

BETWEEN FOOD SECURITY AND PROFITABILITY:
A MULTILEVEL ANALYSIS OF THE AGRICULTURAL WATER CRISIS IN
CHINA

by
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ABSTRACT

Why has the agricultural water system in China been slipping towards a crisis, despite its economy growing leaps and bounds in the past four decades (1978-2016)? This dissertation investigates the institutions of agricultural water use and various actors involved in the water system at national, local and community levels. It situates the crisis in the context of the country's neoliberal shift in the post-reform period and argues that the agricultural water system has caught between a structural dilemma between profitability and food security. Guided by the relational-comparative method and layered analysis, the author collected rich archival, statistical and ethnographic data and conducted two county case studies: one county is located in Hunan Province and the other in Inner Mongolia. After analyzing water policy, water problems, changing patterns of water use and grain production, and the incentives and actions of local officials, farmers and agribusiness companies, the dissertation reaches three conclusions:

First, the agricultural water crisis in China has its roots in the capitalist logic of profit maximization. In the post-reform period, state and non-state actors tend to allocate human, material and financial resources to sectors and activities that would generate greater economic returns, while neglecting the long-term sustainability of the agricultural water system. Second, although the concern over food security increased government funding in agricultural water, it has also facilitated the geographical movement of grain production from South to North, which exacerbates the mismatch between water resources and grain production. Finally, capitalist transformation and social

differentiation in the countryside have undermined the capability of rural communities to take collective actions to solve water problems. Although the newly emerged large farms are able to invest more resources in agricultural water, their behavior is also based on profitability rather than the health of the agricultural water system. Additionally, the differentiation of the rural society has made the distribution of water resources increasingly unequal, favoring agribusiness and large farms over farming households.

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Chapter 1 Introduction

As China rises, its food demand has soared. In 2014, grain production in China reached a record high, 607 million metric tons, but it nonetheless imported another 95 million metric tons of grains (NBS 2015: tables 12-2, 11-8). Most of the imports were soybeans, weighing 71 million metric tons, which were used to produce edible oil and animal feed. In addition, rising standards of consumption have increased demand for resource-intensive products such as meat and dairy products, turning China into a net importer of pork, beef and milk in recent years (Huang 2016; Schneider 2017; Weis 2013). As the country relies on the global market for an increasing share of its food supply, scholars and policy analysts are worried that it could lead to rising food prices and food shortages (Bello 2009; Brown 2011; McMichael 2012). As early as 1995, Lester Brown (1995) predicted that China would not be able to feed its vast population through domestic production and must import food from abroad. Recent food crises in 2007/8 and in 2011/12, though not caused by China, nonetheless added a new sense of unease about China's food demand and its global impact (Moseley 2013).

China has been largely pursuing a food self-sufficiency policy since the Chinese Communist Party (CCP) took power in 1949. Despite increasing food imports in the recent decade, the central government has reiterated that China must feed itself mainly through domestic production. This strategy, called grain self-sufficiency (*liangshi ziji* 粮食自给) or grain security (*liangshi anquan* 粮食安全), is regarded as the bedrock of China's food sovereignty and national security. According to a national plan released in

2008, China will try to keep the rate of grain output to consumption around 95 percent between 2008 and 2020.¹ The current president, Xi Jinping, reaffirmed in 2013 that grain security will be a top priority of the government.² However, the question is whether China can maintain the capacity of grain production to produce sufficient food. The answer to this question matters a great deal, given China's rising economic power.

This dissertation addresses the question by examining agricultural water use in China. Water is vital for agricultural production and food security in the country, which depends on irrigation for 70 percent of its grain output (Khan, Hanjra and Mu 2009). Lester Brown's argument that China would be unable to feed itself is partly dependent on the unsustainability of agricultural water use, which includes water scarcity, depletion of aquifers, water pollution, and the diversion of agricultural water for urban and industrial uses (Brown 1995; Brown and Halweil 1998). Although some scholars contended that Brown might have exaggerated the magnitude of water crisis in China, the worsening water problems have caught wide attention in the past two decades (Ma 1999; Nickum 1998; Economy 2011; Wang et al 2009; Watts 2010).

This dissertation examines the political economy of agricultural water use in China. It reveals how the supply of agricultural water in China has been caught between food

¹ The document can be accessed at http://www.gov.cn/jrzq/2008-11/13/content_1148414.htm

² It should be noted that China has made the policy of grain self-sufficiency more flexible recently. According to its 13th Five-Year Plan (2016-2020), which was released in October 2015, grain security refers to the self-sufficiency of cereals, which mainly include rice, wheat and corn. In addition, the Plan stresses that a major way to guarantee grain security is to maintain the sufficient amount of land and adequate technologies for grain production. In other words, grain output may fluctuate from year to year, but the country will be able to produce sufficient grains if it must. This change is obviously intended to address the new reality that China has increasingly relied on imports for certain grains, most notably, soybeans (Honby 2014; Yan, Chen and Ku 2016). Nevertheless, to produce sufficient grains (cereals) continues to be a main policy goal.

security, which is commonly known as grain security (*liangshi anquan*) in China, and the neoliberal principle of profit maximization in the past four decades. On the one hand, the Chinese state has attached much importance to grain security and striven to produce sufficient grains to feed the nation. The commitment to grain security entails consistent efforts by both state and non-state actors to maintain a sustainable agricultural water system. On the other hand, however, the state and various economic actors, even including farmers themselves, have been subjected to the neoliberal principle of profit maximization, resulting in either the poor maintenance of agricultural water facilities or the over-extraction of water resources. I will examine this contradiction at the multiple levels—national, local and community, and investigate the incentives and actions of state and non-state actors. The goal is to achieve an adequate understanding of the causes and consequences of agricultural water problems, and assess the future trajectory of the agricultural water system against the backdrop of rapid economic growth and rural transformations in China.

The introduction comprises five sections. The first section describes how the water problems have correlated with regional economic development within China, particularly the South-North divide in the use of land and water. The second section reviews the existing theories on agricultural water problems. The third section discusses the structural dilemma in Chinese economic development and the neoliberal shift in the past four decades. The fourth section offers a theoretical framework to understand the agricultural water crisis in China. The last section details methodology, data collection and the organization of the dissertation.

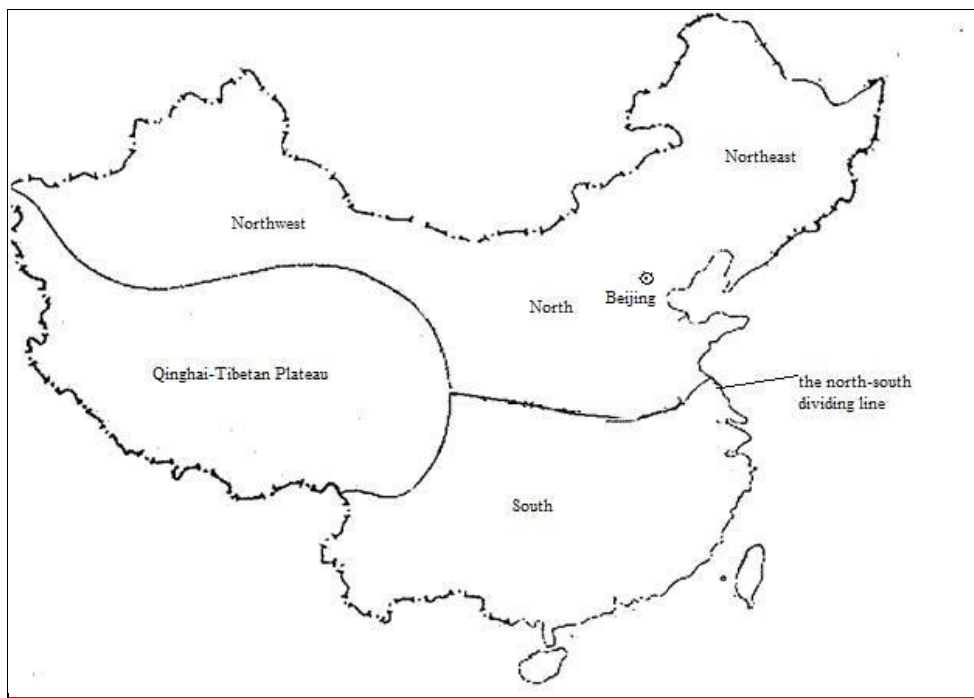
1.1 Water Problems and the South-North Divide in China

Agricultural water problems in China can be classified into two categories. One is related to surface water and comprises the breakdown of irrigation facilities, water pollution and the diversion of water from agriculture to urban-industrial sectors. According to a 2009 report released by the National People's Congress of China, more than half of large irrigation zones were not functioning well, and more than 85 percent of large pumping stations were in urgent need of thorough repair or even reconstruction (NPCC 2009). The conditions of small-scale irrigation facilities were probably even worse. The breakdown of these facilities is dubbed as the problem of "last mile" (*zuihou yigongli*), suggesting that water cannot flow into farm fields without the proper functioning of these facilities even though large irrigation facilities are fixed (Wei and Zhu 2012). Water pollution, which has been widely studied, poses a serious threat to the safety of food products (Economy 2011; Lu et al. 2015; Ma 1999: 159-164). The diversion of water from agriculture to urban-industrial sectors will also undermine agricultural production. The South-North Water Transfer Project (*nanshui beidiao*) is a good example of how the Chinese government has invested enormously to divert water from the South to meet urban-industrial demand in the north (Berkoff 2003; Yan, Wang and Huang 2015).

The other category is related to underground water, which mainly refers to the over-pumping for irrigation, leading to the falling of groundwater tables and the depletion of aquifers, though the use of underground water would also lead to the problems of pollution and the diversion to urban-industrial uses. According to Brown and others, the water table in the North China Plain has been falling 1.5 meters per year since the 1990s,

and even two meters in some regions. Due to over-pumping and water diversion, the downstream of the Huai River and the Yellow River would see no flows for much of a year. In addition, the over-pumping has caused saltwater intrusion, soil salinization, soil compaction and land subsidence (Brown and Halweil 1998; Shalizi 2006; Zhen and Routray 2002; Wang et al 2006).

Figure 1-1 The north-south division of China



Although the two types of problems can exist in any region of China, surface-water problems are more serious in the south while groundwater problems more pressing in the north. This is due to the patterns of precipitation and the availability of water resources. In the south, the level of precipitation is high and surface water is relatively abundant. Thus the main way of agricultural water use is to harness surface water through reservoirs, dams, canals, aqueducts, ponds, etc. By contrast, low precipitation in the north has forced

farmers to rely heavily on underground water for irrigation. Figure 1-1 shows the south-north division. Annual precipitation is usually more than 800 mm in the south while less than 800 mm in the north, excluding the Qinghai-Tibetan plateau. In northern areas which are close to the sea, for example, some parts of Hebei, Shandong and Liaoning provinces, annual precipitation might exceed 800 mm. Nevertheless, in general, the level of annual precipitation decreases as moving northward. This geographical division holds important implications for the analysis of agricultural water and grain security in China.

The reform in China in the late 1970s unleashed decades of rapid economic growth. Partly as a result, grain production has been pushed from the south to the north as land and other resources in the south were allocated for more profitable uses such as industrial production (Chen 2009; Qu and Su 2003; Zhong and Qin 2010). This change is in line with the economic theory of comparative advantage, that is, it is rational for southern regions to concentrate resources on economic activities with the lowest opportunity cost (Hendrischke and Feng eds. 1999; Lin, Cai and Li 2003).

While the relocation of grain production makes perfect sense in the logic of economic growth, it appears problematic in terms of grain security. In China, the south is better endowed with natural resources such as water and soil for grain production. Prior to the mid-1980s, it was the major site of grain production with surplus grains exported to northern regions and elsewhere. Although the north has a larger cultivated area as compared with the south, it is severely short of water due to low precipitation. The relocation of grain production has exacerbated the problems of agricultural water use. In

the north, intensified agricultural production has led to the over-pumping of groundwater, resulting in a rapid drop in the water table (Cao et al 2011). In the south, resources and efforts were concentrated on non-agricultural sectors for the sake of economic growth while those for agriculture and irrigation were undercut, leading to the breakdown of irrigation facilities. In other words, the south-north divide in grain production and water problems have been closely associated with the regional patterns of economic development in the reform period.

The Chinese government has recognized the gravity of agricultural water problems. In 1998, huge summer floods in major rivers such as the Yangtze River inflicted tremendous damages to agriculture and urban infrastructure, revealing the vulnerability of the system of water control and conservancy. The disaster deeply alarmed the central government and prompted it to increase investment in the water system thereafter. As the conditions of the agricultural water system continued to slide, the government has taken a number of measures to counter the trend in the last 10 years. For example, it called to improve agricultural infrastructure including the agricultural water system in its annual No.1 policy document in 2008, a document that signals government priority. In 2011, it used the entire No. 1 document to address the issues of agricultural water use, and reiterated the importance of water supply for agriculture and food security (*Renmin Ribao* 2011).³

However, state agencies at both central and local levels tend to prioritize GDP and revenue growth, which directs financial and administrative resources to more profitable

³ The No.1 documents are issued jointly by the CCP Central Committee and the State Council at the beginning of every year to signal Chinese central government's policy priorities.

economic sectors in some regions while intensifying agricultural production in others. This tendency has exacerbated agricultural water problems and would continue to undermine the system in the future. Thus it remains an open question whether increased state efforts can solve the aforementioned problems and build a sustainable system of agricultural water. In addition, the agricultural water system involves not only state actors but also non-state actors. Thus it is equally important to investigate the incentive and action of these actors and their impacts on the system.

This dissertation tackles three sets of questions. The first set of questions pertains to state policy. How have the national policies of agricultural water use in China evolved in the past six to seven decades (1949 to present)? To what extent were water problems in China affected by state policies? What factors have been driving water policy changes?

The second set of questions regards policy implementation. Whether have state policies that are aimed to improve the agricultural water system been effectively implemented? What are the determinants of effective policy implementation at the local level? How have center-local relations in China shaped policy implementation?

The third set of questions is related to non-state actors including rural communities, households and private enterprises. How are these actors affected by state policies on agricultural water? How have their incentives and actions shaped the efforts in building and maintaining the agricultural water system?

1.2 A Review of the Literature

The problems of agricultural water use, which includes the breakdown of irrigation facilities and over-extraction of groundwater, has been a global phenomenon in the last four decades. Postel (1999: 54) divides the period after the Second World War into two contrasting phases in terms of irrigation development: “the boom years from 1950 to 1980, and the slowing of irrigation’s expansion since then.” In the boom years, governments and international donors had committed large amounts of investment and efforts to irrigation, leading to the rapid expansion of irrigated area worldwide except for Africa. The irrigation development provided a crucial condition for the success of the Green Revolution and contributed greatly to the increase in agricultural output (Bramall 2000: 133-4; Evenson and Gollin 2003).

Postel’s periodization has correlated with the two distinct phases in post-war economic development: the developmentalist era and the neoliberal era (McMichael 2011). The developmentalist era was characterized by large governmental investments in infrastructure and public services, whereas the neoliberal era witnessed the withdrawal of the state from economy, and consequently state investment in infrastructure and public services was reduced. Thus the slowing of irrigation expansion in the second phase should be primarily attributed to the neoliberal shift since the 1980s.⁴ Irrigation development in China largely fitted into this global trend. After decades of intense efforts in irrigation and water projects, the Chinese state cut irrigation investment drastically in

⁴ The decline in irrigation investment was also due to falling crop prices in the 1980s, which has diminished the returns to agricultural water investment considerably, leading to the reduction in efforts after 1980 (Postel 1999: 60-64). The decreased efforts in irrigation and agriculture may have contributed to the recent food crises in 2007/8 (Timmer 2010).

the 1980s, and consequently, irrigation facilities started to crumble and irrigated area stagnated.

However, the trend at the global level in the neoliberal era does not suggest the universal decline in irrigation in all geographical locations or at all times. As a matter of fact, there have been great variations in irrigation and agriculture across time and space. The neoliberal doctrine shifted the responsibility of agricultural water investment to private owners. In areas where the production of agricultural commodities is profitable or when there is a high market demand for these commodities, private owners would have increased irrigation investment. However, the expansion of irrigation does not necessarily indicate a positive development of the agricultural water system. The profit-motivated irrigation investment would overburden the water system and produce harmful social and environmental impacts. This can also be seen from the Chinese case. As I will detail in this dissertation, irrigated area started to rise again in China in the 1990s (Naughton 2007, 259-60), but this was achieved mainly by extracting groundwater in the north, which increased rather than lessened the stress on the agricultural water system.

The parallel trajectories of China and other countries in agricultural water development suggest that the Chinese case holds implications for understanding agricultural water problems in general. On the other hand, the studies that examined agricultural water problems in other countries can also offer insights for this study. In explaining the occurrence of agricultural water problems, scholars have advanced theories at different

levels. In what follows, I will review micro-level theories, theories of capitalist transformation, and urban bias theory.

Micro-level theories

The popularity of micro-level theories rose in the neoliberal era following the criticism and negation of post-war state-led development. Instead of focusing on the state, scholars turned attention to the actors in the market and the civil society (Evans 1997a). There have been two main micro-level theories on the investment and management of agricultural water in China and elsewhere, which I call community organization theory and privatization theory respectively.

The community organization theory argues that neoliberal marketization policies and practices have weakened rural community organizations, thus rendering them unable to effectively organize farmers to manage agricultural water use. Therefore, the solution is to rebuild community organizations such as water-user organizations, villages and farmers' associations, which will involve farmers and manage irrigation projects in a community cooperative fashion (Uphoff 1986; Bruns 1993; Meinzen-Dick 1997; Trawick 2003). This theory is premised on Elinor Ostrom's argument that communal organizations are able to manage common resources based on indigenous practice and a clear definition of rights and responsibilities (Ostrom 1990; 1992).

As far as China is concerned, William Hinton argued that the dismantling of the commune system was the main factor behind irrigation problems since the market reform

in the late 1970s. Concerned with the negative effects of the de-collectivization and marketization, he argued that the replacement of the collective system by the Household Responsibility System (HRS) had contributed to the breakdown of the irrigation system because, without collective organizations, self-interest oriented individuals could not take coordinated action to construct and maintain irrigation facilities (Hinton 1990: 144). Recent studies also argued that ineffective village organizations in the post-reform period prevented households from taking joint action to solve irrigation problems (Luo and He 2004; Luo 2006a; Luo 2006b; Luo and Wang 2006).

By contrast, the privatization theory, which has become a major discourse in social science research after the rise of neoliberalism in the 1980s, argues that the problem is rooted in the vague property rights of irrigation facilities, many of which were owned by the community or the state. The public or collective ownership has made it difficult to draw private investment. In addition, irrigation water as a common resource would be exploited in an unsustainable fashion, leading to what Hardin calls “the tragedy of the commons” (1968). Thus it proposes that the government should privatize irrigation facilities, establish tradable property rights of irrigation water, and encourage private investment (Rosegrant and Binswanger 1994; Seckler 1993). In China, it has been argued that public ownership of irrigation facilities was responsible for their breakdown. Thus an effective method to solve this problem is to auction off or lease out the property rights of irrigation facilities to private investors, who in turn will take good care of irrigation facilities since they rely on selling irrigation water for profit (Song and Wu 2007).

Both community organization theory and privatization theory are a response to the neoliberal shift in the 1980s. By focusing on community organization or market mechanism, they offered partial explanations for the problems of agricultural water. However, neither has taken into account the factors beyond the community or the market. This oversight has raised questions about their explanatory power. For example, the perspective of community organizations cannot fully explain why peasants are unwilling to participate in water management even when effective community organizations are in place, as I will show in Chapter 5. In addition, the effectiveness of community organizations itself has often been a result of large forces. In the Mao period, it was not only community organizations but more importantly the state, which should take credit for mobilizing peasants for irrigation projects (more details in Chapter 2). The decline in peasant participation in the post-reform period was partly a result of changing state behavior, which in turn affected community organizations. In addition, water agencies in the reform period have pushed to transfer the responsibility of maintaining and managing water projects to villages, for example, establishing water users' associations, in an effort to increase community participation in irrigation. However, such practice has not been very successful to increase peasants' effort in irrigation (Luo 2006b; Luo 2011).

As far as the privatization theory is concerned, the lack of private investment in agricultural water projects is not only a matter of public ownership but more importantly, the low profitability of such investments in some regions. In the early 1990s, the Chinese governments at both local and central levels started to privatize irrigation projects, particularly small ones. By 2008, irrigation projects that underwent ownership reform had

accounted for about 35 percent of the total (MOWR 2008). However, the privatization has not stalled the declining trend of the agricultural water system. In addition, the privatization of irrigation facilities would undermine the agricultural water system by over-tapping water resources for private profits, as I will show in Chapter 6.

Theories of capitalist transformation

Neoclassical economic theory that emphasizes comparative advantage and economies of scale argues that small farms will lose out to large farms in market competition (eg. Schmitt 1991; Hallam 1991). Thus they will either be taken over by large farms/agribusiness or use land for purposes other than agricultural production. Despite a fierce critic of neoclassical theory, the Marxist theory of capitalist transformation also predicts that capitalist large farms will take over small farms, but it advances a much nuanced class-centered analysis of the process.

Marxist scholars posit that capitalism is a mighty transformative force that will create new class relations in the countryside. In this process, small-scale agricultural production will disappear and be replaced by capitalist large farms. Peasants, who usually own small pieces of land and are engaged in small-scale farming, will be proletarianized as capitalism transforms the countryside and turns peasants into landless rural laborers or urban workers (eg. Brenner 1976; Hobsbawn 1994: 288-291; Moyo and Yeros, 2005:19). In addition, capitalist transformation within one country will be facilitated by the expansion of transnational agribusiness companies and foreign investments (Engdahl 2007; McMichael 2007, 2009; Pringle 2003: 13-15; Shiva 2000). Moreover, capitalism

(both national and global) weakens the peasantry through diverting resources, including land, labor, capital and water, from agriculture and the countryside to industry and the city. For example, with the expansion of urban-industrial capitalism in developing countries after the Second World War, many rural laborers left the countryside for cities, and more and more farmland was used for urban construction and industry (eg. Warren 1973; Moyo and Yeros 2005:13, 27; Bernstein 2000:33, 39; Basu 2007).

Theories of capitalist transformation hold implications for understanding the problems of the agricultural water system. As capitalism erodes peasant communities, the irrigation system that is based on and serve peasant communities would decline and be replaced by a new system that serves large capitalist farms. However, the transformation to capitalism would be a long process, particularly in countries like China where the peasant population is enormous. As I will show in this dissertation, the irrigation system based on peasant communities is still firmly in place, and the newly emerged capitalist large farms have to rely on this old system. The new irrigation system that specifically serves large farms has only begun to emerge, and its further expansion would require drastic intervention from the state.

Another related theory, urban bias theory, deals with the issue how urban and industrial capitalism has diverted resources such as capital, labor, land and water away from rural sectors to urban-industrial sectors. Given that China is experiencing rapid urbanization in the past four decades, this theory is highly relevant to water problems in the Chinese countryside.

Urban bias theory

Urban bias theory argues that state policy favoring urban-industrial sectors over the countryside has been the source of rural poverty and agricultural backwardness in the less developed countries (Lipton 1977; Bates 1981). Urban-biased policies undermine agriculture and irrigation because it reduces investments in rural infrastructure and drain human resources away from the countryside. Urban bias scholars observed that economic growth in the post-war period, which was associated with urbanization and industrialization, did not significantly improve the rural situation in many developing countries, and rural populations continued to suffer food shortages, malnutrition, poverty and short life expectancy (Lipton 1975, 1977, 1993; Bezemer and Headey 2008).

Urban bias theory can account for many water problems in China. As I will show throughout the dissertation, the Chinese governments, at both central and local levels, have wholeheartedly embraced urbanization and regarded it as the synonym of development. With such a strong preference for urban expansion, urban and industrial sectors are given priority when the governments are allocating resources.

One limitation of the theory is that it oversimplifies the role of the state in policy making, and fails to see that some national governments at certain times are also concerned with food security, food sovereignty, and protection of small rural producers. The debates over the existence of rural-bias policy, that is, state policy favors rural areas over the city, reveal the complicated role of the state in policy making (Varshney 1993). In addition, the governments of some East Asian societies such as Japan, South Korea and Taiwan

implemented policies that were much less urban biased and even pro-rural as compared with many countries in Africa and Latin America (Ho 1978; Wade 1990; Moore 1993; Mao and Chi 1995; Francks, Boestel and Kim 1999). As far as China is concerned, food security and food sovereignty pursued through food self-sufficiency, has also been an important goal of the Chinese state, particularly at the central level. This goal has periodically forced the state's attention back to the agricultural water system as we can see from the pro-rural and pro-irrigation policies issued by the central government in the recent decade.

1.3 Irrigation Expansion and the Neoliberal Shift

The literature review reveals the complex interactions between factors at various levels. At the global level, the shift to neoliberalism has reduced agricultural water investment and slowed irrigation expansion while the expansion of capitalism worldwide would undermine agricultural water systems that serve small farms and peasant communities. At the national level, the state plays a very important role by distributing resources between agricultural water and urban-industrial sectors. At the local and community levels, community organizations and market mechanisms will shape individual actors' interest and capability in coping with agricultural water problems. Therefore, it is an enormous task to capture the complex process of agricultural water development. This section introduces Chinese experiences in agricultural water development as it shifted from the developmentalist to the neoliberal era.

The evolution of the agricultural water system in China has been closely associated with

political change. After taking national power in 1949, the Chinese Communist Party made great effort to build irrigation infrastructure. By 1978, 41 million hectares of farmland were irrigated in China, more than three times that in 1952 (Bramall 2000: 136-8; Gu eds 1999: 7; Chapter 2). The irrigation expansion in the Mao period possessed the features of a developmentalist era when the state greatly invested in water projects. Furthermore, the US-led embargo forced China to rely on domestic production for food supply (Friedmann 1982; Perkins 1969; Yan, Chen and Ku 2016). Facing a rapidly growing population, the country had no option but to improve its agricultural water system as a main means to increase grain production. It was so fixated on grain production that it restricted peasants to divert land and other resources to non-grain crops (Friedman, Pickowicz and Selden 1991).

