed by the Nepalese government during the 1980s. The Department of Irrigation constructed 16 branch canals. The system was designed to serve about 600 hectares of land for rice, but farmers have extended the system to serve 1,300 hectares. So, the Pithuwa Irrigation

Project is a relatively large system. However, local farmers themselves initiated management committees (called "branch committee") for each of the 16 branch canals (Ostrom and Gardner 1993). Each branch committee is in charge of water allocation and canal maintenance. Above the 16 branch committees, there is a main canal committee created by a general assembly of local farmers. Each branch committee determines its own rules for water allocation, and the rules differ from branch to branch. Given the strength and efficiency of these farmer-managed organizations, the Nepal Government has gradually turned over the maintenance and operation of the entire irrigation network to the local farmers. The example from Nepal demonstrates that farmers in poor countries have substantial capabilities to organize themselves in order to manage relatively large irrigation systems. As pointed out by Ostrom et al. (1994), irrigation systems managed by governmental agencies in Nepal are performing less efficiently than those operated by local farmers. The experience of Nepal also suggests that the leaders and employees of farmer-organized institutions are strongly motivated to keep an irrigation system operating efficiently or face the loss of their positions.

In poor countries such as Nepal, local-level management organizations as exemplified by water user associations, are not only active but also manage the entire irrigation system more efficiently than do governmental agencies. It can not be

denied that legal or administrative recognization by state governments contribute tremendously to the success of these user-based organizations. Yet, local organizations for irrigation management in Ningxia appear to be overwhelmed by a strong governmental control. The bottom line for the normal operation of these township and village-based organizations in Ningxia is that governmental agencies at the county level reserve the right to approve the appointment of township and village-based management personnel or officials. The political power of the Chinese centralized government can actually touch every village and township, basically through the ruling Communist Party, which can even appoint the party secretary of a small village. Even at the village level, a party secretary is the top official, and he is as administratively powerful as the officials of a village council, who are elected directly by farmers. Even these officials elected by farmers are administratively subordinated to the state. There is no doubt that this type of top-down control does strongly limit the autonomous functions of township and village-based organizations. Kelley (1983) once pointed out that even localized irrigation management could be controlled by an elite who were articulated to state authority. This argument seems appropriate to describe the situation in Ningxia, as local organizations for irrigation are directly controlled by a group of township or village officials who are themselves controlled the state authority.

Although township and village-level organizations in Ningxia are subordinated to the authority of the state agencies, the rules or regulations for irrigation management recently adopted by villages or townships are becoming important, although they must be compatible with the state legislations (e.g., Ningxia Provincial Legislation for Irrigation Management). Especially since the implementation of the Contract System during the 1980s, farmers have been empowered to manage the land on which they have contracted use rights. In return, peasants are more assertive in the management of irrigation water, which is understandably crucial for economic gains from their agricultural land. But given that townships and villages own marginal irrigation networks receiving water from large irrigation facilities which are owned and managed by the state, it can not be ignored that the assistance from governmental agencies is necessary for the effective functioning of local-level management organizations as regards, for example, the allocation of irrigation water.

6.2 Conclusion

Most earlier anthropological studies of irrigation (e.g., Glick 1970, Geertz 1973) focused on the autonomy of localized management. In his study of eastern Spain during the 14th century, Glick (1970) argued that there was no political centralization in irrigation management. His case study on Valencia indicates that:

> Social control has traditionally rested in the collective will and institutions of the irrigators themselves. The autonomy of local irrigation communities was accepted by all levels of the power structure and enshrined in customary law (Glick 1970:5).

Before 1949, the village-based organizations for irrigation in Ningxia were relatively independent of state authority. But the situation after 1949 has been characterized by the dominance of governmental agencies. Recently, some anthropologists (e.g., Mahdi 1986, Wade 1986) have returned to the above mentioned theoretical orientation. This approach emphasizes that local groups with ownership or user rights over water resources, could manage irrigation systems collectively, carefully, and efficiently. For instance, Mahdi (1986) analyzed the village-based organizations set up by the Erguita mountain tribe in Morocco. He argued that village-based management of irrigation created a kind of equality among users, and that it is an efficient form of water management.

Meanwhile, another type of anthropological approach (e.g., Hunt 1986 and Ostrom et al. 1993) emphasizes the participation of farmers in state-owned irrigation systems. As indicated in Hunt's study on modern Egypt, local farmers could organize themselves into small groups in order to manage a village-owned marginal irrigation network which had to receive water from main canals controlled by the state authority. Such localized organizations are usually based on water users associations (WUA). The experience from Nepal (Ostrom and Gradner 1993) shows that a WUA can be formed by farmers who

share the same canal and who likely contribute labour for maintenance. But few of these studies explained how farmer-managed organizations, such as a WUA interact systematically with the state authority in matters concerning water allocation and canal repair. In fact, when analysing user-based groups in Egypt, Hunt (1986) realized that within a large-scale irrigation system a WUA could not alone deliver water to the lands of users; it had to co-operate with a group of government organizations to ensure the supply of water.

Some anthropologists have given their attention to the interaction between user-based organizations and centralized state agencies for irrigation management. For instance, Lees (1986) analyzed how farmers in Israel, Sudan and Kenya deal with a highly centralized bureaucracy for the management of large-scale irrigation systems management. These farmers create a kind of operational flexibility called "informal adjustments" within regulatory systems controlled by state authority. "Informal adjustments" mean that as users receiving water from state-controlled irrigation systems farmers can informally disobey the state authority if such action best serves their interests. "These 'adjustments' allow participants to conduct themselves as if in sufficient conformity to the rules so as to avoid loss of entitlement of the benefits of participation, while bypassing some of its conditions" (Lees 1986:610). As emphasized by Lees (1986), all of these "informal adjustments" usually occur under

circumstances in which farmland is not private property but is state-owned, and where farmers can have contracted user rights over land. In Ningxia such adjustments can be found in village-based organizations. For example, in order to get more water allocated by the governmental agencies, a village may present their annual plan for water which may include areas of land which do not need irrigation.

Recently, some scholars studying natural resources management (Pinkerton 1989 and Berkes 1994) have applied the approach of "co-management" to analyze the interaction between state-level and local-level management of natural resources. Co-management emphasizes the integration of local-level and state-level management organizations, and the shared power over decision making. However, this thesis indicates that the practice of co-management is far from the reality of irrigation management in the People's Republic of China. Instead, this case study of irrigation management in Ningxia has revealed the existence of a cooperation relationship between governmental agencies and township and village-based organizations.

This kind of cooperation is intended to allocate irrigation water among townships and villages, and to maintain the normal operation of canals with labour input from local farmers. The cooperation is based on two institutional connections between township and village-based organizations and governmental agencies. The first is canal-centred, allocating

irrigation water from the Provincial Ministry of Water and Irrigation to its management bureaus for main canals, and then to directors of sub-branch canals and water releasers at the village level. The second is administrative, focusing on canal maintenance from the Provincial Ministry of Water and Irrigation to County Bureaus of Irrigation and Electricity, and subsequently to township management stations of irrigation. But this type of cooperation has been unbalanced by the centralized political structure of China. Governmental organizations from province to county maintain dominance over the entire process. Nevertheless, the cooperation that exists does maintain the normal functioning of both farmer-managed and state-managed irrigation networks, although township and village-based organizations are much less powerful in decision-making.

Concerning the general situation of irrigation management in the People's Republic of China during the 1970s, Nickum (1982, 1983) has described the co-existence of a powerful centralized management structure with the marginalized People's Commune-based organizations. But he emphasized that the dominance of state authority has not led to the total dysfunction of rural community-based organizations for irrigation management. Nickum (1982) realized that during the 1970s there existed an administrative structure in China which was specialized in managing irrigation, but that it had to subordinate itself to the political authority of the state. He

referred to this administrative structure as a group of specialized governmental agencies controlled by the administrative power of the state at a variety of levels. This thesis has analyzed two types of institutions for managing irrigation systems in Ningxia: centralized (governmental) and localized (township and village-based). The latter, township and village-based organizations are constructed on the basis of township and village-level administrative structures.

In contrast to other poor countries such as Nepal (Ostrom et al. 1993) and Egypt (Hunt 1986), the memberships of localized organizations in Ningxia are not mainly composed of water users. These organizations themselves, supported by an agency of a township government (e.g., a township management station for irrigation) or by a village council, are usually headed by village officials. Some of these officials may work as the part-time staff of a village-based organization. The experience from Ningxia shows that there is a kind of township or village-based administrative structure which is specialized in the management of marginal irrigation networks receiving water from state-controlled canals. This type of localized administrative structure remains subordinate to the authority of a group of governmental agencies for irrigation management. On the other hand, localized administrative structures maintain a kind of cooperative relationship with the governmental administrative structure. But, through two institutional channels, the latter successfully marginalizes

the former, especially during the process of allocating irrigation water.