Although the Chinese state was a major factor in the expansion of water infrastructure, other factors must not be overlooked. First of all, community organizations played an important role. In the Mao period, the Chinese state extended formal administration down to the village level, and established collective grassroots organizations such as production teams, brigades and communes (Schurmann 1968). Under the collective system, these community organizations were very effective in mobilizing rural laborers and households to construct and maintain irrigation projects during the slack winter period (Bramall 2000: 137; Nickum 1978). This demonstrates that community organizations can be more effective if they are sanctioned, coordinated and supported by the state. The Chinese state mobilized human and material resources across communities, and coordinated hundreds of community organizations to work together on large irrigation projects, which could not

be done by any individual community organization alone. The effectiveness of the state-community partnership in economic development was also observed in other societies, particularly in East Asia (1997b; Ostrom 1992).

China also pursued industrialization in this developmentalist era, particularly the creation and expansion of heavy industries, in an attempt to catch up with developed countries. Without access to sufficient foreign capital, the Chinese state chose to transfer agricultural surplus to finance urban industry through “price scissors,” a policy which suppressed the prices of agricultural goods and undermined agricultural development and rural livelihoods (Oi 1993). This contradiction in Maoist policies stemmed from different development goals. On the one hand, the country desired to pursue industrialization. The motivation came from both developmentalist ideology and a competitive global capitalist system. Chinese elites believed that, to survive and compete in the system, the country must develop itself through industrialization (Bo 1991: 280-281). This goal entailed the concentration of resources in industrial sectors. On the other hand, however, the country must feed a vast and rapidly growing population; otherwise it would lead to disasters and shake the legitimacy of the rule, as seen in the famine following the Great Leap Forward (Bramall 2008: 118-141). The security of food supply requires allocating resources to agricultural production, particularly grain production. The tension between the goal of industrialization and food security had thus shaped Maoist policy and pulled it toward opposite directions.

In the developmentalist era, the Maoist state was nearly in total control of the economy.

Thus it could to some extent balance these two contradictory goals. With regard to agricultural water, it devoted a significant share of public expenditure to agricultural water and managed to construct a large number of irrigation facilities by mobilizing both state and community resources (Fan, Zhang and Zhang 2004; Nolan and White 1984).

However, after the shift to the market economy in the neoliberal era, the central government had withdrawn itself from much of irrigation investment in the 1980s (Qian and Ma 2009). The expenditure on the agricultural water system was cut in half in the 1980s (NBS 2009: 74). This had led to the breakdown of irrigation facilities and exerted a negative effect on agricultural production (MOWR 2008). The central government increased irrigation investment from 5.02 billion yuan in 1991 to 25.88 billion yuan in 1997 (NBS 2009: 74). However, the increase was modest at most as compared with the overall increase in infrastructure investment in the 1990s, a period when China started a high wave of fixed assets investment in coastal regions and large cities (NBS 2009: 74). Many scholars argued that the decline in state support had been a key factor causing agricultural water problems in the 1980s and 1990s (Muldavin 1997; Fan, Zhang and Zhan 2004; Bramall 2008: 341).

However, the issue of food security did not go away. Without sufficient investments and efforts, the agricultural water system started to experience more and more problems in the 1990s. Frequent natural disasters such as floods and droughts inflicted damages on farmland and infrastructure, culminating in disastrous summer floods in 1998. These events had forced the Chinese state to further increase investment in the agricultural

water system, particularly after 1998 (Gu eds 1999: 8-9). In the meantime, the pursuit of urban-industrial growth in the 1990s had severely undermined agricultural production, leading to the emergence of a rural crisis in the late 1990s and early 2000s (Li 2008). Grain production fell and the strategic grain reserve was depleted in the initial years of the new century, prompting the central government to take immediate actions (Fan, Zhang and Zhang 2004).

To boost grain production, the Chinese state has devoted ever more resources to the agricultural water system after 1998, and the share of irrigation in total infrastructure investment has approached that in the Mao period in recent years. However, the social, economic and institutional contexts in the neoliberal era have been vastly different from those in the developmentalist era, that is, the Mao period. While the central government in the Mao period could mobilize human and material resources down to the village level through the centralized bureaucracy and the planning system, it was no longer possible in the recent decades due to the rise of neoliberal principles centering on the market and profits in the past four decades. The next section will construct an analytical framework to understand this new situation.

1.4 Profitability and Food Security: Structural Dilemma in the Neoliberal Era

The neoliberal shift coincided with the market reform in China, which replaced collective farming with household farming. Although farmland is still collectively owned in a village, its use rights are distributed to individual households. The market has become a main rule governing households' resource allocation. In general, rural households tend to

allocate resources to economic activities that yield greater returns in the market (Luo and He 2004; Luo 2006a). Another significant change along with the neoliberal shift was the decentralization of the state, which gave much more freedom to local governments in making economic decisions. Jean Oi (1999) used “local state corporatism” to characterize the behavior of Chinese local governments which tend to maximize local revenue by supporting and promoting profitable economic activities such as rural industry.

In short, as China has shifted to a market economy in the neoliberal era, a main principle that determines farmers’ behavior, private investors and local policy is economic returns. For farmers and rural laborers, it is household income; for private investors, it is profit; for the governments, it is revenue. I use the concept “profitability” to capture all three. Profitability refers to a principle that actors and organizations tend to choose or support sectors and economic activities that could generate greater economic returns. This principle is contextually based, and one kind of economic activity or sector would be highly profitable in one context but not in another. For instance, grain farming is not profitable in many southern provinces but is profitable in some northern provinces where the size of landholding is relatively large. The profitability principle is often at odds with the goal of food security because agricultural production in many cases is less remunerative than nonfarm activities. As a result, local actors including local governments tend to allocate resources and efforts to nonfarm sectors rather than invest in agricultural water, and this is particularly so in coastal and southern provinces where urban and industrial sectors are developed.

However, as a country that depends very much on irrigation for agricultural production, it must keep the agricultural water system functioning well to meet the growing food demand. The contradiction between profitability and food security thus constitutes the structural dilemma of agricultural water in the neoliberal era.

The issue of food security is of crucial importance not only because it serves to reproduce the capitalist social order but also because it has much to do with the nature of state power. Scholars argued that the logic of state power is different from that of capital, though the two are interrelated. While the goal of capital is profit maximization and capital accumulation, the state pursues power and status in the international state system, and seeks to control home territories and populations, that is, to maintain internal rule and order (Arrighi 1994; Arrighi and Beverly 2001; Skocpol 1979: 22). In the case of China, food security serves both goals. Food security allows the country to maintain food sovereignty and exercise more power in the state system. In addition, sufficient food supply can maintain social stability and legitimize the rule of the state.

The contradiction between profitability and the legitimacy of the state has also been discussed in the scholarship. For example, in examining mounting labor unrest in China, Ching Kwan Lee argued that Chinese political economy in the reform period was beset by the contradiction between profitability and legitimation (2007: 18-19). Economic growth resulted in intensified inequality and social dislocation that undermine regime legitimacy. To counter the trend, the state had to maintain basic livelihood protection for the unemployed and the poor.

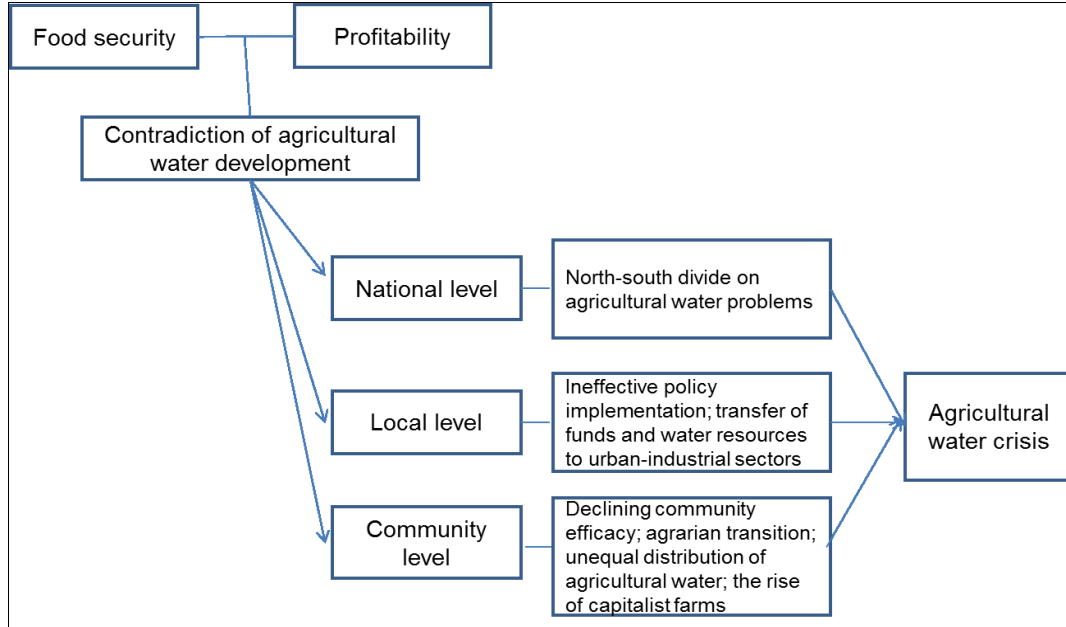
This dissertation frames the agricultural water crisis in a similar fashion. It argues that the crisis and the measures taken to tackle it derive from the structural dilemma characterized by the contradiction between profitability and food security. The contradiction plays out most acutely at the center since the central government represents state power in the international state system and is concerned about regime legitimacy. As noted above, the central government has been shifting its stance on agricultural water. In the 1980s, it reduced irrigation investment substantially but was forced to increase it thereafter due to the gravity of emerging water problems. However, the increase in irrigation investment has not mitigated the contradiction effectively. Rather, it reinforces the South-North divide of agricultural water problems in China. As Chapter 3 will reveal, with the assistance of central funds, northern provinces have expanded irrigated area and increased grain production considerably, but this has exacerbated the problem of groundwater over-extraction and accelerated the depletion of aquifers. In the south, however, the arrival of central funds, as generous as they are, is unable to dampen the enthusiastic embrace of provincial and local governments for urban and industrial growth. As a result, increased irrigation investment might have slowed the breakdown of irrigation facilities in the south, but it has not reversed the declining trend of the agricultural water system.

As local governments prioritize profitability over food security, the central government has to make efforts to bring them into the line through bureaucratic orders, market interventions, and material and non-material incentives. The intervention of the central government has been more successful in the north than in the south with regard to

shoring up grain production. This is because many northern regions depend on agriculture and central funds for a substantial proportion of local income and revenue. In recent years, however, many northern regions have also started to push for the expansion of industrial and urban sectors. Chapter 4 will reveal how central-local relations have affected the implementation of central policies.

At the community level, the agricultural water system is affected by agrarian transition from household farming to capitalist farming, which in many cases has sharpened the contradiction between food security and profitability. The transition undermines the capability of rural communities to take collective action, and farmers are often left on their own to solve water problems. Large capitalist farms are much more capable than small farmers in gaining access to agricultural water, thus these farms would win out in competition for agricultural water in the future. In addition, the rural economy has been increasingly diversified. Rural laborers not only work in agriculture but also engage in non-farm activities. Millions of rural laborers have migrated out of the countryside into the city in search of employment and business opportunities. Chapters 5 and 6 will examine the contradiction and its impact on agriculture water development at the community level based on empirical case studies. Figure 1-2 illustrates how the contradiction has affected actors at the three levels and contributed to the emerging agricultural water crisis in China.

Figure 1-2 The contradiction of agricultural water development in China



Based on the above analyses, this dissertation proposes three theses.

First, the agricultural water crisis in China in the neoliberal era has its roots in the capitalist logic of profit maximization. To achieve higher rates of profit, state and non-state actors in China tend to allocate human and material resources to sectors and activities that would generate greater economic returns, while neglecting the long-term sustainability of the agricultural water system. In south China where the economy is most industrialized and urbanized, it has led to the breakdown of irrigation facilities. In north China, the pursuit of profitability has led to the intensification of grain production and the over-extraction of groundwater.

Second, although the concern over food security increased government funding in

agricultural water, it has also facilitated the geographical movement of grain production from South to North, which exacerbates the mismatch between water resources and grain production. In addition, the concern over food security has led to the governments supporting large farms based on a belief that these farms are more efficient in producing grains.

Finally, capitalist transformation and social differentiation in the countryside have undermined the capability of rural communities to take collective action to solve water problems. Although the newly arisen large farms are able to invest more resources in agricultural water, their behavior is also based on profitability rather than the health of the agricultural water system. The case study in the north shows that profit-oriented large farms are most aggressive in extracting groundwater. In addition, the differentiation of the rural society has made the distribution of water resources increasingly unequal, favoring agribusiness and large farms over common farming households.

1.5 Methodology, Data Collection and Organization of the Dissertation

This study employs a multilevel analysis and the relational-comparative method to guide data collection and analysis. It has investigated the nature of the agricultural water crisis and the measures taken to tackle it at three levels: central, local and community (village). At the central level, it examines central policy changes on the agricultural water system before and after the neoliberal shift. At the local level, it focuses on the county government. As policy implementer and local policy maker, the county government can best represent local state interests, and its decision making will directly affect the

agricultural water system. The community/village level involves multiple actors, including official village organizations, informal social and economic groups, rural households and agribusiness companies.

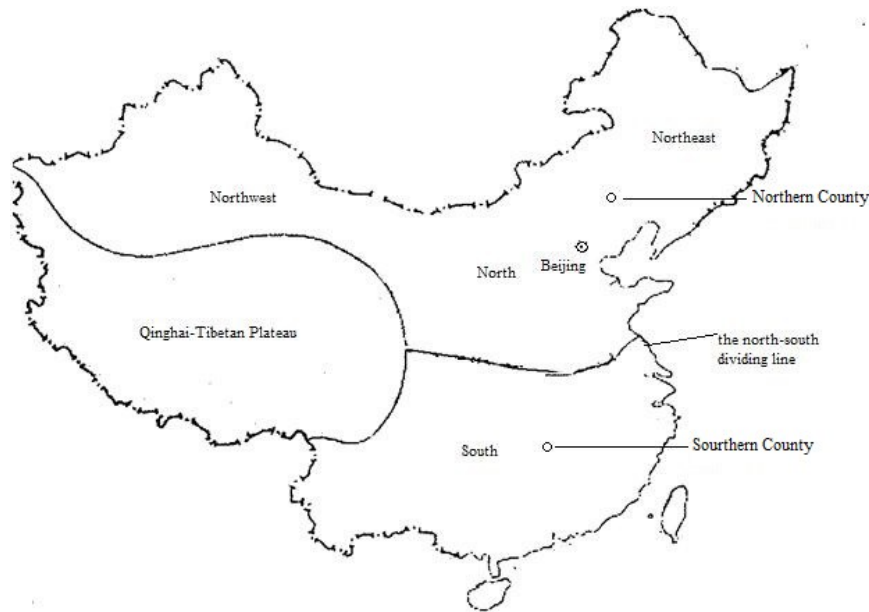
In addition, this study carried out two comparisons. One comparison is to compare two county cases—one county is located in the south of China and the other in the north. The relational-comparative method is similar to Charles Tilly's categorization of "encompassing comparison" (1984: 81-84), but it pays more attention to the variation between cases than the latter. The relational-comparative method sees the cases being compared not as independent units, as the conventional comparative approach does, but as interdependent units, in which the changes in one case will affect others within the same system. The relational comparison aims to find variations between the southern county and the northern one, and to examine the linkages between them in the agricultural water system. The case study method is also used to examine policy implementation at the local levels, the changes in local policies, the roles of villages, households and agribusiness companies. In addition, it compares the agricultural water system with the rural road system, both of which belong to rural infrastructure. The water system mainly serves agriculture while roads are related more closely to nonagricultural activities. The comparison reveals the differences in local efforts devoted to agricultural water and roads.

Case selection

Of the two county cases, the southern county is located in Hunan Province and the

northern county in Inner Mongolia. They are pseudonymized as Southern County and Northern County respectively. Figure 1-3 shows their approximate locations.

Figure 1-3 Locations of the two counties



The two counties represent two common systems of agriculture as well as reflect the South-North divide in the agricultural water system. Southern County, with a population of 1.38 million, represents many parts of south China in terms of agricultural production: farm size is small, with only 0.07 ha. per person; farmers grow water-loving crops such as rice and irrigate farms mainly with surface water. Flood control is a very important task for the water system. In addition, Southern County has experienced rapid industrialization and urbanization since the 1990s. Partly as a result, local efforts on the agricultural water system has been undercut, leading to the collapse of dams, the silting up of canals and the breakdown of pumping stations, while at the same time an increasing amount of land and water has been transferred to its booming urban-industrial sectors.

By contrast, Northern County, with a population of 600,000, represents many regions in north China, where farm size is relatively large, 0.4 ha. per person. Farmers grow drought-resistant crops and rely on groundwater for irrigation. In Northern County, industrial and urban sectors are less developed than those in Southern County, and agriculture still accounts for a significant share of the local economy. Local actors have intensified efforts to withdraw groundwater for agricultural production, and consequently grain output has been increased in the last two decades. The over-pumping of water from underground exacerbated water shortage problem and created a chronic water crisis.

In each county, I selected a few villages for community-level investigation. The selection was aimed to diversify the factors at the village level, such as per capita land holding, accessibility to water, the quality of irrigation facilities, distance to the nearest city, etc. (more details in Chapters 5 and 6).

Data collection

Archival research and semi-structured interviews were employed to gather data.

For the central level, I collected national policies and statistical data for both the Mao era and post-reform era in order to determine the causes and extent of the agricultural water crisis. The policies and statistics examined include those on public spending, taxation, water project funds, irrigated area, water management, and economic development in general.

For the county-level investigation, I combined archival research and in-depth interviews in data collection. I collected local policy documents and gazetteers from local government agencies. I also interviewed local officials at both county- and township levels. In Southern County, I have interviewed 32 local officials either in groups or individually. In Northern County, I have conducted 20 such interviews. These officials came from various government agencies, including the Bureau of Agriculture, the Bureau of Water Resources, the Bureau of Transportation, the Bureau of Finance and the Committee of Development and Reform. The interviews with local officials provided rich information on policy implementation, local policy priorities and officials' personal experiences and opinions.

In each village, I interviewed village officials for the information on irrigation facilities, water management, roads, agricultural production, non-agricultural activities and the changes over time. In addition, I selected 20 to 30 households for in-depth, semi-structured interviews. In total I conducted 201 interviews, 102 in Southern County and 99 in Northern County.

Organization of the dissertation

In addition to the introduction and conclusion, this dissertation comprises five chapters. Chapter 2 examines the expansion of the agricultural water system in the Mao period. It explains how the contradiction between the developmentalist project (industrialization) and food security were solved by mobilizing millions of rural labor for water projects. However, the success was achieved at heavy cost, that is, rural populations were subject

to the domination of the collective system and were forced to take part in these projects under the condition of food shortage and malnutrition while rural surplus was extracted and invested in urban and industrial sectors.

Chapter 3 examines the mismatch between water resources and grain production in the post-reform period. The industrial and urban expansion in the south pushed grain production to the north while the central government promoted grain production in the north due to the concern for food security. As a result, the water-scarce north started to export surplus grain to the water-rich south, reversing the centuries-old trend. Chapter 4 focuses on politics of water investment in the light of central-local relations. It reveals that, although the central government has greatly increased water investments in this century, the effects of the investment were diluted due to the actions of local government.

Chapters 5 and 6 move down to the sub-county level and examine the impacts of rural transformations on the behavior of peasants and private investors in agricultural water use. Chapter 5 uses the southern case to illustrate how social differentiation of the rural society, the diversification of the rural economy in particular, has rendered villages unable to take collective actions on water management. Chapter 6 assesses the impact of intensified grain production and groundwater extraction on the environment in Northern County, and examines rising water demand from industrial and urban sectors. It shows that access to water is a crucial factor in social differentiation, and vice versa. Large farms and agribusiness companies are in a more advantageous position of controlling water, whereas small farmers tend to lose out and have to seek employment elsewhere.

Chapter 2 The Water-Food Nexus in the Mao Era

Water control had been one of the most important tasks in imperial China (Wang and Hu 2011:99; Zhang 2007:80; Wang & Zhang 1990:10-15). The country is home to a great number of rivers, of which more than 5,000 are relatively large, with a watershed area (including attached lakes, streams, etc.) more than 100 square km (Wang & Zhang 1990:5-7). These rivers frequently flooded, often causing serious famine. Thus authorities and society were prompted to take actions to control and manage water. And these actions had in turn shaped social, political and economic institutions in the Chinese history.

This chapter focuses on the water-food nexus in the Mao period (1949-1978). After offering a brief account of water control in the imperial history, the chapter will detail how China in the Mao period greatly expanded the irrigation capacity of its water system. The primary motivation for this expansion was the need to feed a large yet growing population. However, it was Maoist political institutions and rural collective organizations that made the expansion possible. In addition, the large-scale mobilization of rural laborers through collective organizations partly solved the contradiction in resource allocation to competing sectors: either to urban industry or to the agricultural water system.

2.1 Water Control in Imperial China and its Decline in the late Qing and Republican Era

The popular legend of *Yu the Great* traces water control in China to over 4,000 years ago. *Yu the Great*, was a legendary ruler in ancient China and was famous for using drainage to control flood. His success lifted him to be the first ruler of the Xia dynasty, the very first dynasty recorded in Chinese history. Imperial China was an agrarian society vulnerable to frequent water-related disasters such as floods and droughts. Between 206 BC and 1949, there were 1,029 severe floods and 1,056 severe droughts in the 2,155 years, approximately a severe disaster every year on average (Zhu and Zhao 2002:16). To control floods and harness water resources, China built a number of impressive large-scale water projects. One of these is the *Dujiangyan* irrigation system located in Sichuan Province in western China, which was constructed circa 256 BC for the purpose of flood control and irrigation. The irrigation system is still in use today and can irrigate more than 10 million *mu* of arable land (Gu, eds. 1999:38; Wang & Zhang 1990:18-19; Zhang 2007:80).

The success in water control allowed China to achieve relatively high levels of agricultural productivity even prior to the onset of agricultural modernization (Perkins 1969; Wang and Zhang 1990: 28-32). In addition, water control profoundly shaped and was shaped by bureaucratic and social organizations in China. Karl Wittfogel (1957: 18-22, 165) called imperial China a “hydraulic society.” He argued that the construction and maintenance of large-scale water works required an enormous labor force, and the need for a comprehensive organization of labor and other resources often resulted in despotic forms of central state control with total power. Wittfogel’s sweeping claim on the association between the hydraulic society and despotism has been disputed by scholars

(Geertz 1981; Lansing 1991; Perdue 1982; Will 1985). In the case of China, Will (1985) found that the development of hydraulic infrastructure in Hubei Province fell beyond the Wittfogelian model of oriental despotism. He proposed a cyclical pattern instead: development-(crisis)-recession, or phase A to phase B, and argued that the central state's power for action on water control was rather limited, particularly so during the Phase B of maintenance period after the active (re)construction at the beginning of Phase A led by the state. The local and private interests got more involved in water control than suggested, and he critiqued Wittfogel for only focusing on the centralized hydraulic system. Peter Perdue (1982) also showed that important irrigation projects were often carried out by rural elites at the local level from his research of the Dongting Lake in Hunan Province. These local elites, rural gentry members in particular, took a prominent role in raising money, mobilizing and coordinating labor for the construction and maintenance of water projects, sometimes in conflict with central state's interests. Will (1985) and Perdue's (1982) critique of Wittfogel has drawn attention to the significant roles of local government and private investors, which I will also emphasize throughout this dissertation.

While Wittfogel's grand thesis undoubtedly simplified and exaggerated the connection between water control and political structures in China, it is evident that Chinese dynastic cycles had been closely associated with the expansion and breakdown of the system of water control (Wang & Zhang 1990:10-21). Irrigation led to population growth. This population was then dependent on the irrigation system and vulnerable to water shortages when this system deteriorated or failed to deliver the amount of water it required. When

the imperial state was unable to maintain the system of water control, floods and other water-related disasters would lead to food shortages and famines, giving rise to rebellions from below, which would eventually contribute to the downfall of the dynasty. The rulers of a new dynasty took great effort to improve the system of water control and improve irrigation conditions, leading to agricultural development and a new cycle of economic prosperity. Chi (1936) showed that the prosperity and importance of an economic region in China had been highly correlated with irrigation development. In addition, the ruling elites in China were often those who were able to control the regions where irrigation conditions were the best. The Chinese history witnessed impressive development spurts of water system in these three periods respectively: Qin and Han dynasties (221BC-220), Sui and Tang dynasties (581-907), and Yuan, Ming and Qing dynasties (1271-1911), which were the three most prosperous periods prior to the onset of modernization in the 19th century, characterized by economic growth and population boom (Qian and Ma 2009:23).⁵

Paradoxically, the onset of modernization in China in the 19th century was concurrent with another dynastic decline, which was associated with the breakdown of water facilities. Starting from the mid-19th century, the Qing dynasty's water system gradually

⁵ There were similar cases in other parts of the world. Postel (1999:18) wrote: "We can only partially know the appropriate lessons to draw from the Akkadian demise. One overarching message is that a thriving, integrated, resourceful society can collapse abruptly from a cascade of ecological events. The irrigated agriculture that enabled this empire to expand well beyond anything previously known also became a source of vulnerability under the strains of population pressures and water shortages induced by abrupt climatic change."

declined, and was even severely damaged in some regions due to the negligence of the central state. Political corruption and fiscal deficiency inside the state apparatus, peasant rebellions from below and military invasion from outside, jointly led to this inability of the Qing empire. Although the encounter with the West brought new technologies, this did not prevent the water system from further declining (YRCC 1982: 319–365; Wang & Zhang 1990: 450-451; IWHR 1989: 256,390).

During the late Qing Dynasty and Republican Era (1911-1949), the works of large rivers such as the Yellow River, the Yangtze River, the Huai River and the Pearl River, which are the backbone of the Chinese water system, experienced significant decline due to a lack of proper maintenance from the state and non-state actors (IWHR 1989: 390). Take the Yellow River, which is called the mother river of China, as an example. The lower part of the Yellow River was one of the most flooded areas during the late Qing and the Republican Era (IWHR 1989: 392). In the last sixty years of the Qing dynasty (1851-1911), there were 32 years when the Yellow River embankment experienced serious collapses (*juekou*), often in multiple places (YRCC 1982: 358-365). The poor maintenance of river infrastructure reduced its capacity to fight floods and irrigate farmland, lowered agricultural productivity, and caused severe hunger in multiple regions (IWHR 1989: 262-265).

In the Republican period, negligence, civil wars and the Sino-Japanese War jointly exacerbated the conditions of agricultural water systems. In the 38 years of 1911-49, the Yellow River suffered serious embankment collapses in 17 years, leading to widespread

hunger and outmigration in the affected regions (YRCC 1982: 370,378). For example, the collapse in 1929 displaced more than 34 million people, the highest record in the past three centuries (YRCC 1982: 389). The Yangtze River, the longest river in China, was also in a dire situation. There were many lakes associated with the river, including the Dongting Lake, a very large lake in Hunan Province. However, due to enclosure for farmland and a lack of proper maintenance and management, the storage capacity of these lakes and their capacity of flood control were greatly reduced. For instance, the Dongting lake region experienced a serious flood every 83 years before the Ming dynasty, once every 20 years in the Ming and Qing dynasties, and once every 5 years during the Republican era (IWHR 1989: 274).

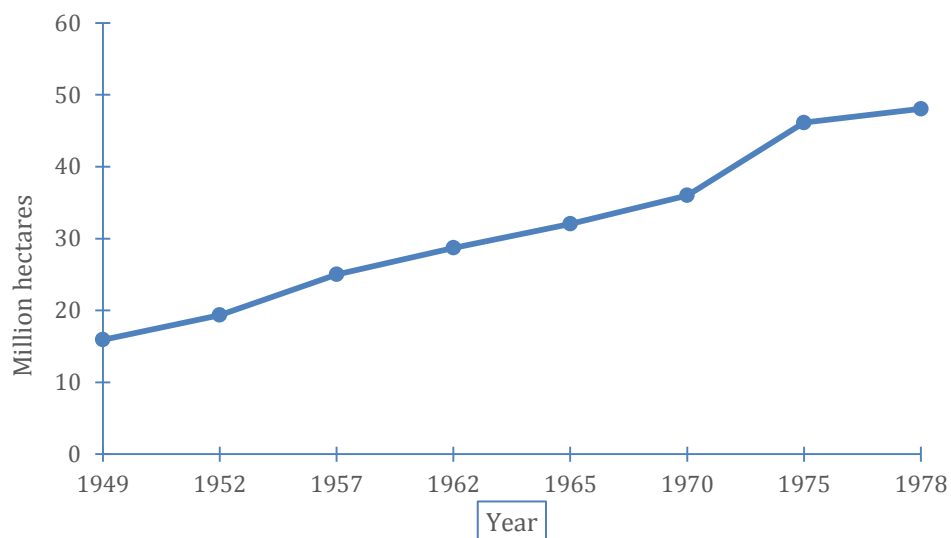
In sum, the water system underwent a secular decline in the late Qing. By 1949 when the CCP took over national power, the water control system was fraught with serious problems and unable to mitigate the impact of natural disasters effectively, and irrigation capacity was also extremely limited.

2.2 Water Control and Irrigation Expansion (1949-1978)

In 1949, the effective irrigated area in China was 15.93 million *ha.*, only 16.3 percent of the total farmland nationwide (MOWR 1990: 633). The communist state took no respite and started immediately to rebuild the national water system. This commitment to water control and irrigation was in line with traditional practices in imperial times, as noted above. It was also due to the pressing need to recover agriculture production to feed China's growing population and to develop the national economy (Wang 2012: 5-6).

China in the Mao period achieved a great success in rebuilding and improving its agricultural water system. It outpaced many other developing countries with regard to irrigation expansion in this period. In addition, the country built irrigation works mainly through its own efforts since it was unable to receive the aid from Western countries in the Cold War period (Bramall 2009: 221-222). Between 1949 and 1978, the country completed more than 50,000 large-scale water projects including 311 large reservoirs, and 20 million small-scale irrigation works, and established 5,600 large irrigated zones (MOF 2007; Gu, eds. 1999: 19). The effective irrigated area tripled, up from 15.93 million ha. in 1949 to 48.05 million ha. in 1978 (Figure 2-1).⁶

Figure 2-1 The expansion of effective irrigated area: 1949-1978⁷



⁶ The numbers on irrigated area vary in different sources, but all sources pointed to the rapid expansion. Naughton (2007: 259) shows that the irrigated area had increased from less than 17 million hectares (255 million mu) in 1952 to around 38 million hectares (around 570 million mu) in 1978; *China Statistical Yearbook* (NBS 1992: 343) shows that the irrigated land was 299 million mu in 1952 and 674 million mu in 1978; Bramall (2009:225) shows that the irrigated area was only 200.4 million mu in 1952 and increased to 614.2 million mu in 1978.

⁷ Data source: MOWR 1990 (633). The data for the year of 1970 was derived from China Compendium of Statistics 1949-2008 (NBS 2010).

The expansion of the agricultural water system in the Mao period can be divided into three phases, punctuated by the Great Leap Forward and the Cultural Revolution. Unlike many other policies, Maoist policies on water control and irrigation were highly consistent, characterized by the unwavering commitment to strengthening the water system to mitigate the impact of natural disasters and expand the nation's capacity of irrigation and water control.

The first phase (1949-1957)

The first phase included the three years of economic recovery (1949-1952) and the First Five-Year Plan period (1952-1957). In October 1949, China established the Ministry of Water Resources as the national authority of water control and management, and held the first national meeting on irrigation in Beijing in November of the same year, which set an agenda prioritizing flood control and irrigation water provision for agriculture (Luo 2011; Wang and Hu 2011:105-106). Efforts were focused on major rivers and lakes, and the goal was to quickly restore the capacity of water control and irrigation. Major measures included repairing the embankments of large rivers, building large and medium-size irrigation projects along these rivers, and mobilizing peasants for small irrigation projects (MOWR 1999: 26).

The first priority was to improve the conditions of major rivers such as the Yellow River, the Yangtze River, the Huai River and the Hai River (Gu eds. 1999: 143; Wang and Hu 2011:106). Take the Huai River, which is located between the Yellow River and the Yangtze River, as an example. The river is approximately 1,000 km in length and covers

an area of around 190,000 square km. It runs through five provinces from west to east: Hubei, Henan, Shandong, Anhui and Jiangsu. The river is historically vulnerable to flooding.⁸ In 1950, the Huai River suffered a devastating embankment collapse, which caught Mao's attention, and he subsequently called for a major action to improve the conditions of the river. The project on the Huai river was the first one that Communist China undertook to deal with the problems of a major river comprehensively. It took six years to complete the project, with more than 2,840 km of embankment repaired or rebuilt, along with many other measures (MOWR 1956:26-30). The Yangtze River and the Yellow River received similar attention in the same period. About 3,160 km of embankment was repaired or rebuilt for the Yangtze River and 1,820 km for the Yellow River (MOWR 1956: 16, 50).

In addition, a number of projects were constructed to harness water for agricultural use from these major rivers, their branch rivers and attached lakes. The country built more than 100 large and medium-size reservoirs and many other major water projects in the 1950s (Gu eds. 1999: 143). For example, a large canal was built to divert water from the Yellow River to the Wei River (later called the People's Victory Canal) in Henan Province in 1951-1953. This increased irrigated area by 39,000 hectares, doubling the wheat production and producing extra 50 million kilograms of grains in the region (MOWR 1956: 18-19, 59).

⁸ See the official website of the Huai River Water Resources Commission:
<http://www.hrc.gov.cn/detail?model=00000000000000006575&documentid=13486>

The Chinese state also encouraged rural communities and peasants to build and improve small irrigation facilities (Wang 2012: 8; MOWR 1999:10-11). These include ponds, small dams, small reservoirs, canals and dikes in the south, and canals, wells and water wheels in the north. The government provided financial and technical support for peasants to build these irrigation projects. A useful practice that echoed other Maoist policies was that the state dispatched technicians and water engineers to the countryside to build demonstration projects and hold training programs for many peasants so that they could later work on the projects on their own. In the winter of 1954 alone, for instance, seven provinces including Sichuan and Zhejiang trained more than 48,000 peasant technicians through constructing demonstration irrigation projects (MOWR 1956: 57).

As a result of these efforts, the capacity of the water system to mitigate water-related disasters was greatly enhanced and irrigated area was expanding at an annual rate of eight percent. The total irrigated area increased from around 15.93 million *ha.* in 1949 to 19.34 million *ha* in 1952, and further increased to 25 million *ha.* in 1957 (MOWR 1990:633).⁹

The second phase (1958-1965)

The second phase started with the Great Leap Forward and saw a great expansion of the agricultural water system. The majority of China's large and medium-size dams and reservoirs and large irrigation zones that exist today were planned, started to be built or completed during this period, along with millions of small irrigation projects (MOWR

⁹ According to Bramall (2000:136-138), irrigated area increased from 200.5 million mu (13.37 million ha.) in 1952 to 296 million mu (19.73 million ha.) in 1957.

1999: 13, 27). The construction of two large reservoirs in my two research sites, one in each site, were both started in 1958 and finished in 1965.

In October 1957, China issued a Twelve-year (1956-1967) National Agricultural Plan (*quanguo nongye fazhan gangyao*),¹⁰ which called to focus on building medium-size and small water projects with the contribution from rural collective organizations and households, while at the same time paying attention to large irrigation works (*Renminribao* 1957). Constructing these irrigation projects was stated as one of the reasons for the collectivization campaigns, which organized rural households into rural cooperatives and collectivized their assets including land. As I will show below, collectivization had a very positive effect on the construction and coordination of water projects (MOWR 1956: 66-67).

On September 24, 1957, the Chinese state called to mobilize rural laborers nationwide to construct irrigation projects for winter 1957 and spring 1958 (Wang 2012:55; Li 2010:113). It was estimated that rural laborers contributed more than 13 billion labor days in this winter-spring irrigation campaign alone, and they completed more than 25 billion cubic meters of earth stonework (Li 2010: 114). This large campaign on irrigation was the prelude to the Great Leap Forward, and was only the beginning of a series of winter and spring irrigation campaigns in the following years in the Mao period (Wu 2006:14; Wang 2008:123).

¹⁰ The first draft of this national agricultural plan was proposed in January 1956 and was revised in 1957. The plan was officially approved in April 1960. See: Zhang 2009:8; Eckstein 1975:20.

The state hoped to use collective organizations to mobilize rural labors to construct public infrastructures, particularly water projects in order to enhance agricultural productivity (Bramall 2009:213; Naughton 2007: 69). Collective organizations such as rural cooperatives, brigades and communes made mobilization of peasants and other resources much easier for the construction of water works (Ji 2016:20). During the second phase, more than 900 large and medium-sized reservoirs were built, and many important water projects were constructed along the large rivers such as the Hai, Liao, Pearl Rivers (Gu eds. 1999: 216). The total number of large and medium-sized reservoirs increased to 1,400 in 1965 from less than 20 in 1949 (USDA 1976). Irrigated area increased to 32.04 million *ha.* in 1965 from 25 million *ha.* in 1957 (MOWR 1990:633).

However, many irrigation works, particularly the large ones, were constructed hastily. As a result, some large projects were not completed, and some projects, though completed, were poorly planned and/or poorly built. Take the *Huayuankou* dam located in the lower part of the Yellow River as an example. The dam was aimed to divert water from the Yellow River for irrigation, but it was built without a proper drainage system. Thus it led to the widespread land salinization and alkalization in the region. In the end, the dam had to be removed (Gu eds. 1999:7, 129; MOWR 1999: 13). Due to the the famine in the wake of the Great Leap Forward, the government became cautious afterwards on starting new water works. The central state proposed to balance between large and small water works, between retaining and draining water, and between contributions by the government and by rural collectives. In 1961, the central state ordered to finish those incomplete works instead of building new ones and to build more auxiliary works and

facilities to make those existing water works function better (Zhang 2000:2; MOWR 1999: 14,27). With these measures, approximately 80 percent of large water projects were completed and improved with supporting and complementary facilities between 1962 and 1965. And this further improved the conditions for agricultural production. Between 1963 and 1965, irrigated area expanded even faster, with an annual increase of about 667,000 hectares (MOWR 1999:14).

The third phase (1966-1978)

A major feature of this phase was that water control and irrigation development nationwide were ordered to follow the “*Dazhai* model.” *Dazhai* (literally, big camp) was a brigade in Shanxi Province and made its fame for the heroic efforts to improve agricultural conditions, such as building terrace and irrigation canals. The *Dazhai* model in general emphasized collectivism, community self-reliance and hard work. With regard to agricultural water, it suggested that water control and irrigation development should focus on building small projects to serve rural communities, building complementary facilities for the existing large projects, and improving water management (Wang 2012:174).¹¹ As a result, the priority of water use changed gradually from flood control to a comprehensive use of water for agricultural production (Wang 2012: 175). This was a further correction to the policies that were implemented in the Great Leap Forward.

In addition, the priority that the Chinese state gave to the agricultural water system was reflected in state investment. The share of agricultural water infrastructure in total

¹¹ Premier Zhou Enlai called the country to “learn from *Dazhai* model in the agriculture sector” (nongye xue dazhai) for the first time in December 1964 in the Central Government’s Work Report (Wang 2012: 174).

infrastructure investment was 7.2 percent in 1966-70, 6.6 percent in 1971-75, and 6.7 percent in 1976-80. In contrast, the number fell to only 2.7 percent in 1981-85 (Xu 2007: 196). In the 1970s, the People's Communes were mobilized to construct auxiliary water works and small projects while at the same time there was heavy state involvement, which concentrated on the systematic management of the agricultural water system and invested in capital-intensive projects (Nickum 1978: 282). In the late 1970s, about 10 billion yuan was invested in agricultural water each year, more than many other sectors received at the time (Qian and Ma 2009:15).

The *Dazhai* model was premised on massive labor mobilization for water projects. Nickum (1978) estimated that the total number of laborers participated in the winter campaigns of farmland and water conservancy could be somewhere between 905 million and 1.05 billion between 1966 and 1977. And the average labor days that each laborer contributed were slightly over 30 days and in some cases 70 or even 100 days (Nickum 1978: 282). In the case of the Hai River, the Chinese state mobilized more than five million laborers from local communes to improve the river's conditions, with a total of more than 1.1 billion cubic meters' earth and stonework finished in 1966-1976 (Qian and Ma 2009:14-15).

The expansion of the agricultural water system significantly enhanced its capacity to mitigate the impacts of natural disasters. Xu (2007:186) found that the period from 1966 to 1979 were the years when China had borne the least impact from floods and droughts through 1960s to the end of 1980s. In 1965-1975, the Hai River, which was located in

North China, was maintained regularly and its capacity for flood control was increased multiple times. The number of newly built tube wells between 1966 and 1971 for 13 northern provinces was three times those built in 1949-1965. As a result, both irrigation capacity and agricultural productivity were increased in North China. The south made similar progress in water control and irrigation development (Xu 2007:182,188).

In sum, China's capacity of harnessing water for agriculture production greatly increased. In 1949, the total amount of water tapped in the countryside was 100 billion cubic meters. This number increased to 255 billion cubic meters in 1965 and to 390 billion cubic meters in 1980 (Xu 2007:180). The overall improvement of the agricultural water system increased the capacity of flood control, drought alleviation and grain production. Many regions in south China changed from single cropping to double cropping or even triple cropping. Some parts of North China started to grow rice for the first time due to the availability of water, which also expanded the sowing area for winter wheat and cotton (Gu eds. 1999:146).

2.3 Agricultural Water, Food Supply and Industrialization

The rapid expansion of the agricultural water system in the Mao period should be largely attributed to the Chinese state. The emphasis on water control and irrigation development directed state and non-state resources in a planned economic system to water sectors. The question is what motivated the Chinese state to do so. This section addresses the question by examining food supply and the strategy of industrialization, two factors that are central to my argument in this dissertation. It reveals that the Mao period was different

from the reform period in that it was under great pressure to supply food for a growing population, while the ambitious urban industrialization plans required the extraction of rural surplus at the same time.

Food supply

After years of wars' devastations, the Communist state had to take great effort to control and harness water in order to produce enough food for its population. This was similar to what imperial powers of China usually did at the beginning of each new dynasty. However, the task of the Communist state was arguably more challenging not only because it inherited a very large population base but also because the population was growing rapidly. Bramall (2009:213) argued that the Mao period was "in many respects a history of the search for solutions to this overriding problem" of feeding people. Eckstein (1975:19) also stated that "these twin factors of agrarian backwardness and demographic pressure have profoundly conditioned the character of China's economic development and its economic policies since 1949." In the initial years, China's food production capacity was low and a large population was at risk of starvation. In 1949, the total grain output was as low as 110 million metric tons with grain production per capita only 209 kilograms (NBS 1992:358; MOA 2009:14,17).

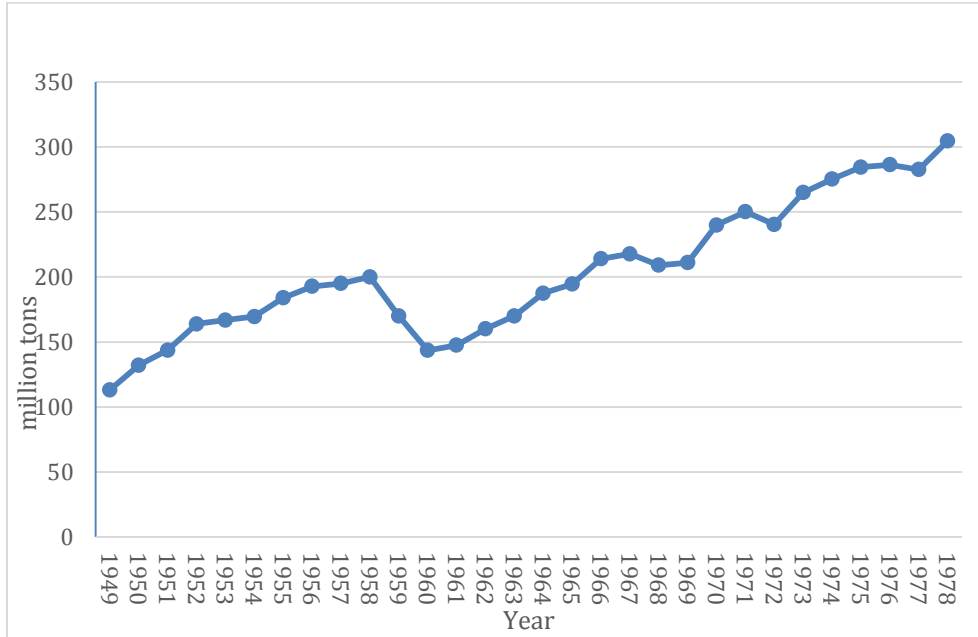
The rate of population growth was unprecedentedly high. Between 1949 and 1957, the population in China grew 2.2 percent a year and increased from 560 million to 647 million. By 1978, the population reached 963 million, almost doubled in 30 years (Bramall 2009:243; NBS 1992:77), even though efforts had been taken to control high

birth rates starting in the 1960s. Domestic stability and an improved public health system mainly accounted for this growth (Eckstein 1975:17). The rapidly growing population exerted great pressure on the Chinese state to increase grain production. In addition, China was prevented from access to the US food aid system due to US-led embargo against it after the Korea War on the one hand (Friedmann 1982); and on the other hand, the good relationship with Soviet Union broke in 1959 and the assistance from it was cut off. Thus China had to mainly rely on domestic production for food supply.

In addition to water control and irrigation, the Chinese state carried out land reform and then launched the collectivization campaigns, which exerted a significant impact on the agricultural water system, as I will detail in the next section. Furthermore, it took great effort to introduce modern industrial inputs such as chemical fertilizer and hybrid seeds in the 1960s and 1970s (Eckstein 1975:18-19).

The Mao period achieved significant success in grain production. Figure 2-2 shows that total grain production increased from 113 million metric tons in 1949 to 305 million metric tons in 1978 (NBS 1992: 358) and grain production per capita increased from 209 kilograms to 319 kilograms for the same period (MOA 2009: 14, 17). In other words, the growth of grain production had outpaced that of population growth. However, the population had not been completely shielded from the fear of food shortages since any fluctuation of grain production would push part of population back to hunger.

Figure 2-2 Total grain production: 1949-1978¹²



Industrialization

In addition to increasing grain production, China was also motivated to pursue industrialization and saw it as a synonym of economic development. This national strategy of prioritizing industrial development, which was adopted from the experience of the Soviet Union, was commonly practiced by other developing countries at the time. In addition, the strategy of industrialization grew out of concerns for national defense. In the context of the Cold War, China felt the threat from both the United States and the Soviet Union, and this led it to attach much importance to defense industry. This could be seen from the fact that China devoted resources to developing nuclear weapons in the 1960s even when its industrial sectors were still in a nascent state (Lin et al. 2003:31-32, 36).

¹² Data source: NBS 1992.

China was severely short of capital for its industrial projects, and heavy industry, which received priority, was capital intensive. The country was not able to access foreign capital or foreign markets due to the US-led embargo and its rupture with the Soviet Union. In addition, even though the Soviet Union provided assistance for China's industrial development in the 1950s, the assistance was far from sufficient. To acquire capital and raw materials for industrial development, Chinese state decided to extract surplus from agriculture and transfer it to industrial sectors and urban areas. The extraction was done through the so-called price scissors mechanism, which intentionally set prices of industrial goods high and agricultural products low (Ash 2006; Lin et al. 2003: 45, 50). Moreover, the state established a system of compulsory grain procurement, which required peasants to sell a large percentage of the grain they produced to the state at low, fixed prices (Naughton 2007:60). This grain procurement policy on the one hand provided food for the urban population and some raw materials for industrial production, and on the other hand served as "price scissors" suppressing the prices of agricultural goods in order to be able to keep urban wages low. The "price scissors" were practiced as early as 1953 and continued until the late 1970s. As a result of the strategy of industrialization, industrial output grew at an average annual rate of 11.5 percent between 1952 and 1978 while in the meantime the share of industry in GDP increased from 18 percent to 44 percent (Naughton 2007: 56).

The strategy of industrialization by extracting agricultural surplus to finance industrial sectors had mixed impacts on the agricultural water system. On the one hand, it made agriculture very important on the state's agenda because agriculture not only supplied

surplus for industrial sectors but also provided necessary food and raw materials such as grain and cotton. As the importance of agriculture increased, the agricultural water system also received much attention. The total investment in irrigation was 1.03 billion yuan for the three years from 1950-1952, accounting for 13 percent of the total infrastructure investment (Wang 2012: 7). In addition to large water projects, the Chinese state set up a fund in 1954 to support the construction and maintenance of small water works (Gu eds. 1999: 69). In general, the share of agricultural water in total infrastructure investment in the Mao period was around seven percent, much higher than those in the 1980s and 1990s, which was less than three percent on average (Fan, Zhang and Zhang 2004; Gu eds. 1999:55).

On the other hand, the strategy to prioritize industrial development allocated more resources to industrial sectors than to agriculture. The percentage of industry in infrastructure investment was more than 50 percent for most of the Mao period, whereas that of agriculture was around 10 percent (NBS 1992: 158). The fever for industrial development led to some disastrous outcomes as it extracted too many resources from agriculture. The Great Leap Forward is an example. In 1958-1960 the Chinese leaders reduced labor and land for direct agriculture production, and allocated them to industrial production (Naughton 2007: 70). This led to a significant fall in grain production, causing a widespread famine. Of course, we have to admit that the diversion of labor to dam construction was also a factor reducing the number of labor engaging in grain production at the time, along with other factors.

In addition, the price scissors that suppressed the prices of agricultural products did not provide economic incentives for peasants and rural communities to devote efforts to agriculture and irrigation. This problem was salient in the reform period as low profitability of agriculture has discouraged peasants from investing in agricultural water. However, during the Mao period the state mitigated this problem by mobilizing rural laborers for water projects through collective organizations in the countryside, as I will show below.

In summary, the need to feed a rapidly growing population and the strategy of transferring agricultural surplus to urban industry drew the attention of the Chinese state to the agricultural water system. However, the extraction of rural surplus diminished rural producers' incentive and reduced their efforts in irrigation. The Chinese state solved this contradiction by mobilizing rural laborers for irrigation projects through its bureaucracy and the collective system in the countryside. This is the issue to which I now turn.

2.4 Collective Organizations and Labor Mobilization

Although the share of agricultural water in total infrastructure investment remained high in the Mao period, the investment still fell far short of the need due to the fact that China was among the poorest countries in the world at the time with a very limited fiscal means. Furthermore, as noted earlier, the majority of financial resources were allocated to industrial sectors in an attempt to catch up with developed countries. Thus China simply could not devote sufficient financial resources to the agricultural water system. This section will show that, besides fiscal investments from the state, another main factor

contributing to the increasing capacity of water control and irrigation was the effective mobilization of rural laborers through the state bureaucracy and collective organizations.

Labor mobilization was employed in water control and infrastructure construction as soon as CCP took national power. In spring of 1950 alone, more than 5 million peasants were mobilized in the campaigns for water projects nationwide. In the three years from 1949 to 1952, a total of 3.36 million of small canals, dams and ponds were built or repaired by peasants (Wang 2012:20). The state institutionalized the practice afterwards. This was made possible by the establishment of collective organizations, through which the ideological indoctrination and bureaucratic control of the communist state was able to reach the village level.