This thesis has analyzed two types of institutional management systems for irrigation in Ningxia, located in arid northwest China. Centralized management has relatively long history dating back to imperial times. Special governmental agencies at the provincial and county levels control main canals and the process of water allocation. The situation remains almost unchanged from the Imperial period to that of the People's Republic of China. On the contrary, township and village-based organizations seem to be easily disturbed by social and political changes. Currently, township and village-based organizations can manage marginal irrigation networks, usually located within the boundary of a village or township. In spite of occasional conflict, governmental agencies have to work together with township and village-based organizations in order to allocate water and maintain canals. But this process of co-operation has been complicated by a powerful centralized institution, which tries to maintain its dominance over local organizations.

In 1991 the Chinese People's Congress revised the National Constitution which encoded the legal status of the Household Responsibility System and the Contract System that had been practised in rural China for more than a decade. Recently, the new constitution, along with other liberal policies, seems to encourage the decentralization of

irrigation management in Ningxia as well as in other parts of China. However, decentralization does not occur overnight. It is in conflict with a strict centralized authority that has existed for the last forty years. Some resist this change; at the same time, others tend to endorse it. Government officials are worried that they may lose control and their power because of the emerging decentralization of irrigation management. Farmers are eager to take advantage of the Contract System to explore its potential for giving them more control over key decisions, noticeably in water allocation.

Since 1995, the Chinese government has allowed farmers to directly elect village officials, who were previously appointed by the state. Currently, this grass-roots democracy enables farmers in Ningxia to have more control over their village-based organizations for irrigation management. For example, if governmental agencies require a labour contribution for canal maintenance, village officials would ask for a daily salary which would be paid to local farmers. More recently, those village officials, working as part-time irrigation officials, tend to put the interests of their village first when applying for irrigation water allocated by governmental agencies.

In addition, the practice of the Contract System has been expanded to the process of irrigation management. As a water user, a farmer may obtain management power over a ditch by means of a contract signed between him and his village

council. A contract for irrigation management not only requires management duties but also guarantees the economic gains for contractors. The successful practice of such a new contract system, as indicated in the case study of Lixin township, illustrates the active participation of users in the process of irrigation management. It also means that the practice of this contract system tends to transform village-based organizations in Ningxia into water users associations.

Water users in Ningxia do not organize themselves along a canal or ditch as do users in Nepal. Some, as individual contracted managers, have to work together with village officials in order to manage a marginal irrigation network controlled by the village. The lack of inter-village cooperation usually leads to more conflicts among users from different villages. These conflicts involve the allocation of irrigation water along one branch canal which extends across several villages, and over the labour contributions of up-canal and end-canal users. For instance, the silt of a branch canal (Hunhua) near the capital city, Yinchuan, has not been cleared for three years because of a labour dispute between up-canal and end-canal users both of whom would not like to give free labour. By 1993, when insufficient water could be transferred through the Hunhua canal, the city government of Yinchuan had to call for the help of volunteers from among governmental employees and the army to clean silt.

At the level of the township there are still limitations to "liberalization and decentralization". For instance, a top official of a township can be elected by farmers, but he must be selected among candidates appointed by the state government at the county level. In addition, the appointment has to be approved by a county government. Furthermore, a township management station for irrigation is not only a township-based organization but also the official representative of a county bureau of electricity and irrigation. Currently, township-based organizations for irrigation are still under the relatively tight control of the state. In fact, the governmental agencies from the province to county seem to realize that the control of township-based organizations is important so as to maintain the normal functioning of a centralized management structure, especially when village-level organizations and farmers as users are becoming powerful. As mentioned in chapter 5, governmental agencies attempt to increase their influence over township-based organizations by instituting new policies and by monitoring the process of the selection of township irrigation officials.

As one might expect in the functioning of any social system, there are differences between theoretical and legal systems of irrigation management in Ningxia and the actual practices of government agencies and farmers. In Ningxia the Provincial Ministry of Water and Irrigation is supposed to control all activities related to water allocation according

to an official plan. Such a plan is designed to use irrigation water efficiently when there is a centralized government authority to operate it. In practice, water use in Ningxia appears to be inefficient. As discussed in chapter 5, 7,000 million m^3 of water from the Yellow River was consumed in Ningxia in 1986, far beyond the volume planned by the Chinese central government (4,000 million m^3). This excessive amount of water released by the Provincial Ministry of Water and Irrigation makes possible the inefficient water use of farmers in Ningxia.