By 1953, the land reform in the countryside was nearly completed, with each household receiving a farm plot on a relatively equal basis. However, individual households were difficult to mobilize, particularly for large projects. In 1955, the Chinese state started to first encourage and later force rural households to join rural cooperatives. By the end of 1956, more than 98 percent of rural households became members of these cooperatives (Naughton 2007:67; Lin et al. 2003:57). As a result, household assets such as land and farm tools were collectivized, and rural households depended on collective organizations for both work assignments and income. However, the agricultural cooperatives were still considered to be too small to take on large-scale public projects. In 1958, the state pushed these rural cooperatives to form even larger units of collective organization: the people's communes, which could consist of as many as 8,000 households (Lin et al. 2003:57). In

addition to the need for labor mobilization, the collectivization also derived from the belief that collective farming was more efficient than household farming. Eckstein (1975: 52) argues that the institutional transformation of agriculture, mainly collectivization, “would not only assure a greater degree of state control over farm income and farm produce but that it would also provide a prime means for increasing agricultural output”. Bramall (2009:230) argues that collective organizations in Mao’s Era enabled grain yields to approximately double between 1955 and 1981 through mobilizing labor to participate in agriculture production on a scale unprecedented in China or any other country.

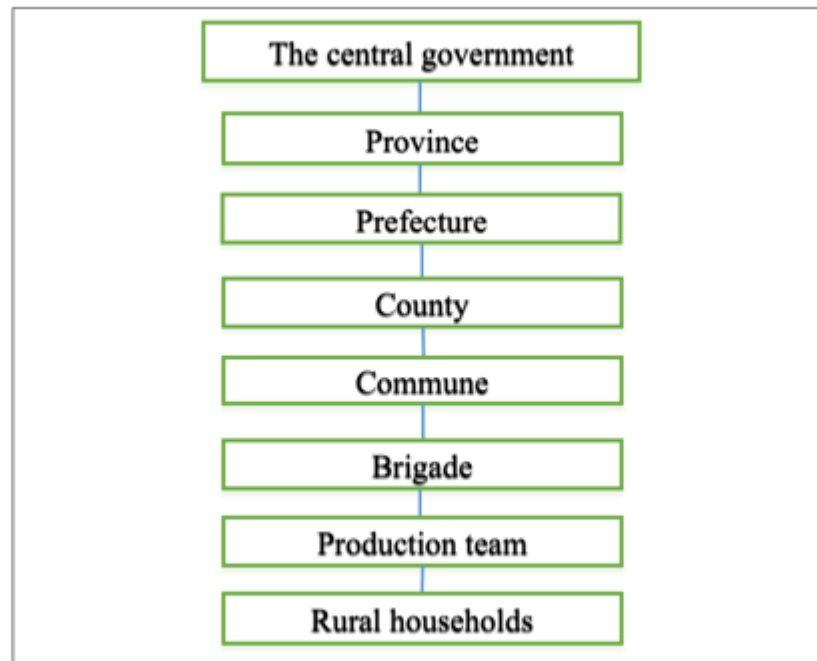
According to the document of “the Decision to Establish the People’s Communes in the Countryside” issued by the central committee of the CCP on August 29, 1958, one of the most important tasks for the People’s Communes was to mobilize rural households and the commune’s resources for the construction of water works and to cooperate in agricultural production (Ji 2016:20). Some scholars argued that the People’s Communes originated from the extensive water conservancy campaigns of winter 1957 and spring 1958, which involved more than 100 million peasants (Nickum 1978:273; Oksenberg 1969). In 1959, the Ministry of Water and Hydropower held a national convention and confirmed that the People’s Communes speeded up irrigation construction (MOWR 1999:13). Thus, it was argued that the CCP hoped from early on to use collective organizations to mobilize rural labors to construct public infrastructures, particularly collective water projects, in order to enhance agriculture productivity (Ash 2006; Bramall 2009:213; Naughton 2007:69).

After the failure of the Great Leap Forward, the Chinese state downsized the People's Communes and organized rural society into a three-tier structure consisting of production teams, production brigades and communes (Bramall 2009:216; Eckstein 1975: 77-84; Schurmann 1968; Lin 1990). The functions of the communes were reduced to administration and coordination, whereas resource ownership, responsibility for production management and income distribution were delegated to much smaller unit, the production team, which usually consisted of 20-30 households (Lin 1990). Rural life and production were profoundly transformed under the three-tier collective system. Domestic work was shifted into public sphere, and the state exerted much greater control over peasants and agricultural production than previously.

These collective organizations made the mobilization of rural laborers much more effective. Prior to the establishment of the collective system, the construction of a relatively large irrigation project normally requires a coordination of hundreds or even thousands of rural households, which was difficult and costly. The People's Communes could overcome the problem of coordination and easily mobilize labor and material resources. This was because the decisions were made not by millions of households but by a much smaller number of collectives such as brigades and communes. Above the level of communes, the county government or even higher levels of government would take command and coordinate collective activities in a large area. Figure 2-3 shows the command structure of labor mobilization in Maoist China. It reveals that the collective system was absorbed into the bureaucratic structure of the state while at the same time they were self-supporting organizations, which largely relied their own resources within

rather than resources from above. In other words, the Chinese state turned the organizations of rural society into an efficient hierarchical structure without adding administrative or fiscal burdens on the state. The bureaucratization of the rural society through collective organizations greatly increased the capacity of the state in labor mobilization.

Figure 2-3 The command structure of labor mobilization in Maoist China



Under the collective system, the construction of water projects basically followed the principle of territorial responsibility: brigades or production teams took responsibility of the construction of small projects within their territories; communes took responsibility of medium-sized projects; and large projects were coordinated by counties and higher level authorities (Yu 1974: 56). More specially, projects that affected more than one

production team within a single brigade should be organized and built by the brigade. The costs should be shared by peasants from the production teams that benefited. If the project involved more than one brigade within the same commune, then the commune would take charge, and the benefited brigades would contribute labor and resources for the project (Nickum 1978:278).

The construction of large projects which usually affected peasants and collective organizations within one county or across multiple counties, followed a principle of shared responsibility as well. To build a large water project, the government not only mobilized communes that directly benefited from the project but also those that did not. The principle of shared responsibility was also intended to strengthen the solidarity and reciprocity among communities. Take the Hai River maintenance project, which was constructed during the 1960s and 1970s, as an example. The main work was conducted within Hebei Province. In the beginning of each year, the project headquarters' office at the provincial level estimated the total number of laborers needed for the project. Then the task was distributed to each prefecture, then to each county, and eventually to each production team. The government provided construction materials and some subsidies for food and construction tools. When the production team was told the number of laborers it was required to mobilize, the team head would hold a meeting and inform all the households of the order from the upper government, and then would discuss and decide who should do the job. The laborers who participated in constructing water projects normally would not get any cash compensation from the state, but they received work points in their own production teams so that they could get a fair share of annual

distribution of cash and grain (Ji 2016; Lv 2014; Nickum 1978: 275). Nickum (1978:284) claimed that by relying on the distributional incentive of the work point system, the commune system was able to use labor more extensively than under an individual wage system.

Rural laborers were mostly mobilized for public infrastructure projects during the wintertime when there was not much agricultural work. According to Yue (2015:63), eighty percent of the work for medium-sized and small water projects was conducted during the slack seasons, mostly in winter and early spring. For some large projects such as the Hai River Maintenance project, which required long-term labor contribution, a certain number of laborers were employed yearlong for the main body of work (Lv 2014).

The collective system mobilized a huge number of rural laborers. In January 1958, it was estimated that around 100 million people participated in the nationwide campaigns for agricultural water infrastructure (Li 2010: 114). In the 1960s, it was estimated that 40 to 60 million peasants were involved in irrigation infrastructure projects each year. On average, each participating peasant contributed thirty days in a year (Bramall 2009:224; Nickum 1978: 280-2). In the 1970s, 100 million workers (30 percent of the total rural labor force) were mobilized each year to devote a few weeks to building and repairing the irrigation system. This greatly increased rural laborer's working days in a year. In the 1920s, a peasant worked about 160 days per year on average, but by the late 1970s, one worked 200 to 275 days per year on average mainly due to the mobilization in water infrastructure construction during the slack seasons (Naughton 2007:237; Vermeer

1988:157). In sum, it was estimated that labor mobilization covered more than 50 percent of the cost of building and maintaining agricultural water infrastructures in the Mao period (Bramall 2000: 137; Nickum 1978).

It should be noted that although peasants benefited from the expansion of the water system, they were often forced to work for these projects because their livelihoods relied entirely on collective organizations. However, many peasants also participated voluntarily. In constructing some large projects such as the Hai River maintenance project, the state provided meals for workers, which was an incentive for rural laborers to participate because they could save food for their families by not eating at home (Lv 2014). Thus, according to one of my interviewees in Southern County, the production team head would first ask those poor households to participate in the projects as a gesture of taking care of the poor in the community. Another incentive for peasants to participate was that these projects could increase the irrigation capacity and thus grain production of their farmland (Chen 2012).

In addition to collective organizations, the buildup of an enormous water infrastructure should be attributed to the bureaucracy of the Chinese state.

Firstly, the Chinese state assigned priority to agriculture and irrigation on its agenda. This was reflected in the campaign slogans such as “take grain as the keyline” (*yiliang weigang*) and “irrigation is the lifeline of agriculture” (*shuili shi nongye de mingmai*). As discussed above, large projects and nationwide campaigns for improving water facilities

were usually initiated and promoted by the central government and many medium-sized and small irrigation projects were initiated by local governments.

Secondly, local governments, particularly county-level governments, played a significant role in the organization and mobilization of rural laborers. These governments coordinated laborers from various communes. Generally, the party secretary at the prefecture level, who was the top administrator in a prefecture, took charge of large water projects, while the party secretary at the county level was responsible for medium-size water projects (Yue 2015:64, 97). Moreover, local officials often worked side by side with peasants in the construction sites of water projects. Nickum (1978: 283) estimated that 1.7 million local officials were dispatched in 1976-77 alone to project sites supervising and participating in the construction of agricultural infrastructure. Fu (1958) showed that many officials from the prefecture and county governments moved their offices to the construction sites in the countryside in the high season of infrastructure construction, i.e., winter and spring. In addition, many propaganda activities would be organized in order to boost peasants' morale at the sites.

Lastly, the government provided technological assistance for water conservancy. Many technicians were sent to construct water projects. In addition, they trained a great number of peasant technicians through demonstration projects and training programs. For example, during the ten years from 1949-1959, there were more than 160,000 peasant irrigation technicians trained in Hunan province through the school system education and onsite training (Liu 1959).

In summary, the establishment of collective organizations and labor mobilization through these organizations played an indispensable role in irrigation expansion in the Mao period, which allowed the Chinese state to overcome the problem of insufficient financial resources for irrigation projects. Some scholars called this an approach that substitutes labor for capital (Perkins 1969; Nickum 1978). It should be noted that this approach rested upon the ability of the state to mobilize rural laborers.

2.5 The Two Cases in the Mao Period

This section examines in detail the changes of the agricultural water system in my two county cases during the Mao period: Southern County in Hunan province and Northern County in Inner Mongolia. Although these two cases are located in very different geographical areas, they showed similar trends of irrigation expansion in the Mao period. In general, Southern County enjoyed much better irrigation conditions than Northern County, mainly owing to high levels of precipitation, but the latter also made significant progress in harnessing water for agriculture. In addition, the expansion of agricultural water use in both cases can be largely attributed to the effective mobilization of rural labor. These findings further corroborate the national trend of irrigation expansion and labor mobilization.

Southern County

Although Southern County enjoyed on average 1,358 mm of rainfall every year, there were no large irrigation facilities in the county before 1949. For irrigation, peasants used ponds to store water and small river dams and ditches to channel water to farm fields.

The number of ponds and river dams in the county in 1949 reached as many as 57,897, but they were of small size and in poor conditions. These irrigation facilities were highly vulnerable and could not fend off large floods or protect against severe droughts. In addition, their irrigation capacity was very limited. Although 80 percent of farmland in the county received some water from rivers or ponds, only 200,000 mu of farmland, 20 percent of the total, received stable water supply and was equipped with a good drainage system to avoid flooding in the rainy season.¹³

One of the most important achievements in the Mao period was the construction of large irrigation projects, which greatly increased the county's capacity of irrigation and flood control. Take reservoirs as an example. The county started to build its largest reservoir in 1958, at the height of the Great Leap Forward, and the main work for this project was finished in 1965. It could irrigate 423,000 *mu* farmland in three neighboring counties and Southern County made up the largest share, 350,000 *mu*.¹⁴ Besides this large reservoir, the country built 159 reservoirs of various sizes in the Mao period. Of these, two are officially classified as medium-sized reservoirs and 157 as small reservoirs. The two medium-sized reservoirs were constructed in 1972 and 1973, respectively, and together they could irrigate 95,000 mu of land. The small reservoirs altogether could irrigate up to 260,000 mu of farmland.¹⁵ After the reservoirs were built, canals and ditches were constructed to channel water to farmland. These canals and ditches formed a comprehensive network of irrigation, which is called an irrigation zone. In the Mao period, Southern County took action to construct and connect these canals and ditches.

¹³ *Southern County Gazetteer* 1995:285.

¹⁴ *Southern County Gazetteer* 1995:286.

¹⁵ *Southern County Gazetteer* 1995:287.

The largest irrigation zone could water 132,000 mu of crops for ten communes in the county.¹⁶ In addition to reservoirs, the county built two large river dams for the first time in its history, which could divert water from the rivers to 114, 000 mu of farmland. As a result, the supply of agricultural water in the county became much more reliable due to the formation of a comprehensive irrigation system. In addition, the reservoirs, river dams and canals greatly increased its capacity in mitigating the impact of floods.

The county also made much progress with regard to small irrigation facilities such as ponds and small river dams in the Mao period. Another 12,059 ponds and 157 small river dams were built for irrigation and flood control. A more significant improvement lays in the quality of the pre-existing and newly built ponds and river dams. These ponds and river dams need constant maintenance. For example, the clearing of mud from the bottom of the ponds should be performed every year to maintain the capacity of water storage. Collective organizations in the Mao period provided a good institutional base for this work. Before the collectivization, one pond usually irrigated farmland for several households and maintenance required coordination. During the collective period, a pond usually irrigated the farmland within the same production team, and thus it had become much easier to organize rural laborers to maintain it. My interviewees told me that the ponds were well maintained due to collective organization during the Mao period.

Besides the facilities mentioned above, others such as pump stations, drainage canals, dikes and river banks were constructed or maintained during this period. For instance, there were no pump stations in the county prior to 1949, and peasants used water wheels

¹⁶ *Southern County Gazetteer* 1995:288.

to elevate water to high-level farmland. In the Mao period, the county constructed hundreds of pump stations and used electric pumps to lift water and channel it to farm fields.

In sum, in the Mao period, the county built and maintained a comprehensive irrigation system and it was home to more than 72,000 water projects, including one large reservoir, two medium-sized reservoirs, two large river dams, 160 small reservoirs, 857 pump stations, 7,000 small river dams, and over 65 thousand ponds by the end of 1970s.¹⁷ This greatly increased the irrigation capacity of the county. The farmland with stable irrigation increased from 200,000 mu in 1949 to 850,000 mu in 1979.¹⁸ This laid a good foundation for agricultural production. In 1949, the total grain production was 245 million kilograms, and it increased to 609 million kilograms in 1978, more than doubled. In the meantime, grain production per mu in 1978 increased 2.88 times to 576 kilograms on average from 200 kilograms in 1949.¹⁹

The construction and improvement of these facilities was the result of a combination of efforts from the state, collective organizations and peasants. The state invested a total of 71.2 million yuan during the Mao period. A large number of peasants were mobilized for the construction and maintenance of these projects, and they contributed more than 248.15 million labor days in total and completed more than 300 million cubic meters of earth and stonework.²⁰ There were four waves of intensive labor mobilization. The first

¹⁷ *Southern County Water Resources Gazetteer* 1981:2; *Southern County Gazetteer* 1995: 285-189.

¹⁸ *Southern County Gazetteer* 1995: 285; *Southern County Water Resources Gazetteer* 1981: 2.

¹⁹ *Southern County Gazetteer* 1995:251; *Southern County Water Resources Gazetteer* 1981: 3.

²⁰ *Southern County Water Resources Gazetteer* 1981:20-21.

was in the First Five Year Plan period (1953-1957), when more than 5 million labor days were contributed to irrigation improvement each winter. The second took place during the Great Leap Forward and its aftermath (1958-1962), when on average more than 10 million labor days were contributed each year. The third was from 1963 to 1965, when more than 5.5 million labor days were contributed each year. The last was from 1969-1979, when more than 11 million labor days were contributed on average each year.²¹ The only large reservoir was constructed during the second and third waves of labor mobilization, between 1958 and 1965. The project cost 53.93 million yuan in total, of which 18.93 million yuan came from the central government and two million yuan from peasants. A great number of peasants were mobilized from communes in the county and they contributed more than 33 million labor days, the total value of which exceeded 33 million yuan, 61.2 percent of the total cost of the project. They completed 14.92 million cubic meters of earth and stonework for this project.²²

Archival documents and my interviews revealed the vivid picture of this large-scale mobilization of laborers. In the construction sites during each winter, peasants were organized into military-like groups. Peasants from the same commune were classified as one regiment (*tuan* 团), and under each regiment there were companies (*lian* 连) and squads (*ban* 班). They were encouraged to show good performance in competition. All kinds of propaganda measures such as movies, books, newspapers, radio and posters, were used to boost workers' morale. Cadres ate, slept, and worked together with peasants at the construction site. Many technicians were trained through onsite training and after-

²¹ *Southern County Water Resources Gazetteer* 1981: 20-21.

²² *Southern County Gazetteer* 1995:286.

work schools while working at the construction site. It was a boisterous scene as if an army of rural laborers were fighting a battle. After one project was completed, the construction site quieted down, and only a small number of workers would remain to deal with maintenance. The army was then dispatched elsewhere to fight another battle.

Northern County

In Northern County, the average annual precipitation is between 310-460 mm. Before 1949, the man-made irrigation system in Northern County was virtually non-existent and there were only a few small canals and ditches diverting water from rivers to a few hundred hectares of farmland. In the Mao period, the county achieved great progress in irrigation.

From 1949 to 1978, the county constructed one large reservoir (together with several other counties), six medium-sized reservoirs and 16 small reservoirs. Connected with newly built canals and ditches, these reservoirs and the rivers formed 10 large irrigation zones, accounting for half of the irrigated area of the county. In addition, it built two large and 22 small pumping stations, which irrigated hilly lands with river water. The county also started to sink tube wells and equipped them with motors and pipelines in the late 1960s and 1970s. Prior to 1949, Northern County had about two thousand of the so-called “little muddy wells” (*xiaotujing*), which were only a few meters deep and could only irrigate one mu of farmland each. Starting in the 1960s, Northern County used diesel or electric pumps to extract water from the wells, while at the same time it improved the technology in well building by using bricks/stones and concrete. These wells could reach

10 to 20 meters down. The number of these tube wells increased from 10 in 1960 to 2,654 in 1978.²³ Irrigation efforts during the Mao period expanded irrigated area in the county from a few hundred hectares in 1949 to 24 thousand hectares, 16.4 percent of its total farmland in 1978.²⁴ The grain output per mu in 1949 was only 18 kg and the total grain output of the county was 46,645 metric tons, and these two numbers increased to 97 kg and 160,390 metric tons in 1979 respectively.²⁵

Similar to Southern County, the construction and development of these water facilities were a result of the combined efforts of the state and the mobilization of peasants through collective organizations. From 1951 to 1979, the total state investment on water construction and water management was 41 million yuan. In 1951, state investment was 7,200 yuan, and it increased to 552 thousand yuan in 1956, 1.1 million yuan in 1966, and more than 5.3 million yuan in 1979.²⁶ A great number of peasants were mobilized. They contributed approximately 60 million labor days and finished more than 68 million cubic meters of earth and stonework.²⁷

Take the county's large reservoir as an example. Construction was started in 1958 and completed in 1965. More than 52,400 labors who came from more than 19 counties and cities in Inner Mongolia, were mobilized. At the peak, there were more than 48,000

²³ *Northern County Gazetteer* 1991:347-348; *Northern County Water Resources Gazetteer* 1988, chapter 5:11.

²⁴ *Northern County Gazetteer* 1991: 6-8, 257, 327-350; *Northern County Water Resources Gazetteer* 1988, chapter 9.

²⁵ *Northern County Grain Gazetteer* 1989:139-140. Here the grain output includes the output of both grain and beans in the statistics.

²⁶ *Northern County Gazetteer* 1991: 374; *Northern County Water Resources Gazetteer* 1988, Chapter 9: 3-4.

²⁷ *Northern County Water Resources Gazetteer* 1988, Chapter 9: 6-7.

people working in the construction site daily. They contributed more than 23.48 million labor days and finished 9.11 million cubic meters of earth and stonework.²⁸

The construction of one of the medium-sized reservoirs further demonstrated how water projects were done in the county. The reservoir was contracted between 1974 and 1976. It cost about 11.6 million yuan in total, 3.5 million yuan of which came from the state and the rest was shared by local communes that benefited from this project. In the first several months of construction, approximately 2,000 peasants were working on the site daily. They were mobilized mainly from six communes and one large state-owned farm, which all benefited from the reservoir. They shared the cost of labor, trucks and money in proportion to the benefits they would receive. From summer 1975 on, many other communes were also asked to join the project and the number of workers on the ground rose to 10,000, along with 1,000 trucks. In total, peasants contributed more than 4.5 million labor days and completed a total of 2.21 million cubic meters of earth and stonework. The county government played a significant role in mobilizing and coordinating the communes. In addition, the county government also called its own agencies and urban work units/factories to donate trucks, machines and other construction materials to support the construction of this project. The county government also founded a dozen small sideline factories near the construction site for machine repair, dynamite production, steel production, and wood production to provide assistance. Like in Southern County, many cadres came to the construction sites, and they worked, lived and dined together with peasant laborers.²⁹

²⁸ *Northern County Gazetteer* 1991:327-328.

²⁹ *Northern County Water Resources Gazetteer* 1988, Chapter 4:31-35.

2.6 Conclusion

To conclude, in the Mao period a comprehensive agricultural water system was built with investment from the Chinese state and massive mobilization of labor through collective organizations in the countryside. The expansion of the agricultural water system not only increased agricultural production during this period, but also laid a good foundation for agricultural production in the reform period. The chapter shows that the crucial conditions for this expansion were effective mobilization of collective organizations and the political priority that the agricultural water system received from the state. However, these two conditions weakened after China initiated the market-oriented reforms in the late 1970s.

The control of the rural society through collective organizations was weakened as the Household Responsibility System replaced the commune system. Under the Household Responsibility System, rural households made their own economic decisions and relied on the market for income to a much greater extent than previously. The Chinese state could no longer mobilize peasants in ways that it did in the Mao period. In addition, the state, and local governments in particular, shifted their priority away from agricultural water to more profitable sectors. These changes made significant impacts on the agricultural water system. The following chapters will examine these changes in the water-food nexus in the post-reform period.

Chapter 3

North Feeds South: The Water-Grain Mismatch

The remarkable increase in irrigation capacity during the Mao period laid a firm foundation for agricultural growth in the early reform period. Partly as a result, grain production increased one third from 304 to 407 million tons between 1978 and 1984, permitting China to export grains for the first time since the early 1960s (MOA 2009: 17; Naughton 2007: 259). Despite the initial success, however, the further growth of grain production has been increasingly mismatched with the distribution of water resources in China: the water-scarce north has produced a growing share of grain while grain production in the water-rich south has stagnated and then declined. The mismatch has been both the cause and a reflection of the agricultural water crisis in China. This chapter examines the northward movement of grain production in the reform period and its impact on the agricultural water system. It reveals how the contradiction between profitability and food security and the measures to solve it have contributed to the mismatch.

3.1 Decentralization and Decline of Water Investment in the 1980s

Despite the important role of the agricultural water system, the Chinese state slashed funds for it in the 1980s. Annual spending on water infrastructure decreased from 3.25 billion yuan in 1976-79 on average to 1.36 billion yuan in 1981. The five-year investment decreased from 15.72 billion yuan in the 1976-1980 period to 9.3 billion yuan in the 1981-1985 period, down by 40.8 percent (NBS 2009: 74). The proportion of water

investment in total infrastructure investment decreased from more than seven percent to three percent in the early 1980s and further down to less than two percent in the late 1980s (Figure 3-1). There was a wide gap between the funds needed and those allocated. It was estimated that at least 3.1 billion yuan was needed every year in the 1980s to maintain and repair government-owned irrigation facilities in the 1980s. However, the government budget for water investment and management was around half a billion a year in this period. For example, it was only 470 million yuan in 1986, only 15 percent of that was needed (Zhang 1995: 139).

The funding cuts have been attributed to political and institutional factors. Politically, the reform was a radical negation of the Mao period. The Maoist policies such as the “mass-line” politics and “politics in command (*zhengzhi guashuai*)” were criticized and abandoned. As noted in the preceding chapter, the construction of water projects was a key policy and practice in the Mao period, thus it bore the brunt of the reform. According to Ms. Qian Zhengying, the Minister of Water Resources at the time, senior officials at the top argued that the Mao period overemphasized the importance of irrigation, and thus the mistake must be rectified (Qian and Ma 2009).

Another important factor was the institutional change stemming from the reform of fiscal decentralization in 1980, which was a part of the general process of decentralization noted in the introduction. The decentralization reform in China after 1978 has garnered wide attention in scholarship. It is regarded as a major factor contributing to the economic growth in the 1980s and 1990s. For instance, Jean Oi suggested that the

reform, which allowed local governments to retain surplus revenue after fulfilling the quota turned over to the central government, had motivated them to promote rural industry, leading to the takeoff of the rural economy (Oi 1999). Other scholars argued that the decentralization reform had enhanced the incentive of local governments, promoted market principles, and stimulated local economic development (Wong 2000; Shirk 1993; Huang 1996; Zhao and Zhang 1999; Qian and Weingast 1997). However, while the decentralization reform boosted the Chinese economy, its effect on the agricultural water system was nearly the opposite.