In his study of large-scale irrigation systems in ancient Peru, Steward (1959:100) pointed out that:

> An irrigation state plans, creates, and manages waterworks that increase the yield of farm land, and it brings new land under cultivation. In order to do this, however, it must devise a political organization and a power structure. ..... Once state political, religious, and military institutions are created, they exist of their own right and for their own sake as well as to serve the public.

In Ningxia a large group of special bureaus and their staff have had a long tradition in the political management of irrigation. "Political management" means that a management group intends to maintain its power and authority with administrative efforts including regulations and rules, and that it tries to distribute resources without much concern for economic accountability. The study of centralized management of irrigation in Ningxia shows that governmental agencies specialized in irrigation management are most concerned about their political power. The Provincial Ministry of Water and

Irrigation and its special agencies adopt a policy of low water fees in order to gain the political support of farmers for the centralized institutional management. This type of political support costs considerable money from the national revenue, and the system of low water fees leads to the inefficient use of irrigation water at township and village levels.

Although the " political management" of irrigation might be one major reason why overuse of water occurs, another important reason can be found at the level of township and village-based organizations. As noted by Lees (1986), "informal adjustments" are usually created by farmers in poor countries to serve their economic interests. In Ningxia these "informal adjustments" contribute as well to the overuse of irrigation water, especially when new liberal policies have empowered local management groups. Usually, these informal adjustments include the application for extra water based on land which does not need irrigation and the use of water allocated to end users along the same canal. It should be pointed out that the "political management" by governmental organizations in Ningxia, as exemplified by low water fees, actually encourages some farmers to adopt these "informal adjustments" without worrying about economic loss.

Large-scale irrigation systems have a long history in Ningxia, as well in many parts of China. This thesis has analyzed the structure of centralized and localized

institutions for managing irrigation, and it has discussed a cooperative relationship between them. However, some questions remain unanswered and deserve further study. For instance, what is the relationship between township and village-based organizations in Ningxia for irrigation management and the social organization of local society? How are these irrigation-oriented organizations culturally articulated in local rural society? To answer these questions, it will be necessary to analyze the historical and contemporary social structures of local rural societies. In addition, localized organizations for irrigation management in Ningxia are township and village-based, rather than associations or groups directly controlled by local users. Future studies should analyze how local users interact with these township or village-based management groups. Furthermore, since there are two levels of rural community-based organizations for irrigation in Ningxia: township and village, the relationship between them deserves further study. A detailed analysis of the institutional mechanism for conflict resolution and actual examples of conflicts and solutions, are also much needed to better understand the practice of irrigation management in Ningxia. These issues will be the topics of my intended field research in the years to come.

Appendix 1: Dynasties of Imperial China

Qin dynasty	221 BC - 206 BC
Han dynasty	206 BC - 220 AD
Three Kingdoms Era	220 AD - 285 AD
Ji dynasty	265 AD - 420 AD
Northern and Southern dynasties	317 AD - 589 AD
Northern Wei dynasty	386 AD - 534 AD
Suei dynasty	518 AD - 618 AD
Tang dynasty	618 AD - 907 AD
Liao dynasty	916 AD - 1125 AD
Sun dynasty	960 AD - 1279 AD
Jin dynasty	1115 AD - 1234 AD
Yuan dynasty	1272 AD - 1368 AD
Ming dynasty	1368 AD - 1644 AD
Qing dynasty	1644 AD - 1911 AD

Appendix 2:

Legislation for Irrigation Management in Ningxia[34]

(issued in 1983)

Principle

Article 1.

Irrigation systems are the hydraulic facilities which are very important for securing the welfare of people, economic construction and development of national economy. They are the precious property of the state and people. In order to efficiently utilize irrigation and water resources to develop industry and agriculture, this regulation is issued regarding the situation of the province.

Article 2.

The state agencies at a variety of levels, army forces, people's organizations, factories, city and rural communities shall obey this regulation.

Article 3.

The state owns and manages the hydraulic facilities which are invested by the state. The facilities, which are invested collectively by rural communities, or through subsides from the state, are collectively owned and managed by these

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[34]. The translation only includes the articles relevant to the institutional management of irrigation system.

communities.

Management and Organizations

Article 4.