A central component of the decentralization reform was to establish a contract-responsibility system, which redrew the boundaries of the rights and responsibilities of both local governments and enterprises. As far as enterprises were concerned, the system permitted a state-owned enterprise to retain residual profits after paying a predetermined quota to the government, whereas previously it must remit all profits to the government. In the late 1980s, the system was replaced with the tax-for-profit scheme (*ligaishui*), in which the remittance quota was turned into a number of taxes paid to the government (Zhao and Zhang 1999: 256). The reform also transferred most of the responsibilities of investment and public services from the center to local governments, which obtained a much greater degree of autonomy than previously in decision making and policy implementation.

The contract-responsibility system profoundly altered the local-center relations in water investment and management. The new system requires a local government to fulfill a

certain revenue quota remitted to the central government. Beyond the contract quota, the more revenue the government generates, the more it can retain. In addition, the local government is supposed to raise a significant proportion of funds itself for public projects and services (Zhao and Zhang 1999: 257-9). It was against this background that the central government cut irrigation investment substantially, and transferred much of the responsibility of financing the agricultural water system to local governments, which were expected to raise funds for their water projects (Zhang 2008; Gu eds 1999).

However, the incentive of local governments, particularly those in the south, was to increase revenue by promoting local economic growth in the neoliberal era. As a result, it tended to concentrate resources in profitable urban-industrial sectors that can stimulate economic growth. Contrary to the expectation that local governments would take responsibility for the agricultural water system, water investment at the local level was cut even more than that at the central level (Lohmar et al 2003: 9). Take Hunan province as an example. Agriculture, including water infrastructure, accounted for 12.4 percent in fixed asset investment in 1978, but it decreased to less than 3 percent in the second half of the 1980s (HBS 1991: 27). As a result, many water projects crumbled and could not irrigate farmland effectively. In addition, little money was allocated to building new projects or repairing the existing infrastructure, and local irrigation management agencies were so short of funding that they could not even pay the salaries of technicians and workers in full amount (He and Li 1995; Jin and Pi 1990; MOWRH 1986). Irrigated area in the province reportedly declined from 2.76 million in 1982 to 2.67 million hectares in 1989 (HBS 1982:127; HBS 1990: 54). The actual decline might be greater since local

governments tended to underreport their failures. Hunan province was not an exception. The diversion of resources away from water conservancy and the shrinking of irrigated area were observed in many other provinces (Wang 2012: 216-32).

Without sufficient funds from either central or local governments, the Ministry of Water Resources (the Ministry of Water Resources and Hydropower between 1982 and 1988), which is the highest-level authority of water administration in China, launched a major reform in 1984 that reoriented the water system to the goal of economic self-reliance, a neoliberal economic principle (Harvey 2005). The reform identified three principles called “Two Pillars and One Key” (*liangge zhizhu, yiba yaoshi*). The two pillars refer to the collection of water fees and the engagement in multiple businesses, and one key is the economic responsibility system. All reformative measures were aimed to raise funds for water management. The collection of water fees suggests that the water management agency would charge rural households and individuals for using water for agriculture. The multiple-business principle encourages water management agencies to engage in other economic activities rather than only supplying water for agricultural production. The responsibility system requires that water management agencies must raise funds themselves to cover the cost of water management including the salary of their personnel.

As a result, water management agencies, previously focusing on improving the water system and directing water to farms, shifted attention to profitable businesses. Take Field Reservoir in Southern County as an example. The building of the reservoir was initiated in 1973, and major works of the project, including a large dam, a hydropower facility and

artery canals, were completed in 1978. The reservoir was the third largest irrigation work in the county, and could irrigate 114 thousand mu of farmland if all auxiliary facilities were built to allow the reservoir to operate in full capacity. However, the auxiliary facilities have never been completely finished due to a lack of adequate funds in the reform period.

The reservoir started to face financial problems soon after it went into operation in 1980. The reservoir management staff comprised of 69 persons in 1984, and the management must cover staff salaries and daily operation expenses itself due to the drying up of funds from upper-level governments. A 1984 report that the reservoir management submitted to the county bureau of water resources and hydropower showed that it ran a deficit of about 40,000 yuan a year, about half of its annual budget. To cover necessary expenses, the management agency had to follow the Ministry of Water Resources' call and involved itself in multiple businesses. In addition to fishery and hydropower that were economic activities originally designed for the reservoir, the management agency opened a grocery store and a restaurant, and bought a bus to transport people between the county town and the township where the reservoir is located. The involvement in multiple businesses improved the reservoir's economic conditions. Between 1985 and 1990, the management agency was running a budgetary surplus and able to improve the living conditions of its employees. However, increased income did not translate into the improved supply of agricultural water. On the contrary, the management appointed more talented members and allocated most economic resources to profitable businesses such as fishery and the bus business, and only took a minimal effort to keep irrigation running. The reservoir

irrigated 55 thousands mu in 1990, only half of its full capacity and increased little from the early 1980s on.

In the meantime, regional inequality in economic development took a toll on the water system under the decentralized system because less-developed regions were unable to raise sufficient funds to cover the expenses of water management. For example, the amount of central water funds that Northern County received decreased from 4.15 million yuan every year in 1976-1980 to 1.79 million yuan in 1981-1985. To make up for the shortage of water funds, the Water Resources Bureau in the county encouraged the management agencies of irrigation facilities such as reservoirs to engage in commercial activities including fishery, manufacturing, shop keeping, etc. However, these activities could not generate sufficient income in less developed regions while at the same time diverting human resources away from the agricultural water system management. As a result, irrigated area in Northern County declined in the 1980s and early 1990s. According to the county's water gazetteer, irrigated area declined from more than 500,000 mu in 1978 to about 400,000 mu in 1990. The causes for the decline include insufficient water funding for repair and maintenance, the silting of irrigation districts, the breakdown of irrigation facilities and the damages caused by floods.

In addition to the "Two Pillars and One Key," the Ministry of Water Resources pushed through the policy of compulsory labor contribution in 1989, which mandated that each rural laborer must contribute 10 to 20 labor-days every year to rural public works including irrigation projects (Gu eds 1999: 280). The goal of the policy was to increase

the contributions from peasants and mobilize rural labor to compensate for the shortage of water funds. As noted in Chapter 2, mobilizing labor for water projects was a common practice in the Mao period. However, the situation was changed substantially in the post-reform period. While peasants were highly dependent on the state and the collective system for livelihoods before 1978, they were allowed to make their own economic decisions in response to the market and other external economic factors after the reform. In other words, the control of rural labor by the state was significantly weakened. As a result, tension arose when local governments compelled peasants to contribute labor to public projects. When the latter failed to comply, local officials would fine them for missed work days, which had further increased the economic burden on the latter and added to rural distress in the 1990s (Ouyang 1999).

In summary, the reform led both central and local governments to focus efforts on economic growth while neglecting the agricultural water system in the 1980s. The central government cut irrigation funds drastically, and local government diverted resources away from water conservancy. The drying up of funding prompted local water management agencies to engage in money-making businesses, and as a result, the importance of water conservancy was downgraded and even neglected. The 1980s was thus a decade when the pursuit of profitability overrode the significance of food security, leading to the cutting-back of efforts and resources for the water system at both central and local levels.

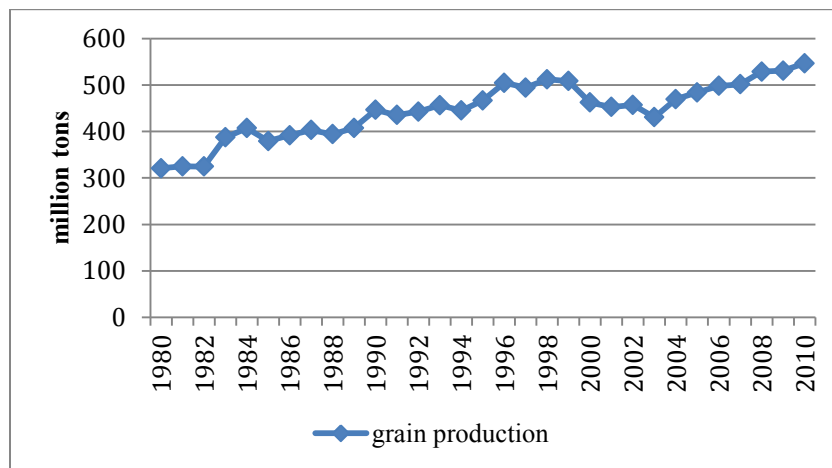
3.2 Northward Movement of Grain Production

By the early 1990s, it had become clear that the transfer of water investment responsibility to the local level did not work because the cut in water investment had caused the increasing incidence of facility breakdowns. The crumbling of irrigation facilities reduced the capacity of the agricultural water system in flood control and drought alleviation. In the 1970s, the rates of disaster-damaged farming area (*chengzai qu* 成灾区) were 42 percent and 28 percent of the disaster-struck areas (*shouzai qu* 受灾区) in the case of floods and droughts respectively, but these increased to 53 percent and 46 percent in the 1980s (Zhang 1995: 139).³⁰ In addition, due to insufficient funding, many irrigation works could not be built with auxiliary facilities such as small dams, canals, dykes and aqueducts, keeping them from operating in full capacity. These problems contributed to the shrinking of irrigated area in the 1980s and amplified the negative effect of natural disasters. Nationwide, irrigated area declined from 45 million to 44.4 million hectares between 1979 and 1988, reversing the decades-old growing trend (MOA 2009: 7).

Partly as a result, grain production had stagnated and even declined in the second half of the 1980s after it peaked in 1984 at 407 million tons. In 1985, it dropped to 379 million tons and had not recovered until 1989 (Figure 3-1). The crumbling of water facilities, the shrinking of irrigated area, the impact of natural disasters and the stagnation of grain production had altogether alarmed the central government.

³⁰ The rate is the proportion of disaster-damaged farming area to disaster-struck farming area.

Figure 3-1 China's grain production: 1980-2010³¹



The central government was thus forced to increase agricultural water investment in the 1990s for the sake of grain security. In 1989, the State Council issued a guiding document on the development of agricultural water in the 1990s. The document, entitled “State Council’s Decisions on Greatly Developing the Infrastructure of Farmland and Water Resources,” acknowledged the insufficiency of efforts in the 1980s and called to shore up investments and resources at both central and local levels. Following the policy, the central government allocated much more funds for agricultural water than previously. Between 1989 and 1995, the budget for agricultural water infrastructure had grown from 3.0 billion yuan to 14.3 billion yuan, more than quadrupled (NBS 2009). In addition, the central government also launched a number of projects to improve agricultural conditions. A good example is the National Comprehensive Agriculture Development Program (*nongye zonghe kaifa* 农业综合开发), which was initiated in 1988 and has been in

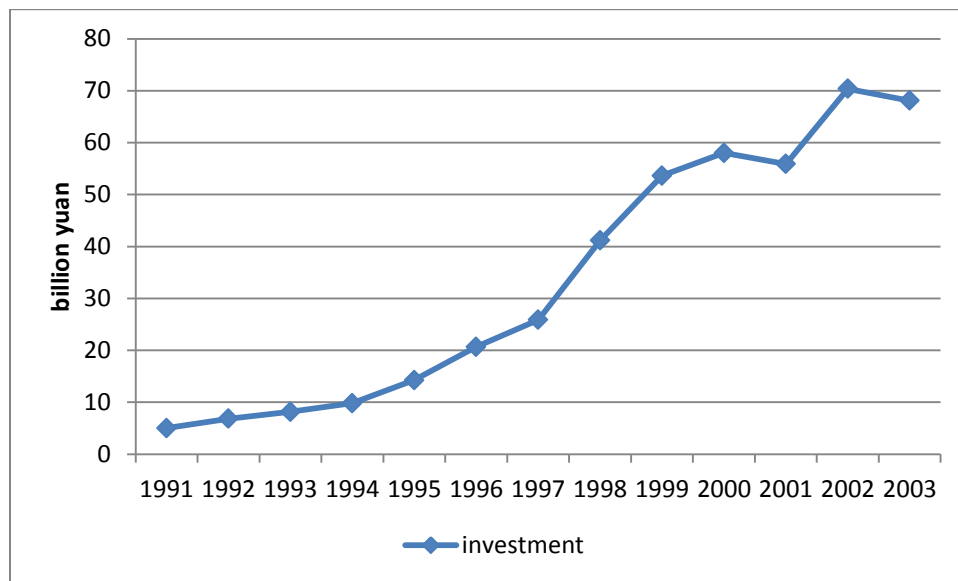
³¹ Data sources: MOA 2009:17; NBS 2011.

operation ever since. Between 1988 and 1999, central funds for the project totaled 26.9 billion yuan (more than two billion yuan a year on average), plus nearly an equal amount of supplementary funds provided by local governments.³² More than half of the funds were used for agricultural water use.

Figure 3-2 shows annual agricultural water infrastructure investment from the central government between 1991 and 2003. The total investment increased from around 5 billion yuan to more than 68 billion yuan, an annual growth rate of 24 percent on average. In 1995, the investment grew more than 45 percent from 1994. In 1998 and 1999, it shot up again, with the investment growing nearly 60 percent in 1998 and 30 percent in 1999. Another two events also contributed to the surge of central funds for agricultural water infrastructure. In 1994, Lester Brown published the widely-known report, entitled “*Who Will Feed China?*”, which raised concern worldwide about the prospect of China’s grain production. The Chinese government was under pressure to demonstrate that it was able to produce sufficient grains for domestic consumption. In 1998, huge summer flood caused tremendous damage and exposed the vulnerability of the agricultural water system. This again prompted the central government to step up water investment further. The next section will detail central efforts to rejuvenate the agricultural water system.

³² The data are available on the website of the project: <http://nfb.mof.gov.cn/>

Figure 3-2 Agricultural water infrastructure investment from the center: 1991-2003³³



In short, the concern about food security forced the Chinese state to improve the agricultural water system in the 1990s. With increased investments and efforts, irrigated area started to expand again, along with the growth of grain production. Between 1990 and 2000, irrigated area expanded from 47.4 million to 53.8 million hectares, up 13.5 percent, while grain production exceeded 500 million tons in 1996, another milestone after 1984 (Figure 3-1 above).

However, the contradiction between grain security and the pursuit of profitability did not go away. As the central government pushed to improve agricultural conditions including water conservancy in the 1990s, the contradiction was played out very differently in the

³³ Data source: NBS 2009 (74).

south and in the north. In the south, particularly coastal regions such as the Yangtze River Delta and the Pearl River Delta, rapid industrialization and urbanization were drawing resources away from grain production. The increased funds on water and agricultural infrastructure from the center appeared puny as compared with the profits from urban and industrial sectors. As a result, despite the call to improve agricultural conditions including irrigation from the center, local actors such as government officials and rural residents continued to devote most of their resources to urban and industrial development. This trend was even fueled by Mr. Deng Xiaoping's speeches in 1992 which unleashed a new tide of fervor for export-oriented industrialization. The result was that large tracts of farmland, including land with access to good irrigation, were lost to factories and cities. Take Guangdong province as an example. Irrigated area in the province declined from 1.8 million hectares in 1990 to 1.5 million hectares in 2000. In the meantime, cropping area declined from 4.0 million to 3.3 million hectares (MOA 2009: 97-100, 144-146). As compared with Guangdong, urbanization and industrialization in Hunan province, where Southern County is located, was less dramatic, but the province also devoted more resources to urban and industrial development than to water conservancy and agriculture. Irrigated area in the province stagnated around 2.7 million hectares in the 1990s, and its cropping area declined from 5.4 million to 5.0 million hectares (MOA 2009: 97-100, 144-146).

In the north, the increased investments and efforts made a notable impact on irrigation and agricultural production. This was so because competition between grain production and industrial-urban development for resources was much less intense than that in the

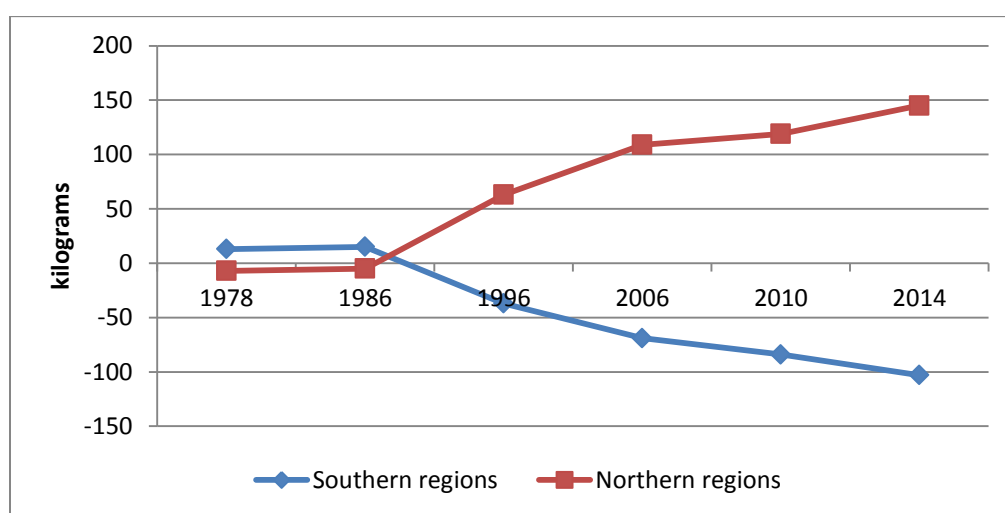
south. According to the comparative advantage theory, the opportunity cost of allocating resources such as labor, land and capital to agriculture was much less than that in the south (Hendrischke and Feng eds. 1999; Lin, Cai and Li 2003). In addition, with a larger size of landholding, rural households can derive a substantial income from agriculture if agricultural conditions are improved. The effect on irrigation and agriculture was most pronounced in the northeast provinces such as Heilongjiang and Jilin. For example, irrigated area in Heilongjiang increased rapidly from 1.1 million hectares to 2.0 million hectares in the 1990s, almost doubled. In the meantime, cropping area in the province increased from 7.4 million to 7.9 million hectares. Inner Mongolia, where Northern County is located, witnessed a similar trend. From 1990 to 2000, irrigated area expanded from 1.3 million to 2.4 million hectares, and cropping area increased from 3.9 million to 4.4 million (MOA 2009: 97-100, 144-146).

Due to the differences in agricultural investments and efforts, grain production started to retreat from the south while expanding in the north. The geographical movement of grain production changed regional food relations within China. Until the end of the 1980s, the south had produced more grains than the north and exported surplus to the latter. In the 1990s, however, the trend was reversed. Instead of importing grains from the south, the north as a whole started to export grains to the south. Figure 3-3 shows per capita grain production in the south and north after being subtracted by the national average.³⁴ As it reveals, grain production in the north has increasingly exceeded the national average since the 1990s, while that in the south has dipped further below the average, suggesting

³⁴ The figure shows the differences of per capita grain production between the south and the national average, and between the north and the national average respectively, and it also tracks the increasing difference of per capita grain production between the north and the south.

that the trend of northward relocation has been strengthening. In 2014, grain production in the south was 341 kilograms per person, 103 kilograms less than the national average (444 kilograms), whereas in the north it was 589 kilograms, 145 kilograms more than the average.

Figure 3-3 Per capita grain output subtracted by the national average: 1978-2014³⁵



The expansion of grain production in the north had much to do with government policy. Confronting the contradiction between economic growth and grain production, the central government has intentionally supported northern regions over the south to produce more grains. For example, the National Comprehensive Agriculture Development Program invested much more in the northeast, the North China Plain and the Middle Yangtze Region than in others (Wang 1995; MOF 2001). In the first phase of the project, the government identified 11 regions to be primary project sites, of which eight are located in

³⁵ Data sources: NBS 2010; NBS 2015; MOA 2009.

the north (Han 1995; Wan 1990). Northern County in this study was among the first five hundred counties that implemented the project. According to the documents collected from the county's archives, the project was aimed to increase grain production by expanding irrigated area (mainly by means of sinking tube wells), create terrace fields to reduce soil erosion and improve soil quality. In addition to this project, the county implemented a number of projects, all of which were aimed to increase grain production.

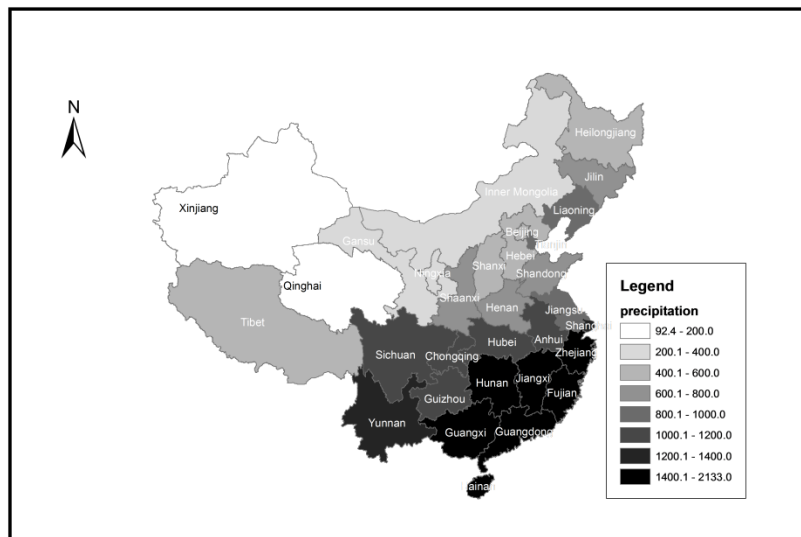
In summary, the concern about food security led the Chinese state to increase investments on water and agricultural infrastructure in the 1990s. However, these investments had little effect in the south where rapid industrialization and urbanization diverted resources away from grain production. By contrast, the investment expanded irrigated area and grain production in the north where the competition for resources between urban-industrial sectors and agriculture was less intense than in the south. As a result, grain production expanded in the north while it was squeezed out in the south, leading to the northward movement of grain production.

3.3 The Water-Grain Mismatch

The northward movement of grain production in China has offered a temporary solution to the contradiction between food security and the pursuit of profitability. By moving the main sites of grain farming to the north, China could achieve rapid industrialization and urbanization while at the same time increasing grain production for food self-sufficiency. However, the solution created a mismatch between grain production and water resources. As noted previously, the south is endowed with abundant water resources and is thus

suitable for grain production. Figure 3-4 shows that the levels of precipitation decrease as one travels from south to north. Annual precipitation in most southern provinces exceeds 800 mm. In southern coastal provinces, the level of precipitation even reaches over 1,200 mm a year. This creates a favorable condition for grain production because grain crops are usually water intensive. In general, approximately one cubic meter of water is needed in order to produce one kilogram of grain (Allan 1998). Over the past two centuries, southern coastal provinces, the Middle Yangtze River region (Hunan, Hubei, Jiangxi and Anhui) and the Sichuan Basin have been the main sites of grain production, particularly for water-intensive crops such as rice, due to their abundant water resources.

Figure 3-4 The distribution of annual precipitation in China



The north as a whole, by contrast, is short of water. In the North China Plain including Hebei, Henan and Shandong, annual precipitation is around 600 mm, and the Yellow River, Hai River and Huai River also provide an important source of water. However, due to water deficiency, the region has mainly grown relatively drought-resistant crops

such as wheat. The northwest, the Qinghai-Tibet Plateau and Inner Mongolia are severely short of water, with the level of annual precipitation around 400 mm and even less than 200 mm in some regions. These regions thus lack enough water resources to farm grain crops and had traditionally imported grains from the south. The situation in the northeast is somewhat better. The level of precipitation is relatively high, and the three major rivers including the Songhua River, the Heilongjiang River and the Ussuri River provide a source of irrigation. Nevertheless, the region must rely on groundwater for irrigation in recent decades. The varying levels of precipitation contribute to the uneven distribution of water resources in China. The north as a whole, which covers 63.5 percent of the country, only accounts for 19 percent of water resources. As far as groundwater is concerned, the north is also far behind the south, with only about 30 percent of the total (Liu and Chen 2001; Wang et al 2007; Zhang, Xia and Hu 2009). The size of land holding is larger in the north than in the south. The north is home to about 65 percent of farmland and 46 percent of the population. Per capita farmland in some regions can be as large as 0.5 hectare. However, grain production is not merely dependent on farmland but also on water resources. Without sufficient water, the productivity of farmland is low. This is why the north had to purchase grain from the south even if it had more farmland than the latter in the 1980s and earlier.

Scholars use the concept of virtual water to capture the inseparable relationship between water and grain production. Virtual water refers to the water needed to produce agricultural commodities. When the commodities are traded, the water used to produce them is also traded (Allan 1998, 2003; Hoekstra and Hung 2002). The trade of virtual

water provides a solution to the problem of water deficits in regions such as the Middle East and North Africa (Allan 1998). The guiding principle is that water-deficit regions should import water-intensive commodities while exporting less water-intensive commodities as a way to ameliorate water shortage. For example, the Middle East and North Africa imported 50 million tons of grain annually in the 1990s, and this tonnage requires about 50 billion cubic meters of water to produce it, which is equivalent to the volume of fresh water that flows into Egypt down the Nile in a year. Thus grain imports to the region have a great positive effect on its water use (Allan 2003: 107-08). However, the mismatch between grain production and water resources in China runs directly against the idea of using the trade of virtual water to solve the problem of water shortage.

A study shows that the north exported 26 million tons of grain a year to the south on average between 1990 and 2008. The virtual water contained in these grains amounted to more than 23.3 billion cubic meters a year (Wu et al 2010).³⁶ In 2014, the north as a whole exported 83.6 million tons of grain to the south, provided that every person consumed the same amount of grain. Virtual water contained in these grains amounted to more than 83.6 billion cubic meters. The South-North Water Transfer project, the most ambitious water project in China so far, plans to divert 44.8 billion cubic meters of water a year from south to north. However, this is less than 54 percent of the virtual water exported from north to south through the trade of grain. In other words, the water diverted from south to north cannot make up the loss of virtual water even if all water

³⁶ Wu et al (2010) uses the grain-water ratio of 1.116 meaning one cubic meter of water can produce 1 kg of grain in China, slightly higher than the ratio of 1 used by Allan (2003). However, Wang et al (1999) uses the ratio of 0.849 and Lu et al (2010) uses 0.8. This study follows Allan (2003) and Yang & Zehnder (2001) to use a rough ratio of one kg grain to one cubic meter of water to simplify the calculation.

from the south is used for agriculture in the north. In actuality, the goal of the project is to supply water to cities in the north, and little water will be used for agriculture.

Table 3-1 below shows provincial data on surplus grain and virtual water that is contained in it. Surplus grain is computed by subtracting grain for self-consumption in a provincial region from its total grain production. In the north, most provincial regions produced surplus grain in 2014, which was traded to regions where grain production could not meet the demand. The largest producers of surplus grain are Heilongjiang, Jilin, Inner Mongolia and Henan, but all these provinces are short of water. Inner Mongolia, where Northern County is located, is particularly water deficient. Annual precipitation in the region is only 305 mm in a normal year, but it sent out 16.41 billion cubic meters of water through the grain trade in 2014. Some regions in the north could not produce sufficient grain for their own consumption. Most notably Beijing and Tianjin, two mega cities with large numbers of migrants, must purchase grains from other regions. In addition, the Qinghai Plateau and some northwestern regions such as Shaanxi must import grains due to the low levels of rainfall and adverse agricultural conditions. It should be noted that some northwestern regions such as Xinjiang, Ningxia and Gansu, despite the shortage of water, started to produce surplus grain and trade their virtual water in the market in recent years.

Table 3-1 North vs. South in terms of surplus grain and virtual water in 2014 (million tons; billion cubic meters)³⁷

Southern Regions	Surplus grain	Virtual water	Northern Regions	Surplus grain	Virtual water
Anhui	7.16	7.16	Heilongjiang	45.41	45.41
Jiangxi	1.28	1.28	Jilin	23.11	23.11
Hunan	0.11	0.11	Inner Mongolia	16.41	16.41
Hubei	0.03	0.03	Henan	15.85	15.85
Jiangsu	-0.42	-0.42	Xinjiang	3.95	3.95
Chongqing	-1.83	-1.83	Shandong	2.52	2.52
Hainan	-2.14	-2.14	Ningxia	0.84	0.84
Yunnan	-2.31	-2.31	Hebei	0.83	0.83
Sichuan	-2.38	-2.38	Gansu	0.09	0.09
Guizhou	-4.18	-4.18	Tibet	-0.43	-0.43
Guangxi	-5.75	-5.75	Qinghai	-1.54	-1.54
Shanghai	-9.64	-9.64	Liaoning	-1.95	-1.95
Fujian	-10.22	-10.22	Shanxi	-2.88	-2.88
Zhejiang	-16.87	-16.87	Shaanxi	-4.78	-4.78
Guangdong	-34.02	-34.02	Tianjin	-4.97	-4.97
			Beijing	-8.91	-8.91

³⁷ To simplify the calculation, this study assumes that per capita grain consumption is the same among all provinces in the same year. I calculate each province's total consumption by multiplying per capita consumption by its population. A province's grain surplus is then calculated by subtracting its total grain consumption from total grain production. A positive number means the province has grain surplus and can export its grain, while a negative number means the province is short of grain and must import grain from other provinces. Based on virtual water theory, we calculate each province's virtual water discrepancy. Data source: 2015 *China Rural Statistical Yearbook* (NBS 2015).

Most southern regions could not produce sufficient grain for themselves and must purchase grain from the north. The regions that are most deficient of grain are coastal regions in the southeast including Guangdong, Zhejiang, Shanghai and Fujian, which experienced rapid urbanization and industrialization and drew large numbers of migrants. As they imported grain from the north, virtual water was also imported, though these regions have abundant water resources (Liu et al 2007). The most serious problem concerning the water-food nexus in the south is that the main grain sites now produce little surplus grain. According to the guiding policy of the central government for 2008-2020, six provinces in the south are identified as main grain-producing zones, including Sichuan and five provinces located in the middle and lower Yangtze River (Hunan, Hubei, Jiangxi, Anhui and Jiangsu). However, as shown in Table 3-1, Jiangsu and Sichuan could not produce sufficient grain for themselves while Hunan, Hubei and Jiangxi produced almost no surplus grain. Only Anhui still maintains a surplus grain output. These regions are all water abundant and among the places best suited for grain production in China. However, their inability to produce surplus grain suggests that they are not sharing their water resources with other water-scarce regions through the trade of virtual water.

In summary, the contradiction between the pursuit of profitability and food security and the measures to solve the contradiction created a mismatch between grain production and water resources in China in the 1990s. The water-scarce north has been producing an increasing share of grain while the water-rich south must purchase grain from the north. Seen in the perspective of virtual water, it is the water-scarce north that exports water to the water-rich south rather than the other way around. This distorts water relationship

between China's south and north and holds the key to understanding the agricultural water crisis in the country.

3.4 The Mismatch and the Agricultural Water Crisis

Voluminous studies have been conducted on China's water crisis: water pollution in major rivers and lakes, the breakdown of water facilities, the drying up of rivers and lakes, and the depletion of aquifers. Brown and Halweil (1998) contended that water problems had (and would further) undermined grain production in China. This study turns their argument around and offers a more nuanced explanation. It argues that the concern for food security in the context of the fanatical pursuit of profitability has created the mismatch between grain production and water resources, exacerbating China's agricultural water crisis. In what follows, I will examine how various water problems are related to this mismatch.

The crumbling of irrigation facilities

The Mao period left a legacy of millions of irrigation facilities. However, many of these irrigation facilities were incomplete and required follow-up work. For example, after the major dam of a reservoir is constructed, auxiliary facilities must be built to supply and distribute water to farms. These facilities may include levees, dykes, canals, pump stations, sluices, ditches, flumes, culverts, viaducts and pipelines. However, many of irrigation works from the Mao period did not yet build these auxiliary facilities and could not operate in full capacity.

The central government transferred the responsibility of water conservancy to local actors in the 1980s. However, local governments, particularly those in the south, were diverting resources away from agricultural water to urban-industrial sectors, thus the auxiliary facilities were rarely built. In the north, the economy did not grow as fast as that in the south, thus many local governments were tight on budget and could not allocate funds for maintaining and constructing irrigation facilities. In addition, irrigation facilities are fixed assets that are easily worn out, and require constant maintenance. Due to a lack of resources for effective maintenance and management, many reservoirs, pump stations and large irrigation zones were breaking down.

The agricultural water crisis prompted the central government to survey the conditions of irrigation facilities in the 2000s. According to a research report released by the National People's Congress in 2009, most irrigation facilities were in urgent repair and maintenance. More than 50 percent of large irrigation zones and 60 percent of small irrigation zones saw their irrigation facilities crumbling. More than 95 percent of large pumping stations were in need of urgent repair and reconstruction. As far as reservoirs are concerned, more than 40,000 reservoirs were breaking down to the point that they could create catastrophic disasters once the dams were collapsed in the event of floods (NPCC 2009; Guo et al 2011).

In the south, irrigation facilities have been giving way to urban and industrial development. Take Hunan province as an example. Roads, factories and mines are often built at the expense of irrigation facilities. In 1985 alone, due to the construction of road

for factories and cities, the province damaged 465 kilometers of canals, 3,245 ponds and 2,435 other facilities (MOWRH 1986). My own fieldwork in Southern County in 2010 found that the government used irrigation funds to build water scenes for urban real estate, factories were built on or near river banks, and private investors were destroying rivers and canals by digging sands for building materials in the city. In Guangdong Province, the funds for water conservancy have been growing in the past two decades, but much of the money was used for facilities that serve urban and industrial sectors whilst less than 30 percent was used to improve the agricultural water system, and urban and industrial development was encroaching on farmland (Li 2002; Zhan 2012). As a result, irrigated area in the province declined from 2.29 million hectares in 1980 to 1.77 million hectares in 2013, down 22.7 percent (GBS 1993: 111; GBS 2014: 79). In Jiangsu, another coastal province that has experienced rapid economic growth, rivers, canals, reservoirs and ponds were silted up with at least 30 percent reduction in the capacity of water flow or storage; more than 40 percent of pump stations was in need of repair or could not work at all; only 30 percent of sluices and culverts were usable, according to a survey (Ren and Zhou 2006).

Northern regions also experienced the breaking down of irrigation facilities. However, different from their southern counterparts that were unwilling to invest in irrigation, local governments in the north were unable to invest in irrigation due to budget constraints. In addition, it should be noted that many local governments in the north desire to imitate the development model of the south and allocate more resources to urban and industrial sectors as well (more details in Chapter 4 and 6).

In short, the crumbling of irrigation facilities in the south including coastal regions, the most economically developed regions in China, highlights how the pursuit of profitability has contributed to the underinvestment and even neglect of the agricultural water system. As a consequence, grain production in many southern regions stagnated and declined. To meet the growing demand for food, the north has intensified grain production, contributing to another serious water problem in China: the depletion of aquifers.

Falling water tables

Until the early 1960s, ground water resources had been rarely tapped in China. In 1965, there were only 150 thousand tube wells. However, the quantity of tube well started to grow very rapidly thereafter. By the late 1970s, there were 2.3 million tube wells. The number of tube wells rose very slowly in the 1980s due to the neglect of the agricultural water system overall. However, it started to rise rapidly in the 1990s, as the main sites of grain production were moving from south to north. In other words, the intensification of grain production in the north has been positively associated with the sinking of tube wells for irrigation. By 2003, the number of tube wells rose to 4.7 million. A recent census of irrigation facilities showed that there were 5.4 million tube wells for irrigation at the end of 2011, pumping out 104 billion cubic meters of water from underground (Wang et al 2007: 45-47; MOWR & NBS 2013).

The over-extraction of groundwater has led to falling water tables. The problem started to attract wide attention in the mid-1990s, as the issue of food security in China was

highlighted by Brown (1994; 1995). The Ministry of Water Resources conducted a comprehensive survey of groundwater problems in 1996. The survey found that the groundwater overdraft was a widespread phenomenon and took place in 24 of China's 31 provinces. The cones of depression were found in more than 164 locations and affected more than 180 thousand square kilometers of area (Wang et al 2007: 48). The World Bank published a report in 1997 that also sounded an alarm on the problem of groundwater overdraft. Groundwater in the Hai River basin, which covers Hebei, Beijing, Tianjin and parts of Shanxi, Henan, Shandong, Jiangsu and Anhui, was over-extracted by as much as 30 percent and in many areas groundwater tables dropped by 100-300 meters (Johnson, Liu and Newfarmer 1997: 88). In 1998, Brown and Halwail (1998) suggested that the water table beneath the North China Plain was falling 1.5 meters per year, a disastrous rate that would soon exhaust groundwater resources. In recent years, it is found that the problem of falling water tables has been worsening. In 2006, there were 216 cones of depression, 52 more than the number in 1996. The cones of depression in the North China Plain are particularly worrisome. It reportedly has the largest cone of depression in the world, 8.8 thousand square kilometers (MOLR 2006; Xinhua Net 2014). The overdraft of groundwater will cause a series of environmental problems, including the drying up of rivers and lakes, desertification, land subsidence, sea water intrusion, salinization and water pollution (Shalizi 2006; Wang et al 2007).

The problem of falling water tables in the north is unevenly distributed and is correlated with the intensity of grain production. The Hai River basin is where it is most serious. This is due to the overdraft of groundwater in the region, fueled by the combined demand

from agriculture, industry and city. In 1997, groundwater accounted for 60.8 percent of all water resources tapped, and the utilization rate of all water resources reached 89.4 percent, suggesting that the region had nearly exhausted its water resources. Other major zones of grain production also saw the increasing draft of groundwater. In the northeast, which is now the most important site of grain production in China, the volume of groundwater tapped for irrigation grew from 8.5 billion cubic meters in 1980 to 26.6 billion cubic meters in 1997, and its share in all water resources tapped was up 19 percent from 23.9 to 42.9 percent for the same period (Liu and Chen 2001: 8). The northwest mostly relied on surface water for irrigation in the 1980s and 1990s, but as grain production started to intensify in the recent decade. Local actors have turned to groundwater for irrigation. For instance, the share of groundwater in all water used in Xinjiang increased from less than 10 percent in the late 1990s to 23 percent in 2012.³⁸ The most dramatic case is Inner Mongolia, which is now the third largest grain producer (based on per capita grain production) following Heilongjiang and Jilin. The drafting of groundwater increased from 1.5 billion cubic meters in 1986 to 9.1 billion cubic meters in 2014, and the share of underground water increased from 14.6 percent to more than 50 percent over the same period (Zhou 1987).³⁹

In short, the intensification of grain production is a major factor contributing to the problem of falling water tables in the north. The problem is most serious in the North China Plain, but it now spread to the northeast and northwest as these regions are tuned into major sites of grain production.

³⁸ Data source: website of Xinjiang Water Resources Bureau. See <http://www.xjslt.gov.cn/index.htm>

³⁹ Also see 2014 Report on Inner Mongolia Water Resources (*Neimenggu shuiziyuan gongbao*), by Inner Mongolia Water Resources Bureau.

Water pollution

The problem of water pollution in China has been well studied. Economy (2011) detailed the horrific pollution of the Huai River, one of the major rivers in China. Other scholarly or popular works also touched upon the issue of water pollution in China (Johnson, Liu and Newfarmer 1997; Liu and Wu 2012; Ma 1999; Nickum 1998; Qu and Fan 2010; Smil 1994; Watts 2010). Over the past two decades, the incidents of water pollution have frequently made the headlines. In 1980, 20.7 percent of the rivers were polluted, and the figure rose to 37.6 percent in 1999. Although the Chinese government has taken great effort in the recent decade to prevent and treat river pollution, the problem continued to be very serious. In 2015, the percentage of the rivers polluted was 35.5 percent, only slightly lower than that in 1999, given that the data reported by the Chinese authority is truthful (Liu and Chen 2001: 94-97; MOEP 2016). The conditions of lakes are even worse than the rivers. In 2015, of the 61 lakes surveyed, 55 or more than 90 percent suffered from eutrophication, and 30.6 percent of large lakes and reservoirs were polluted (MOEP 2016). Groundwater is also heavily polluted. A national survey of groundwater in 2015 reveals that 61.3 percent is polluted. The problem in the north is worse than in the south as another survey shows that 79.6 percent of groundwater in the north is polluted (MOEP 2016).

The primary reason of water pollution is that urban (residential) and industrial sectors discharged toxins and wastewater to rivers, lakes and underground. The problem exists widely across China, but it is most serious in economically developed regions, such as coastal regions, the Hai River Basin and the northeast (which was the base of heavy

industry in China before the 1990s), whereas the problem is relatively moderate in western China (Liu and Chen 2001: 94-97). The variation can be explained by the logic of the pursuit of profitability noted in the introduction. The industrial and urban pollution of waters caused severe harm to grain production both in the south and north. Although the main sites of grain production have shifted from south to north, the south still produces a significant share of grain in China, 44 percent in 2014. In addition, grain production and urban-industrial sectors exist side by side in the North China Plain.

However, the concern for food security, which contributes to the intensification of grain production in the north, is also responsible for water pollution. To produce sufficient grains, the governments and farmers applied chemical fertilizers, pesticides and plastic mulches intensively, which contribute a major source of water pollution. In 2014, China consumed 60 million tons of chemical fertilizers, 1.8 million tons of pesticides and 2.6 million tons of plastic mulches, having increased from 12.7 million tons of chemical fertilizers in 1989, and from 0.73 million tons of pesticides and 0.48 million tons of plastic mulches in 1990 respectively (NBS 2015: 41; MOA 2009: 8). However, only 35.2 percent of fertilizers and 36.6 percent of pesticides were absorbed by crops. That is, 38.9 million tons of fertilizers and 1.1 million tons of pesticides were discharged to water and soil in 2014. Most of plastic mulches were left in farm fields, polluting soil and water (MOEP 2016). Chemical fertilizers and pesticides, once discharged to water, will contribute to the eutrophication of lakes and rivers, heavy metal pollution and the elevated levels of nitrite in groundwater. In addition, the expansion of animal farms, which are built to meet the growing demand for meat in China, has also been a major

source of pollution as animal waste containing antibiotics, hormones and bacteria is discharged into open water (Jin and Shen 2013; Schneider 2017).

According to the Ministry of Agriculture, agricultural production (including raising animal in factory farms) has surpassed industrial and urban sectors and become the largest source of pollution in China (Beijing Times 2015). Water pollution is positively associated with the intensity of farming activities. For example, the northeast, the North China Plain and the Middle Yangtze region, which are all the main sites of grain production, are among the regions that suffer most from the problem of water pollution (Yu, Hu and Zeng 2015). In addition, as grain production is intensified in the north, the pollution of groundwater is more serious than in the south, as noted above.

In sum, major water problems, including the crumbling of agricultural water facilities, depletion of aquifers and water pollution, have all been related to the contradictions in the structural dilemma between profitability and food security. The crumbling of agricultural water facilities in the south has been due to the bias toward urban-industrial sectors. The depletion of aquifers has been caused by the intensification of grain production in the north, which the Chinese state has promoted due to the concern for food security. All sectors, including agricultural, industrial and urban service sectors, have contributed to water pollution. However, the causes and results of water pollution are closely associated with the movement of grain production under the structural dilemma, that is, water pollution in the south has mainly derived from urban and industrial production, whereas it in the north has been mainly due to the discharges of wastes and toxins from agriculture.

3.5 Conclusion

This chapter shows that the neoliberal shift after the reform has sharpened the contradictions between profitability and grain production. In the 1980s, the pursuit of profits under a decentralized system led to the drastic cut of funding for the agricultural water system, leading to the breakdown of water facilities and the stagnation of grain production. To counter the trend, the central government increased water and agricultural investments in the 1990s. However, this reinforced the trend of the northward geographical movement of grain production, which was originally set in motion by the rapid expansion of urban and industrial sectors in the south, particularly in coastal regions. As a result, grain production and the distribution of water resources have been increasingly in mismatch, i.e., the water-scarce north has produced more and more grains, leading to serious water problems.

The worsening water problems have prompted the central government to take more forceful measures in the new century, including offering billions of water funds and setting red-lines on the exploitation of water resources. However, the central efforts must be implemented at the local level. The next chapter will look into central-local relations in China and assess whether and to what extent the new central measures, under the constraints of the profitability-food-security dilemma, can reverse the declining trend of the agricultural water system.

Chapter 4

Central Mandates and Local Interests: Politics of Water Investment

On 28 November 2014, *Southern Weekend*, a liberal newspaper in China, posed a puzzling question, “Why did huge water investments fail to alleviate droughts over the past decade?”⁴⁰ The newspaper pointed out that the Chinese state invested more than one trillion yuan in water sectors between 2005 and 2013. Yet, the acreage of farmland that was damaged by droughts did not diminish but expanded to 157 million hectares in the nine years, which is equivalent to 1.2 times all farmland in China. The newspaper attributed the problem to official corruption that scythed away agricultural water funds. Official corruption is indeed a factor, given the prevalence of corruption not only in the water system but in the entire administrative system (Kwong 2015; Sun 2004; Wederman 2004). This chapter will demonstrate, however, that the diminished impact of water investment has been due more to the structural dilemma than to the corruption of individual officials. The contradiction between food security and profitability has diluted central endeavor at the local level as local governments moved to concentrate resources on profitable economic sectors. The preceding chapter examines the regional manifestation of the structural dilemma. This chapter will take a step further and focus on the manifestation of the dilemma in center-local relations.

⁴⁰ “Why China experienced years of droughts after millions dollars investment poured into irrigation” (niannian jutou, liannian ganhan: wanyi nongtian shuili touzi weihe bu jieke) *Southern Weekend* (nanfang zhoumo), November 28, 2014.

I will first examine the structure of China's water management system. After that, I will detail the changes in central policy since the late 1990s that have resulted in rapid growth in agricultural water investment. I will then examine the responses of the local governments in the two counties in the context of increasing water funds. My research shows that, although the central government called for greater effort on the agricultural water system, local governments' responses to the call varied. In Southern County, the local government continued to concentrate resources on urban and industrial sectors, and diverted a significant proportion of central funds for purposes unrelated to agriculture. By contrast, Northern County invested increasing funds to sink tube wells, and the over pumping has led to the falling of water tables. As the competition for water has intensified between agricultural and urban sectors in recent years, the county also prioritized water supply for industrial and urban sectors, thus placing a great strain on the agricultural water system.

4.1 The Water Management System in China

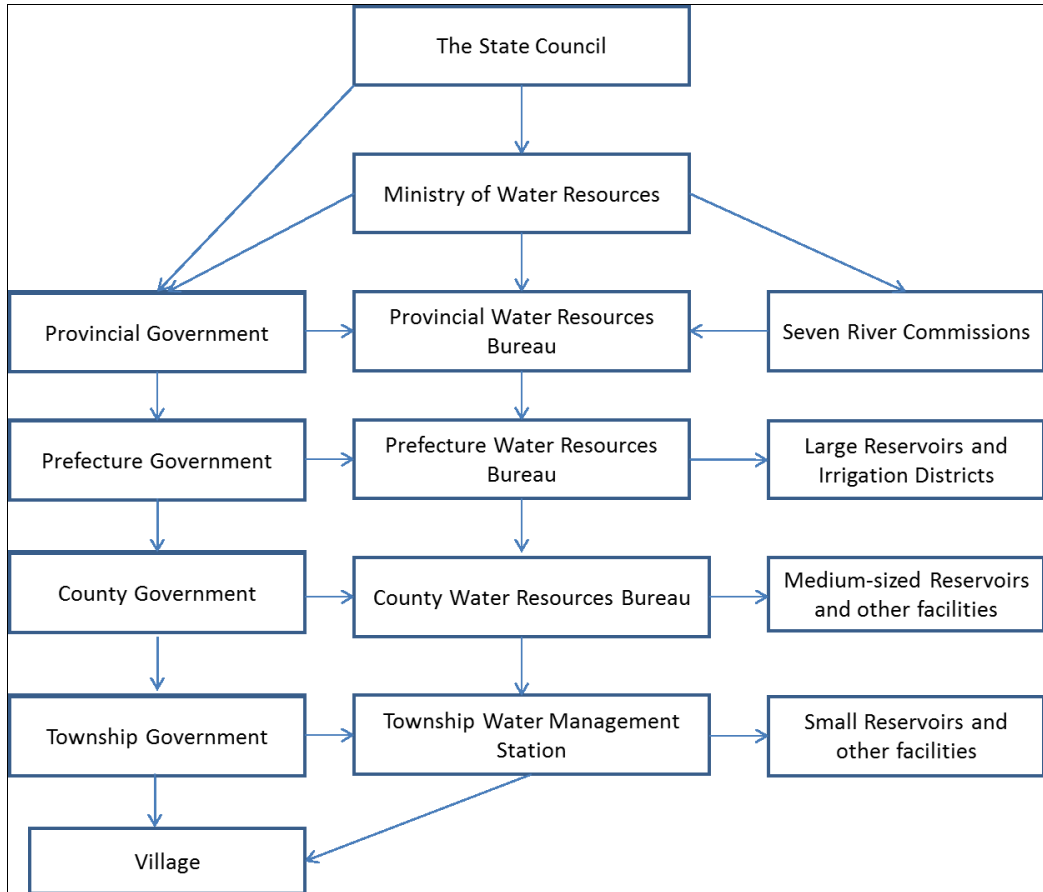
The water management system in China is a complex structure that comprises organizations and institutions from the national level down to the village level. Figure 4-1 shows all important components of the system. The system contains two different structures: the vertical structure and the horizontal structure. The two structures lead to the decentralization of decision making power in the water management system. As a result, the power of the central state is limited, and it must rely on the cooperation of local actors in carrying out its policies and programs.

The vertical structure is a salient feature of the system. At the top is the State Council, the highest administrative authority in China, and the Ministry of Water Resources is one of its agencies. Under the Ministry of Water Resources are Water Resources Bureaus at provincial, prefectural and county levels (at the township level are Water Resources Stations). These agencies form the hierarchy within the water management system. In addition, the vertical system of governments from the State Council to provincial, prefectural, county and township governments is responsible for water investment and management. This is so due to the horizontal structure that connects water agencies to governments at every level.

The horizontal structure refers to the water management system at a particular administrative level, which usually comprises a local government and a Water Resources Bureau. Take the county level as an example. The Water Resources Bureau is the principal government agency managing the water system in the county, including rivers, lakes, reservoirs, canals, pump stations, etc. However, it must be subject to the authority of the county government, and its funding also comes from/through the government. Thus the Water Research Bureau must follow the order of the county government, and as a matter of fact, it is one of the agencies of the county government. In addition, the Water Resources Bureau reports to the upper-level Water Resources Bureau, that is, the prefectural Water Resources Bureau, and follows policy commands from the latter. Thus, the Water Resources Bureau must be subject to the authority of both the county government and the prefectural bureau. The prefectural Water Resources Bureau does not have direct authority over the county government, but it can exert influence through the

prefectural government.

Figure 4-1 Structure of the water management system in China⁴¹



In addition, other government agencies are also involved in agricultural water investment. These include Bureau of Land Resources (*guotu ju* 国土局), Bureau of Finance, Bureau of Agriculture, Bureau of Development and Reform (*fagai ju* 发改局) and Office of Poverty Alleviation. These agencies have their own sources of funding and often invest in agricultural-water-related projects. Local officials I interviewed in Southern County called this *jiulong zhishui* (九龙治水) (literally, nine dragons govern the water), and

⁴¹ Figure 4-1 is partly based on Lohmar et al (2003: 5).

argued that water investment and management should be more centralized and streamlined.⁴²

In short, the decision making power of water management in China is decentralized, and the local government holds a very large say in water investment and management in its jurisdiction.

Figure 4-1 also shows that the Chinese state has set up ad hoc commissions for large rivers that flow through more than one province. These ad hoc commissions will coordinate provincial governments in water resources management. The most well-known commissions have been the Yangtze River Water Resources Commission and the Yellow River Water Resources Commission. These commissions report directly to the Ministry of Water Resources, a level above the provincial level. Likewise, water ways and irrigation facilities that flow across jurisdictions will be coordinated by a higher level of water management agencies. For instance, a large irrigation district that covers more than one county will be coordinated by the prefectural water agency.