The governmental agencies for irrigation at a variety of levels are the specified organizations of the People's Government at the corresponding level that are in charge of managing irrigation systems. They are the agencies administrating those minor agencies specialized in managing hydraulic facilities. The irrigation system, managed by the state, is controlled by a administrative agency at a certain level of which the government shall set up a agency for management. The collective-managed irrigation system can be controlled by community-based organization and personnel.

Article 5.

The management of irrigation shall be under the centralized leadership, and arranged by state agencies at a variety of levels. The irrigation systems, which benefit the territory of a city, county or township, are managed by this city, county or township. The irrigation across cities, counties or township shall be managed by an state agency above city, county or township.

Article 6.

The major duties of agencies for irrigation management are: maintaining irrigation facilities efficiently, and serving local agriculture. The duties of management personnel are:

implementing governmental policies relevant to irrigation management, maintaining and operating irrigation facilities, allocating irrigation water and collecting water fee.

Article 7.

State agencies for irrigation management may set up committees for management, which include representatives from regions benefitted by irrigation system. The resolution presented by a committee must be approved by a high-level governmental agency for irrigation, and then can be implemented.

Allocation of Water

Article 13.

Water resources are the property of the state, and shall be centrally arranged by special agencies for irrigation. The allocation must be implemented according to the regulated plan.

Article 14

Users shall make their plans for water consumption, and present them to state agencies for irrigation management. According to the engineering requirement of irrigation facilities, water availability and climate changes, these agencies will balance the plans, and report them to high-level agencies for approval. If the shortage of water occurs, state agencies can concentrate the available water, and allocate it proportionally or on the basis of rotation.

Regulation for Irrigation Management[35]

(issued in 1988)

Principle

Article 1.

In order to efficiently utilize water resources and to maximize the economic benefits of irrigation facilities, and to develop industry and agriculture, this regulation is issued according to Legislation for Water Resources in the People's Republic of China and Legislation for Irrigation Management in Ningxia.

Management of Irrigation Facilities

Article 5.

The state owns irrigation facilities, invested by the state. They should be managed by special agencies set up by the state. Bureaus for management shall be set up for main canals and electrical pumping regions, and management offices shall be established for branch canals. Management offices can be established as well for middle or small reservoirs, pumping stations and drainage.

Article 6.

Irrigation facilities, which are invested by township or village, are collectively owned and managed by the township or

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[35]. The translation includes the articles relevant to institutional management of irrigation systems.

village. The structure of management organizations may vary according to the scale of facilities.

(1) Management office can be set up for large branch canal or reservoir.

(2) The management of small irrigation facilities such as ditches or small pumping stations can be contracted to individuals, groups of persons or households.

Article 7.

Township management station for irrigation is the representative agency of a city or county bureau of electricity and irrigation, as well as the management organization of a township. The duties of a township management station include: management of the maintenance and construction of irrigation facilities within the territory of the township, monitoring user-based organization for irrigation, coordination of conflicts, implementing government policies relevant to irrigation management, and assisting state agencies to collect water fee.

Article 8.

Irrigation shall be managed democratically. Across the irrigated region, a management committee shall be set up, and it can be composed of representatives from city, county and special agencies for irrigation. The duties of a management committee involve: monitoring the working plans of governmental agencies for irrigation management, drafting or revising regulations for managing irrigation.

Article 9.

Each management office should regularly call for a conference attended by representatives from local users. The conference will discuss how to implement the official policies and regulations issued by management committee, and discuss the plan for irrigation and maintenance. But the resolution of the conference has to be presented to a high-level governmental agency for irrigation management for approval.

Management of Water Allocation

Article 14.

Water allocation shall be centralized according to official plans. Times for releasing or suspending water from main canals must be approved by the Provincial Ministry of Water and Irrigation (PMWI). The volume of water released by main canals should be balanced by PMWI. The volume of water released by reservoir or small pumping station should be reported to county bureau for irrigation for approval. A management bureau for main canal allocates water to its management offices, which will re-allocate it to each branch-canal. Then each management office or director of sub-branch canal may assign water directly to users. Water gates of main or branch canal must be controlled by personnel appointed by state agencies for irrigation.

Article 15.

Each management office (for branch canal) or management station (in township) is in charge of making plans for water allocation, which should be based on irrigated area of land and other types of water consumption reported by users. The plans must be compatible with the quota of allocated water set up by management committee. A plan for water allocation shall be reported to a management bureau for main canal, and announced to user-based management organizations and personnel.

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