Another important unit in the system is villages, which are the lowest level of social-bureaucratic organization in China. As seen from Chapter 2, the village-level organizations contributed greatly to the expansion of the agricultural water system in the Mao period. In the post-reform period, however, the de-collectivization reduced the village organization to a coordinator that does not have the power of control. Thus it has become difficult for villages to mobilize rural households to contribute to agricultural

⁴² The focus group discussion at Southern County Bureau of Finance: May 7, 2013.

water use. I will discuss this issue in detail in Chapters 5 and 6.

4.2 “Repaying the Debt”: Central Push to Rejuvenate the Agricultural Water System

The year of 2011 is another major turning point in the history of water investment in China. The State Council used its No.1 policy document to highlight the importance of the agricultural water system and promised to double water investment over the following ten years. In 2010, the total water investment from the central government reached 138.6 billion yuan, the highest level in the post-reform period. A doubling of water investment means that the central government would invest 277.2 billion yuan every year between 2011 and 2020. Mr. Chen Lei, the Minister of Water Resources remarked that the Chinese government was repaying the “debt” that it owed to the agricultural water system (Xinjingbao 2011). That is, the Chinese state should have invested the money in the system in the 1980s and 1990s but held off until now. In actuality, “repaying the debt” started at least a decade earlier than the release of the No.1 Document in 2011. As noted above, the center tripled water investment right after the summer floods in 1998. The water investment debt that the Chinese state “owed” was enormous. One conservative estimate puts it at three trillion yuan. If it were the case, it would take at least another 15 years for the Chinese government to pay off the debt if half of the investment is allocated for agriculture water.

Figure 4-2 Water investment financed by central and local governments: 2004-2014⁴³

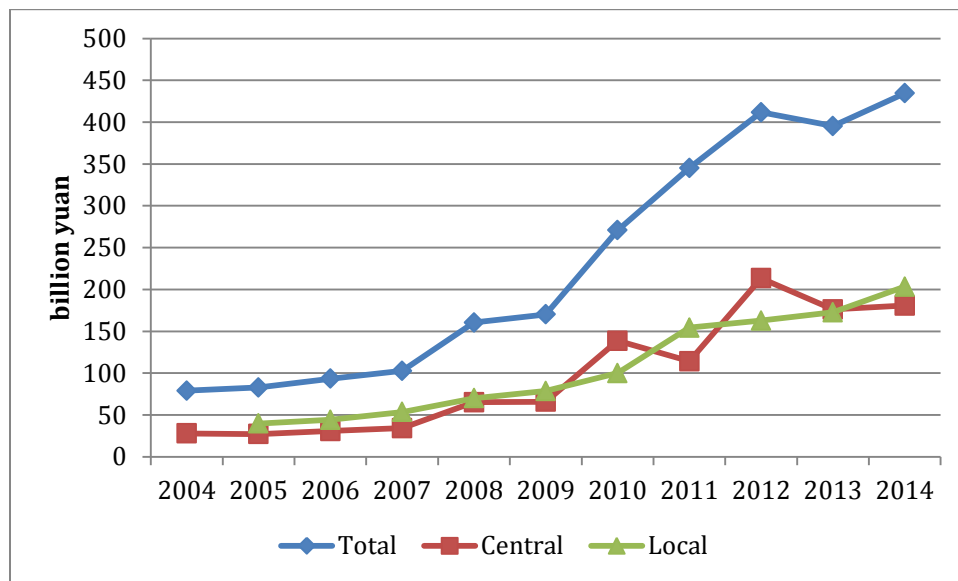


Figure 4-2 shows that water investment jumped from 170 billion yuan in 2009 to 434 billion yuan in 2014, up 155 percent. The increase was started by the central government, which doubled its investment in 2010 and nearly doubled it again in 2012. The central government also used the investment as a leverage to draw investments from local governments. One of the conditions for the reception of central water funds is that local governments must match an equal amount or a proportion of it for the same project. That is to say, the central government provides only a proportion of funding for a proposed local project, and the rest must come from the local government. These local funds, called counterpart funds (*peitao zijin* 配套资金), is a sign of shared responsibility between the center and local government. This is a key way for the central government to mobilize local resources to achieve national goals. Figure 4-2 shows that the surge in central

⁴³ The data derives from Annual Statistical Reports on Water Development, released by the Ministry of Water Resources.

investment has pulled up local water investments. As a result, water investments at the local level increased from 78.5 billion yuan in 2009 to 203.4 billion yuan in 2014. Figure 4-3 below also shows that central and local governments invested similar amounts of water funds in most of the years, suggesting a system of shared responsibility being in place.

The Ministry of Water Resources classifies all water investments into four categories: flood control, water supply, water conservancy and hydropower. Agriculture water use falls into the category of water supply, and it to some extent also depends on flood control and water conservancy. Flood control, such as building levees and dredging rivers, protects the irrigation system in the event of flooding. Water conservancy (*shuitu baochi*) refers to the treatment and prevention of the erosion of water systems such as rivers, valleys and basins. The investments for water supply not only include the funds for the supply of agriculture water but also those for the supply of water to industries, villages and cities. For example, the well-known “South-North Water Transfer project” falls into the category of water supply, but is mainly designed to supply water to cities in the north.

Figure 4-3 Composition of water investment: 2004-2014⁴⁴

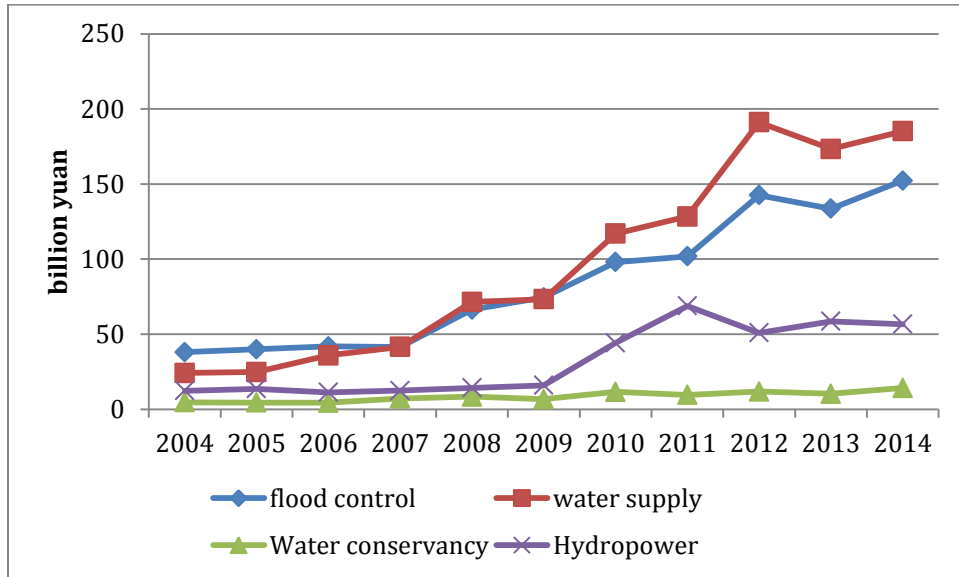


Figure 4-3 above shows the four types of investments from 2004 to 2014. Flood control and water supply received the largest investments, accounting for 37.3 percent and 45.4 percent in 2014 respectively. The funds for hydropower amounted to 56.7 billion yuan, making up 13.9 percent, whereas water conservancy received 3.5 percent. However, the funds for water supply include those for water supply for industrial use and residential use. According to the 2014 annual report of water resources, about 11.4 billion yuan was allocated for irrigation districts, and 37.8 billion yuan was allocated to build and repair small-scale irrigation facilities. These two investments make up 26.6 percent of the total investment for water supply in 2014. Therefore, it is difficult to decide how much funding has been allocated for agricultural water use because many funds are used to improve the comprehensive water system, from which the agricultural water system

⁴⁴ Data source: Statistical Bulletins on China Water Activities (*zhongguo shuili fazhan tongji gongbao*) each year, released by the Ministry of Water Resources of China. Please see: <http://www.mwr.gov.cn/zwzc/hygb/slfztjgb/>.

benefits. However, it is safe to state that the direct investment in agricultural water supply only accounts for a small proportion of all water funds, about 12.1 percent in 2014. Therefore, the total amount of all water funds after 2010 has increased rapidly, but the funds allocated directly for agricultural water were modest, as most of funds were used to improve the comprehensive water system or to construct large water projects such as hydropower and large-scale water transfer. For example, the central government invested 10.3 billion yuan in the South-North Water Transfer Project in 2014, which is close to the total amount of funds allocated to all irrigation districts across the country in the same year.

Nevertheless, the central government has paid much more attention to the problems of agricultural water than in the 1980s and 1990s. In 2004, the Chinese state launched the project of “Building a New Socialist Countryside,” under which many policies were undertaken to boost agriculture and improve conditions for rural residents. Water investments also grew as a result of the policy shift. In 2008, the State Council used the No.1 Document to focus on agricultural infrastructure, and the total water investment was increased by 56.3 percent in the year (Figure 4-2 above). In short, over the past decade and a half, the problems of the water system including agricultural water have drawn increasing attention from the center. The rest of this section will detail major measures undertaken to improve the agricultural water system since the turn of the century and the new targets set in recent years.

Strengthening embankment for large rivers and new large water projects

The 1998 floods exposed the vulnerability of the dams, levees and banks along large rivers including the Yangtze River, the Songhua River and the Huai River. After the floods, the Chinese state started to fortify embankment for all major rivers, and a significant amount of water funds were allocated for reinforcing existing embankments and constructing new embankments. The annual reports of water resources show that a few thousand kilometers of embankments were repaired and fortified every year after 1999. Between 2001 and 2014, the total length of embankments increased from 273,401 kilometers to 284,425 kilometers, up 11,024 kilometers. In the meantime, the length of up-to-standard embankments increased from 76,532 kilometers to 188,681 kilometers, up 112,149 kilometers. Provided that the new constructed embankment is all up to standard, the length of all embankments that were fortified in the period reached 101,125 kilometers, that is, the Chinese government fortified 7,223 kilometers of embankment every year on average (MOWR 2015:41).

In addition, the Chinese government started a number of major water projects that will improve the agricultural water system. For example, it carried out 19 major projects along the Huai River, which was flooded in 1991 and 1998, and again in 2003. The investment in the Huai River totaled 44.7 billion yuan and all projects were basically completed in 2010 (Xinhua Net 2010a). In addition, the Chinese government started to build a number of reservoirs. The building of reservoirs was mainly driven by the demand for hydropower, but some of the reservoirs were also designed to control floods and supply water to agriculture. The number of reservoirs increased from 84,363 in 2004

to 88,605 in 2011. That is to say, China constructed 4,242 new reservoirs in the eight years, of which 107 are large reservoirs, 477 are medium-sized and 3,658 are small reservoirs (MOWR 2015:36). It should be noted that two enormous water projects were also being built in this century: the Three Gorges Dam and the South-North Water Transfer Project. The main purpose of the former is to generate hydropower and that of the latter is to quench the thirst of northern cities for water, particularly Beijing and Tianjin.

Repairing and fortifying reservoirs and dams

The poor conditions of Chinese reservoirs would shock most observers. At the turn of the century, China was home to 84,083 reservoirs, of which 420 are large, 2,744 are medium-sized and 80,919 are small reservoirs. However, as many as 30,413 reservoirs, 36.2 percent of the total, were dangerous with their dams at the risk of collapsing. These dangerous reservoirs comprised 145 large, 1,118 medium-sized and 29,150 small reservoirs (Wang, Xu and Quan 2002). After a decade of repair and fortification, large and medium-sized reservoirs were all reinforced and removed from the list of safety watch. However, by 2012, there were still more than 40,000 small reservoirs at risk, according to the Minister of Water Resources (Chinanews 2012).

The safety problem of reservoirs is not new. In the 1970s, the collapse of hundreds of dams raised the alarm of reservoir safety. A survey carried out in the late 1970s found that one third of reservoirs were at potential risk and should be repaired (Guo et al 2011). However, the issue was shelved in the 1980s and early 1990s as the Chinese state axed

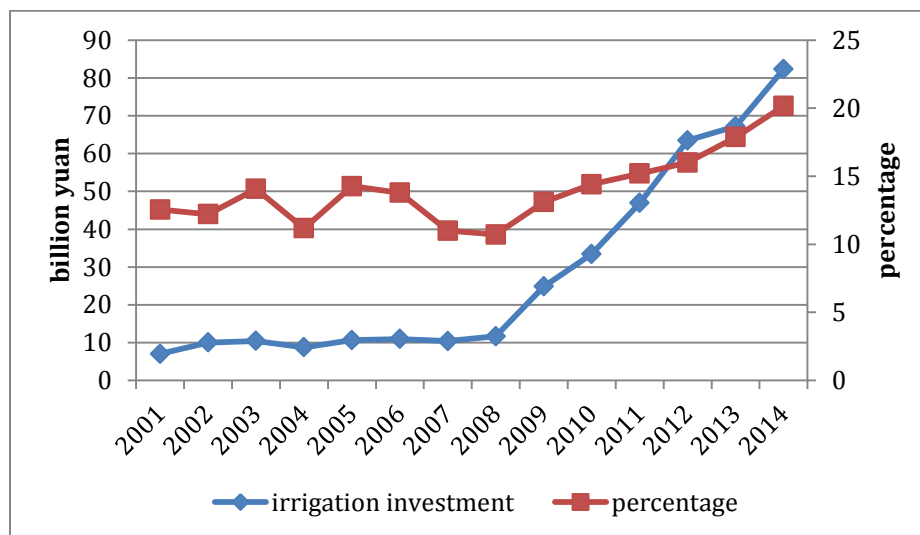
water funds. Prior to 1998, the central government financed the reparation and fortification of only 69 large reservoirs and 12 medium-sized reservoirs, a tiny proportion of those at safety risk (Renminwang 2001). In the three years after 1998, the central government invested 3.4 billion yuan to repair and fortify 183 large or medium-sized reservoirs (Renminribao 2001). After that, the pace of repairing and fortifying reservoirs accelerated. Between 2001 and 2007, the central government invested 27.6 billion yuan and repaired and fortified more than 2,000 reservoirs (CCTV 2007). In 2008, the Ministry of Water Resources, with the permission of the State Council, drafted and carried out another ambitious plan, which invested 62 billion yuan and completed the reparation and fortification of 7,356 reservoirs in three years. By 2011, all large, medium-sized and major small reservoirs had gone through reparation and fortification (Guo et al. 2011). Between 2011 and 2015 (the 12th Five-Year Plan), the Chinese state repaired and fortified all small reservoirs that were identified as at safety risk, 50,742 in total (Zhongguoshuilibao 2016). In summary, between 1998 and 2015, China completed repairing and fortifying all dangerous reservoirs, which amounted to approximately 60,000.

Direct agricultural water investment

Before 2008, direct investment in agricultural water only made up a small proportion of total water investment. Figure 4-4 shows that the proportion was around 10 percent between 2001 and 2008 and that annual irrigation investments amounted to about 10 billion yuan a year. These irrigation investments were usually used for large irrigation facilities. According to the annual reports of water resources, irrigation funds were mostly

used to build auxiliary facilities in large and medium-sized irrigation districts; ii) to improve the irrigation system in order to increase water use efficiency, including repairing canals and ditches; iii) to build electric pump stations and sink tube wells; iv) to improve the quality of farmland, such as preventing soil erosion and treating salinized farmland; v) to build and promote the use of water-saving facilities and technologies, particularly in arid areas.

Figure 4-4 Irrigation investment and its share in all water investments: 2001-2014⁴⁵



These irrigation funds were mainly allocated to improve major irrigation districts and large-scale irrigation facilities while neglecting small ones, which were supposed to be taken care of by townships and villages. However, it was clear in the early 2000s that rural communities and households alone could not deal with the decline of small irrigation facilities effectively. In 2005, the central government decided to establish a

⁴⁵ Data source: *China Water Statistical Yearbook* (MOWR 2015:140)

special fund for repairing and maintain small irrigation facilities. The fund went into operation in 2008, when the central government allocated three billion yuan for township- and village-level irrigation. The fund was increased to 13.6 billion in 2014, and the central government allocated 76.9 billion yuan in total for the special fund by 2014 (Guangaiwang 2013; Chinanews, 2013). Figure 4-4 shows that irrigation investments increased very rapidly from 11.7 billion yuan in 2008 to 82.3 billion yuan in 2014. And the share of irrigation in all water funds also grew to 20.2 percent in 2014.

In short, direct investments in irrigation (or agricultural water use) occupied only a marginal position in state efforts to improve the water system after the shock of the 1998 summer floods. In the first 10 years after the floods, the attention was focused on large rivers, large/medium-sized reservoirs and large water engineering projects such as the Three Gorges Dam and the South-North Water Transfer Project. It was not until around 2008 that the central government shifted attention to small reservoirs and small-scale irrigation facilities that serve directly agriculture.

“Three red lines”

To cope with the impending water crisis, the Chinese state has set “Three Red Lines” on water consumption, water use efficiency and water pollution control. The red lines suggest that they will be strictly enforced. The three red lines were raised in the 2011 No.1 Document, and were specified in another document released by the State Council in January 2012. Table 4-1 specifies the red lines and produces specific targets of water consumption, water use efficiency and water pollution control (Shen, Jiang and Sun

2015). The first red line is the ceiling of total water consumption. In 2010, China consumed 600 billion m^3 , and the economic growth would lead to the further growth in water consumption. This red line is made out of the concern of water scarcity. As noted earlier, per capital water resources in China is only one fourth of the world average, about 2,100 m^3 per person.

Table 4-1 The targets of the Three Red Lines

Targets	2015	2020	2030
Total water consumption must not exceed	635 billion m^3	670 billion m^3	700 billion m^3
Industries will reduce their water use per US\$1,600 (CNY10,000) of industrial added value	73.5 m^3	65 m^3	40 m^3
Irrigation efficiency must exceed	53%	55%	60%
The number of water function zones meeting the water quality standards will be more than	60%	80%	95%
All sources of drinking water meet standards for both rural and urban areas		Yes	Yes

The control over total water consumption can be achieved by increasing water use efficiency, which is measured by the next two indicators in Table 4-1. The water

consumption for every 10,000 yuan added value is expected to decrease from 105 *m*³ to 73.5 *m*³ in 2015 and further down to 65 *m*³ in 2020 and 40 *m*³ in 2030. In addition, irrigation efficiency is set to increase from less than 50 percent in 2010 to 60 percent in 2013. The control over water pollution is measured by water quality in water function zones and that of drinking water. Water function zones refer to any water zones use water for specific purposes such as drinking, fishery, ecological restoration, entertainment, industrial production and agriculture.

The State Council calls the Three Red Lines the most stringent policy of water management, and promises to enforce them effectively. These targets have affected water investments. To increase irrigation efficiency, the central government invested to repair canals and ditches to prevent irrigation water from leaking on the way to farms. In addition, the government promotes the application of water-saving facilities and technologies, particularly in water-scarce regions. However, as noted previously, the contradiction between food security and profitability has been the major factor in creating various problems. And this contradiction has not been sufficiently addressed.

Additionally, although the central government has enhanced policy support for agricultural water use, these policies must be implemented at the local level. Whether local governments will carry out these policies willingly and effectively matters a great deal to the prospect of the agricultural water system. Furthermore, despite the increase in central water funds, central budget alone is not sufficient to counter the declining trend of agricultural water use. To succeed, it must mobilize local resources. The following two

sections examine how central-local dynamics affected water investments in the two research sites.

4.3 Southern County: “The Local Fund Never Came”

Southern county is located in a region with abundant surface water resources. It lies to the south of Dongting Lake, the second largest fresh water lake in China. There are four major rivers and 131 water ways in the county that are longer than three kilometers. The lengths of the four major rivers in the county add up to 326 kilometers. The county built a comprehensive agricultural water system in the Mao period, as introduced in chapter two. The abundance of water resources and large numbers of irrigation facilities are no doubt a boon, but this also presents an enormous task for the county to control flood and maintain the agricultural water system.

In the 1980s and 1990s, the local government devoted minimal levels of financial resources only to keep the water system from falling apart while funds from the central government were merely a trickle. In the 18 years from 1986 to 2003, water funds from various levels of government totaled 255 million yuan, only 14 million yuan a year on average.⁴⁶ Furthermore, this aggregate figure conflates water funds before and after 1998. And the amount of water investment before 1998 was significantly less than that after 1998. According to the national data, the former was approximately one third of the latter. Assuming this was also true for the county, it can be estimated that annual water investment was about 8.5 million yuan a year in the county between 1986 and 1997. My

⁴⁶ Unless specified, data for the two research sites derives from official documents, government reports, local statistical compilations and local media reports.

interviews with local officials suggest that this may as well overestimate the actual investment. Mr. Wang, the head of the water management department within the Bureau of Water Resources, had worked for the bureau since the 1990s. He told me that the county budget for water investment was about two million yuan a year in the 1990s before it increased to five million in 2003.⁴⁷ If so, the total water investment was likely less than five million yuan a year in the 1990s because water funds from upper-level governments were usually about the same as the county-level investment at the time. In short, both local and central governments severely underinvested in the water system in the 1980s and 1990s.

The 1998 summer floods exposed poor conditions of the water system nationwide, including Southern County. More water funds started to come down from the central government to the county after that. In 2002, Field Reservoir received a central fund of 9.2 million yuan to repair and fortify its major dam. The dam was in a very poor condition after it was in use for more than 20 years without any repair and maintenance. If it collapsed, it would affect a great proportion of the population in the county and cause severe damages to farms, railways, highways and several towns in the downstream area. The budget for reparation and fortification was 18.5 million yuan, of which 9.2 million yuan was promised by the central government while the other 9.3 million yuan should be shouldered by local governments as a counterpart fund. After the central fund was paid to the reservoir, the provincial government allocated 450,000 yuan. The rest of the fund, 8.85 million yuan, was the responsibility of the county government. However, “the local fund never came,” the management staff told me on June 8, 2010 when I held a focus

⁴⁷ Interview date: May 6, 2013.

group discussion with them. In the end, the management agency only spent 9.65 million yuan.

Due to the insufficiency of the funding, the management agency had to scale back the original repair plan and focus only on the most necessary parts of the project. The management staff told me that the dam was much safer than before it was repaired, but it was still at risk since a few fortification plans had to be scrapped as there was no local counterpart fund. In addition, the repair only improved the safety of the dam but did little to agricultural water use. Canals and ditches were silted up or crumbled, and were unable to carry water to farms as efficiently as they would be.

The shortage of local funds was due less to the local government's weak financial capacity than to its investment priority. The county is much less concerned about grain self-sufficiency than the central government because it could purchase grain from the market if there were a shortage. In addition, the export of surplus grain cannot generate much income for the county due to the comparatively low prices of grain. Instead of investing in the agricultural water system that could not lead to a fast rate of economic growth, the county government focused most attention on urban and industrial sectors. In 2000, the county grew 8.9 percent, to which agriculture only contributed 1.1 percent, whereas industry contributed 4.6 percent and services 3.1 percent. In the same year, the county's fiscal expenditure totaled 265 million yuan, of which only 14 million yuan, 5.3 percent, was spent on agriculture, which includes multiple sub-sectors such as

agricultural water use, crop farming, animal husbandry, forestry and fishery.⁴⁸ That is to say, the spending on agriculture was even less than its contribution to economic growth (12.4 percent, or 1.1 out of 8.9 percent). Thus, despite the call from the central government, the government of Southern County continued to favor economic growth overwhelmingly over food security.

Table 4-2 Sources of water investment in Southern County: 2006-2014⁴⁹

	Total investment (million yuan)	Investment by central, provincial and prefecture governments		Investment by the county government	
		Amount	Proportion	Amount	Proportion
2006	42.0	30.0	71.4%	12.0	28.6%
2007	106.6	75.5	70.8%	31.1	29.2%
2008	98.4	68.4	69.5%	30.0	30.5%
2009	130.0	100.0	76.9%	30.0	23.1%
2010	224.0	143.0	63.8%	81.0	36.2%
2011	337.1	257.1	76.3%	80.0	23.7%
2012	481.5	368.5	76.5%	113.0	23.5%
2013	451.2	292.1	64.7%	160.0	35.5%
2014	324.2	244.2	75.3%	80.0	24.7%

⁴⁸ *Southern County Statistical Yearbook* 2001: 14-15.

⁴⁹ *Southern County Statistical Yearbooks* 2007-2015.

In the most recent decade, prompted by the central government, Southern County has significantly increased the volume of water investment. Table 4-2 shows sources of water investment in the county between 2006 and 2014. The proportion of water investment from the county remained about from one quarter to a third in the period. However, as the central government increased water investment, the investment contributed by the county government grew accordingly. Overall, total water investment in the county jumped from 42 million yuan in 2006 to more than 300 million yuan in recent years, and the investment from the county government increased from 12 million yuan to 80 million yuan and even more in some of the years.

However, my research shows that the tendency of the county government to favor urban-industrial sectors over grain production has not significantly changed. It is found that water investments in the county have continued to prioritize profitable sectors over agriculture water use. The county government has employed a number of methods to channel water funds to profitable sectors rather than grain farming. Below I will discuss three major methods found in my field research.

First, water projects are built to support urban and industrial expansion rather than agriculture, even though they are in the name of supporting agricultural water use. In the past decade, Southern County renewed dam construction after it was ceased in the 1980s and 1990s. Official records show that the county has built four large dams since 2006. However, while dam construction in the Mao period was aimed to support agriculture, in recent years has it been to promote urban expansion, tourism and hydropower. For

example, the Pearl Dam, which was built in 2006-2008, had received 22 million yuan from the county government alone and probably more from upper-level governments. The main function of the dam is not to irrigate farmland but to create a beautiful urban scene that could boost the prices of real estates around the water. An irrigation official told me that, although the Bureau of Water Resources was responsible for this project, it was the county leaders who decided on the site of the dam. He said, “As irrigation experts, my colleagues and I do not think that the site of the dam should be in the place where it is now.”⁵⁰ In addition to urban real estate, tourism is another sector that can stimulate rapid economic growth. The county government started a number of projects to reshape the existing reservoirs to attract tourists. For example, the local government has invested millions of yuan in tourist facilities of the large reservoir in the county from 2007 onward. Around the reservoir it built villas, a golf course and various facilities for water-related entertainment. Another two large dams are also built in tourist regions, and the last dam is built to generate hydropower to meet the increasing demand for electricity due to industrial and urban expansion.

Second, the government concentrated water funds in a few villages to build demonstration zones for grain production and the New Socialist Countryside. Although the county tends to prioritize industrial and urban sectors over agriculture, it has to show that it abides by central policy and does not violate any policy directives from above. In addition, as grain production has become a strategic national goal, the central government has offered generous infrastructure and development funds to regions that produce grains. To receive central funds, the county government tried to demonstrate its efforts in

⁵⁰ Interview date: July 20, 2010.

promoting grain production. My fieldwork in the county reveals that the county government has poured millions of dollars to a few villages to build the demonstration zones for officials from above to visit. The agricultural water system in these villages is the best in the county. This strategy is successful. From 2008 onward, Southern County has been recognized as a major grain-producing county, and thus received large amounts of development funds. The deputy director of the Finance Bureau of the county told me that the county received 400 million yuan of development funds from upper-level governments in 2012 alone for its status being a major grain-producing county.⁵¹ However, the concentration of resources in a few places would actually produce negative effects on the agricultural water system as it neglects the health of the water system at large. I will discuss this problem in more details in the next chapter.

Finally, water funds are also disproportionately distributed among the subsectors of agriculture. The county government has channeled more water funds to cash crops that could boost both economic growth and local revenue than to grain crops. For example, the county has been trying to turn itself into a base for tobacco production since 2005. Between 2005 and 2014, it invested more than 200 million yuan to build the infrastructure for tobacco production, including irrigation facilities, roads and tobacco houses. The irrigation project for tobacco, called *yanshui gongcheng* (literally, the tobacco-water project), received generous water funds. It is unknown how much money has been invested in the irrigation system for tobacco. My field visits to tobacco production bases in 2013 revealed that the irrigation system for tobacco farms is among the best in the county. In addition to tobacco, water funds have also been used to support

⁵¹ Interview date: May 7, 2013.

the farming of vegetables, tea and herbs for making medicines. The focus on cash crops such as tobacco, vegetables demonstrates the bias that the county government holds against grain crops, leading to water funds concentrated in areas of cash crops. This suggests that most farms, which are planted with grain crops, rice in particular, have received disproportionately low amounts of water investment.

In summary, water funds in Southern County have been oriented toward profitable sectors such as tourism and real estate, demonstration zones and cash crops, whereas grain farms, which account for about three quarters of farmland in the county, are neglected or given low priority. The concentration of water funds in nonagricultural sectors, demonstration zones and cash crop farms has undercut the investment for regular farms and undermined the efforts to improve the agricultural water system as a whole.

In addition, it should be noted that water funds for agriculture have only made up a small proportion of all water investments. At the national level, as noted above, most water funds are aimed to control floods and supply water for uses in the city. This is also the case in Southern County. Flood control has absorbed a significant proportion of water funds. The county is a place that has seen frequent floods and droughts. According to data from the county bureau of water resources, there was a serious drought every two years and flood every three years since 1949. In the event of natural disasters, the local government must work to minimize the costs of natural disasters and avoid any human casualties. Otherwise, local officials would be punished or even removed from their position. When there is a serious drought or flood, or a warning for one, major county

leaders, usually top county governor, will take the responsibility of coordinating government agencies, townships and villages to fight the disaster. Therefore, it should be noted that not all water funds were used directly for agricultural water use, though water investment has appeared very high in volume.

Nevertheless, the central government started to stress the importance of small irrigation facilities after 2008, and allocate water funds to repair and improve these facilities, including small reservoirs, canals, ditches and irrigation ponds. In the past five years, Southern County has also allocated water funds to improve small irrigation facilities. The next chapter will examine in detail how these funds were used and what impacts they had on the agricultural water system. It should be noted that these funds accounted only a small proportion of all water investments, usually less than 20 percent.

4.4 Northern County: Save Agricultural Water for the City

Northern County is located in eastern Inner Mongolia where the economy is relatively underdeveloped. Different from Southern County whose industrial and urban sectors make up the major share of the economy, Northern County is still an agricultural economy where the share of agriculture in the economy is much higher than that in the former (Table 4-3). In 2013, agriculture accounted for 25.8 percent of GDP in Northern County but only 11.2 percent in Southern County. Moreover, many nonagricultural sectors in Northern County are intimately related to agriculture. Industrial activities such as grain processing, meat production and alcohol production assume a crucial position in the local economy. Therefore, the contradiction between food security and profitability is

not as sharp as that in the south as the growth of grain production can be profitable in the county. As was shown previously, the problem in Northern County is not that it produces an insufficient volume of grain but that it produces too much grain in a water-scarce and environmentally vulnerable region.

Table 4-3 Key economic indicators of Southern and Northern County⁵²

	1995		2000		2005		2010	
	S	N	S	N	S	N	S	N
GDP (billion yuan)	2.4	1.1	6.2	1.5	14.4	3.1	49.0	9.3
Local revenue (million yuan)	201	51	236	60	535	170	2,548	508
Rural income per capita (yuan)	1,670	1,059	2,535	788*	4,371	2,626	9,227	4,746
Share of agriculture in GDP (percent)	38.6	—	31.5	45.9	20.8	46.4	12.6	28.5

Note: * A severe drought struck Northern County in 2000, leading to a rapid fall in rural income.

In the 1980s and 1990s, a major factor that held back water investment in the county was its poor financial capability. The county was recognized as poor county by the central

⁵² Sources: Statistical Yearbooks of the two counties in various years. S and N stand for Southern and Northern County respectively.

government, along with 591 other counties in the 1990s. In 1995, local revenue amounted to only 51 million yuan, and annual rural income was 1,059 yuan per capita on average, only two thirds of the national average, which was 1,578 yuan (NBS 1996:36). By comparison, local revenue in Southern County reached 201 million yuan in the same year, about four times that in Northern County. Table 4-3 shows that Southern County has outperformed its northern counterpart in nearly all economic indicators. In addition, the share of agriculture in GDP has been substantially lower in Southern County than that in Northern County.

Due to a tight local budget, Northern County had to mainly rely on central funds for water investment in the 1990s, while the local government took responsibility to mobilize peasants to contribute labor to water projects. In the early 1990s, due to the insufficiency of water funds, the county could only repair some existing irrigation facilities such as canals and culverts. Irrigated area started to expand, but at a slow speed. In 1993, for instance, the central government transferred only 2.2 million yuan to the county for water investment. In the late 1990s, the central government increased support for underdeveloped grain-producing areas such as Northern County. Water funds from the center were increased to 7.0 million yuan in 1995 and further to approximately 10.0 million yuan in 1999. In this period, attention was focused on both surface and ground water. The county inherited from the Mao period a number of irrigation facilities that harness surface water, including 15 reservoirs and 84 pump stations. Some of the water funds were used to improve these facilities. Contrary to Southern County where irrigated area stagnated or probably declined in the 1990s, Northern County saw its irrigated area

expanding from 340,000 mu in 1991 to 429,135 mu (28,609 ha.) in 2000, up 26.2 percent.

The year of 2000 was a turning point with respect to water investment in Northern County. A severe drought struck the county in full force and halved its grain production. In the meantime, the central government further increased development funds for poor and grain-producing regions in western China. As a result, the county received a growing volume of water funds, which totaled 149 million yuan between 2001 and 2005. After 2006, the county received about 50 million yuan a year for water investment. With these water funds, the county sank a large number of tube wells. In addition, the rising grain prices, which were a part of grain policy of the central government, motivated farmers to increase grain production. The most efficient way to do so is to sink tube wells and turn rain-fed farms to irrigated farms. The yield of the latter is usually a few times the former or even higher in a normal year, given low levels of precipitation in the county.⁵³ Thus both the local government and farmers were actively sinking tube wells. As a result, the number of deep tube wells increased from about 1,000 in 1999 to more than 9,000 in 2013, plus another 20,000 shallow wells. The extraction of ground water through the wells enlarged irrigated area in the county from 28,609 hectares in 2000 to 55,945 hectares in 2013, nearly doubled. This also boosted grain production in the county, which increased from 642,000 tons in 1998, the highest level in the 1990s, to 1.25 million tons in 2013, also doubled. This growth fits into the regional pattern. As seen from the previous chapter, northern regions like Inner Mongolia and Northeast China have become the backbone of grain production in China as grain production relocated from south to north.

⁵³ Annual precipitation in Northern County is usually between 301 mm and 406 mm.

However, the swelling number of tube wells has strained the county's scarce water resources. Mr. Cui, 44 years old at the time of interview, had been working for the Bureau of Water Resources of the county since 1989. He told me that the falling of groundwater tables accelerated in the past decade due to the intensification of groundwater irrigation. The water table fell nearly eight meters every year, and on average, groundwater tables in the county fell from 30 meters in the 1990s to more than 100 meters in recent years.⁵⁴ The over-pumping of groundwater drained away surface water while at the same time making recharge increasingly difficult. In addition, while low levels of precipitation have to do with climate change in the region, it also results from shrinking surface water in the county and surrounding areas, which reduces the likelihood of rainfall.

To deal with the problem of over-pumping, the county government started to introduce water saving technologies as early as in the 1990s. Farmers used to use traditional water-saving methods such as border irrigation, furrow irrigation and land leveling, and these methods have relatively low fixed cost, but they were adopted in the quite early age and have exhausted their potential of water saving (Liu, et al. 2008). However, the issue of water saving has never become more serious than in recent years. The county government no longer financed sinking new tube wells in recent years. In addition, it used a large water fund from the central government to promote drip irrigation. Drip irrigation can save water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. Thus drip irrigation is generally more efficient than conventional

⁵⁴ Interview date: March 19, 2013.

water-saving methods. The county started to install the facilities of drip irrigation in 2010. By 2015, it had installed drip irrigation for 900,000 mu of farmland (60,000 ha.). The financial cost of adopting drip irrigation is not low. The main equipment of drip irrigation including main line, valves and laterals, cost around 600-800 yuan per mu and they can be used for about 20-30 years. But every year farmers need to replace the drip tape, which will cost another 120-130 yuan per mu. In the phase of experimentation, the county government subsidized the installment of the main equipment and also the disposable drip tape. For instance, in 2012, besides providing free equipment to households who agreed to adopt drip irrigation, the government also subsidized 100 yuan for the replacement of drip tape per mu. Thus, individual households only paid 20 yuan for the replacement of drip tape per mu. Taken together, the central government had invested 648 million yuan in drip irrigation in the county. The project of drip irrigation is expected to reduce agricultural water use. According to my interviews with local officials, technically irrigating one mu of farmland only requires 15 to 20 cubic meters of water if drip irrigation is adopted, comparing to the 100 cubic meters with traditional irrigation methods. Thus it can save water up to 70-80%. The effect of drip irrigation remains to be evaluated in the county. A major concern arising from my fieldwork is whether farmers are willing to bear the recurring cost, that is, 120 yuan per mu after the first year.

The water-saving policy is well in line with the center's red lines. It seems that the initiative came from the central government as it provided nearly all funds for the application of drip irrigation. However, while agriculture has become the target of water saving and efficient water use, the city or industry has been largely spared from scrutiny.

Moreover, to stimulate economic growth further and increase revenue, the local government has now turned to industrial and urban sectors, particularly urban real estate. Table 4-3 shows that the share of agriculture in GDP declined from 46.4 percent to less than 30 percent in recent years, suggesting that the importance of agriculture in further economic growth has diminished.

Northern County, like many other cities and towns in China, has in recent years focused on urban real estate development for it can generate local revenue. When I was doing fieldwork in 2013, urban houses were sprawling well beyond the old county town and into the countryside. The size of the old county town was about 5.5 square kilometers in 2005, and it was expanded to more than 10 square kilometers. Along with the change was the growth of the population in the county town from 30,000 in the 1990s to 80,000 in 2013. According to the county's urbanization plan, the goal is to increase the population to 100,000 by 2015 and 200,000 by 2030. The county town will expand to 26 square kilometers accordingly. The county is located in a place with abundant land, thus the conversion of farmland into urban land, would not be a constraint. The biggest problem is water. The population growth has led to over pumping in the county town, and the water table declined to more than 150 meters. Moreover, underground water in the town is severely insufficient to meet the demand from further population growth.

The solution is water transfer. The county started to transfer water from the largest river that flows through the county. As noted above, the river does not contain much surface water. Thus the county sank 14 large tube wells along the river and transport water to the

county town through pump stations and water pipes. The distance between the water source and the county town is 34 kilometers. The project was started in 2012 and largely completed in 2015. The total cost of the project amounted to 137 million yuan, and there will be costs of maintaining the facilities thereafter. The central government provided 80 million yuan for the project, and the rest was financed by the local government. According to my interview with Mr. Cui, the central fund was offered to supply drinking water for rural residents. The local government also stated in official documents that the project was a part of the policy to supply water to rural residents who have no access to safe and clean water, with local media showing the pictures of rural residents receiving water from the project. However, the real purpose of the project is to send water to the county town, according to Mr. Cui. The water transfer project sends about 9.1 million m^3 of water to the city in a year. The total volume of water could irrigate 6,000 hectares of farmland if one hectare of farmland uses 1,500 m^3 . If drip irrigation is applied, it could irrigate at least two times more, i.e., 18,000 hectares.

In addition to the water transfer project, the county government built a dam in a river near the county town to create a water scene for urban real estate. This blocked farmland in the downstream from access to any water in the river. Walking on the river bank, I found the dam created two distinct scenes: on the one side is a beautiful lake-like water scene, but on the other side is the dried riverbed without a drop of water. This resembles the two faces of water use policy in the county: while agriculture is squeezed and must use less water, the city is favored with a generous share of water supply.

In short, as water has become increasingly scarce in Northern County, the county government has used water funds to build projects to save water from agriculture but to expand water use for the city. Although it appears legitimate to promote water-saving agriculture in the county, the increasing demand from urban expansion for water would push the county further into a water crisis. It is very likely that the largest river in the county will also dry up due to the intensive pumping for urban water use in the near future.

4.5 Conclusion

The central government has greatly increased water investment since the 1990s. The 1998 summer floods prompted it to allocate water funds for repairing and fortifying river embankment and reservoir dams. Under the strategy of “Building a New Socialist Countryside,” the government also allocated fund for strengthening agricultural infrastructure including irrigation facilities. The 2011 No.1 Document that focused on the water system has led to a new wave of water investment, and the total water investment in recent years has been more than ten times that in the 1990s. Scholars and officials remarked that the Chinese government is paying the debt it owed to the agricultural water system in the first two decades of the post-reform period. However, despite the large amounts of water funds reported by the central authority of water resources, it should be noted that more than 80 percent of water funds are not targeting the agricultural water system directly, and the funds for hydropower, the South-North Water Transfer project, and other projects to supply water to industries and cities assume a large share in all water investments.

In addition, most of water investments at the local level were also diverted to urban and industrial sectors. It is particularly so for areas like Southern County that derives economic growth much more from nonagricultural sectors than from agriculture. In Southern County, agricultural water funds have been diverted to building dams and water facilities for urban areas and tourist sites. And the local government refused to match counterpart funds for central agricultural water funds. In Northern County, agriculture assumes a relatively important position in the local economy. Central water funds and local efforts created a frenzy rush for tube wells in the first decade of this century. However, this has strained the water system and caused the water table to sink. In recent years, large central water funds were allocated to install drip irrigation. While water has been saved from agriculture, it is diverted to the city as the county relies on urban real estate development for economic growth and local revenue. As a result, water investment in the county is pushing the local water system toward a water crisis.

In a nutshell, the structural dilemma between food security and economic growth has shaped central-local relations in water investment. As compared with the central government, local governments are much less concerned about food security and grain production than economic growth and local revenue. As a result, while the central government invested heavily in agricultural water use, local governments often divert central funds to supply water for profitable urban and industrial sectors. This has undercut water funds for the agricultural water system in Southern County, and diverted water away from agriculture to the city in Northern County.

Nevertheless, as the central government poured funds into the agricultural water system and employed policy tools to create incentives for local governments to get in line, funds for agricultural water use have increased from both central and local sources. The next two chapters will examine how villages and farmers have responded to water investment from the government and how the contradictions between grain production and nonfarm sectors have shaped their incentive and behavior in agricultural water use.

Chapter 5

Who Tills the Land?

Rural Transformation and Agricultural Water in Southern County

On July 1st, 2010, Wen Jiabao, the then Chinese Premier Minister, came to visit Southern County for a collapsed dam and assess the progress of reconstruction. The dam, built in 1964, is positioned in one of the major rivers in the county and functions to divert water from the river to nearby farmland. A serious flood, following days of heavy rain, caused the dam to collapse. The premier's visit to the disaster-struck area worried provincial officials because it would expose the problems of water infrastructure. However, county officials were upbeat as they hoped to seize this opportunity to showcase their demonstration projects such as a modern grain-production base. Therefore, local officials made careful arrangements for the premier's visit to the dam. Nothing unanticipated had occurred. However, the event took a surprising turn after the visit. On the way back to the county town, a group of peasants stood beside the road and waved to the minibus that was carrying the premier. As usual, Premier Wen wanted to show his approachability to ordinary people and thus he asked the bus to stop. Mr. Chen, a middle-aged peasant, came forward to report that excessive coal mining in his township caused land subsidence and damaged houses and farms. However, households that were affected could receive little compensation. After the premier intervened, the problem was solved, but local officials lost the opportunity to flaunt the demonstration projects. Moreover, they were criticized by the premier for inability to solve the issue.

The event unfolded when I was doing fieldwork in the county. After obtaining more details, I found that what occurred was at odds with two popular assessments of China's agricultural water. The first assessment is that agricultural water is crucial to peasant livelihood and peasants pay much attention to it. The second is that peasants are unable to take collective action on irrigation because they are not organized (as noted in the introduction chapter). Both assessments cannot account for the event. Peasants in the township are much less concerned about irrigation than about nonfarm activities. The collapse of the dam affected 20,000 mu of farmland (1,333 ha.), but it did not cause an outcry from peasants since farming was not a major source of their income. Peasants were working in factories, running shops, driving trucks, doing construction work nearby and/or migrating elsewhere for jobs. Mr. Chen, for instance, owned a vegetable store in the central town of the township. In addition, the encounter with the premier was carefully plotted. Peasants knew that they could not get close to the premier at the scene of the dam due to the tight control by local officials. Thus they planned to intercept the motorcade on the road to the county town. After the premier got off the bus, a representative came forward with others supplementing his account. I learnt that a group of peasants had planned these steps carefully and created a scene of random encounter with the premier so that they would not be punished by local officials later. This demonstrates that peasants in some cases can organize and take collective action.

This chapter examines micro dynamics of agricultural water use at the sub-county level in Southern County, and details how rapid rural transformations in the past three decades have rendered the rural society inadequate to meet the challenge of reviving the

agricultural water system. I argue that social differentiation and the diversification of rural economic activities in the countryside have sharpened the contradiction between food security and profitability for peasants and rural communities. As a consequence, some rural households are much less interested to take effort to improve irrigation facilities than others. In addition, although it is true that village organizations are weakened and often unable to organize peasants to maintain irrigation facilities, it is an outcome of social differentiation that generates varying degrees of interest in agricultural water. As I will show, villages and peasants are able to organize and take collective action on public projects if their interests converge, as in the case of rural road construction.

The rest of the chapter is organized as follows. First, I will introduce the four villages where I carried out fieldwork and compare their social and economic conditions. Second, I will examine social differentiation and economic diversification in the villages and in the county at large. Third, I will show how social differentiation has affected households' attitudes and behavior toward agricultural water use. Finally, I will make a comparison between roads and irrigation facilities to show how rural households can take collective action on road construction but not on irrigation, though both are rural public works.

5.1 From County to Villages: Fieldwork and Micro-level Investigation

The village is the lowest official administrative level in water management, and it is tasked to manage and maintain small-scale irrigation facilities such as canals, ditches and ponds, which store and carry water to farmland. In 2000, there were 915 villages in

Southern County, but the number was shrunk to 392 in 2004. By the time of my fieldwork in 2013, it declined further to 368. The decrease was a result of the village-merging policy, which was widely practiced in China in the first decade of this century. The government merged two or three neighboring villages into one. After the merge, the population of a village usually increased to around 2,500 people. The upsizing of villages can reduce administration cost. In addition, the merging made it possible to fully incorporate village officials into the bureaucracy by reducing the number of village officials while increasing their salaries. Previously, village officials received a very low salary and they were supposed to work only part time. But the merging also brought problems for village governance. A major problem I found is the increased social distance between village officials and ordinary peasants as the officials focus more on orders from above than popular demand from below.

Along with the merging of the villages was the expansion of urban neighborhoods in the county town. The number of urban neighborhoods increased from 12 in 1995 to 33 in 2004 and further to 54 in 2013, testifying the rapid urbanization of the county. According to the population censuses, urban residents, including permanent urban residents and long-term migrants, accounted only for 15.6 percent in 2000, but it increased to 43 percent in 2010, and the population of urban residents reached 502,000.⁵⁵

I started to carry out fieldwork in Southern County in the summer of 2010, when I collected data on social and economic conditions of the county. In addition, I conducted a case study of Field Reservoir and performed interviews with peasants and irrigation

⁵⁵ Population census is conducted every ten years. The data derives from the 2000 and 2010 censuses.

officials. In April 2013, I started another extensive fieldwork in the county. In addition to interviews with county officials, I purposively selected two townships and four villages (two in each township) to investigate how geographical locations and economic conditions shape community and household actions on the agricultural water system. Of the two townships, one township (Dragon Township) is located only eight kilometers from the county town whereas the other (Mountain Township) is 72 kilometers away (Table 5-1). In Dragon Township, there are booming nonfarm opportunities. An industrial park, which houses more than twenty enterprises, is located in it. In addition, a great number of its rural laborers are working in the county town. By contrast, nonfarm opportunities in Mountain Township are limited. To find nonfarm work, rural laborers in the township have to migrate outside the county, and many are working in Guangdong province as factory workers. Field Reservoir, on which I conducted a case study in 2010, is located in Mountain Township.

Table 5-1 also shows that income per capita in Mountain Township (11,400 yuan, or 1,781 US dollars) is much less than that in Dragon Township (18,300 yuan, or 2,860 US dollars). The difference mainly derives from nonfarm income. A modern grain production base is located in Dragon Township. The government stated that the base covered 30,000 mu of land (2,000 ha.), but my fieldwork found that the core area was about 3,000 mu (200 ha.). One of the villages in the township selected for my fieldwork is located within the core of the base, while the other is next to the village but is outside the core base. This provides a good case of comparison as the production base received much more irrigation funds than did the villages outside the base.

Table 5-1 The two townships in the year of 2013⁵⁶

	Dragon Township	Mountain Township
Distance to the county town (kilometers)	8	72
Number of villages	13	16
Population (persons)	38,900	51,800
Farmland (hectares)	2,140	2,655
GDP (billion yuan)	1.42	1.07
Annual income per capita (yuan)	18,300	11,400

I use capital letters—Dragon A, Dragon B, Mountain C and Mountain D—to denote the four villages I visited. Dragon A and Dragon B are located in Dragon Township while Mountain C and Mountain D in Mountain Township. In addition, Dragon A is located within the grain production base. Within each village, I interviewed village officials for basic social and economic conditions, with a focus on policy implementations in the village. In addition, I randomly selected 25 to 30 households for a questionnaire survey and a semi-structured interview, and collected 105 questionnaires in total. The rest of this section will briefly describe the conditions of each village based on my interviews with village officials while the next three sections will report my findings from the questionnaire survey and household interviews.

⁵⁶ Data source: *Southern County Yearbook* 2014.

Dragon A is located about 13 kilometers away from the county town, and situates at the center of the grain production base. The farmland totals 2,400 mu, mostly rice paddies, and land per capita is from 0.6 mu to 1.4 mu, depending on the production team to which one belongs. In any case, the size of land holding is very small in the village, so is in other villages. There are 701 households and 2,460 residents in the village, of which about 1,500 are counted as laborers. According to village records, about 380 laborers migrated outside the county in search of work, and amongst them, 130 crossed the provincial border. Most of migrant laborers went to Changsha, the capital of Hunan Province. In addition, village officials told me that dozens of people in the village went to work in coal mines in other provinces because wage rates were higher. A miner could earn more than 5,000 yuan a month. Most of the laborers in the village took nonfarm jobs nearby or in the county town, including taxi or truck drivers, small business owners, factory workers, chefs, construction workers, domestic workers, and etc. Most of them took care of their farms while working as nonfarm workers because it takes less than an hour to travel from their workplace to home. There were also nonfarm opportunities within the village. The villagers were running a rice factory, a cement factory, a gas station, a kindergarten, and a few restaurants and convenience stores. Peasants who work mostly on farms usually age above 50 years old. Many of them also took part-time nonfarm work nearby. Irrigation facilities within the village include a small reservoir, 40 ponds and three kilometers of canals and ditches. Located in the production base, the village received millions of water funds, with which it cemented all canals and hired people to maintain all irrigation facilities on a regular basis. Thus I was surprised when some villagers complained to me that they could not irrigate their farms. Further

investigation revealed that the village was receiving water from the largest reservoir in the county. However, as major canals were crumbled due to poor maintenance, reservoir water could no longer reach the village in recent years. However, the village is located in the production base. Thus the county government invested millions of yuan in 2013 to construct a new canal to divert water from coal mines in the neighboring township to the village.

Dragon B is located next to Dragon A, and peasants in the two villages are engaged in similar economic activities. Dragon B is slightly larger than Dragon A, with a population of 2,756 and 714 households. The farmland is about 2,700 mu. A major difference between the two villages is that Dragon B is located outside the core zone of the production base. This caused the divergent paths of irrigation investment as irrigation facilities were much underinvested in Dragon B than in Dragon A. As a result, villagers, both village officials and ordinary peasants, exhibited strong grievances toward the local government for the unfair treatment. The party secretary of the village complained to me, “In the grain production demonstration zone, roads and irrigation facilities are well built and maintained with millions. However, we did not receive any of those funds. As a matter of fact, our village is more supportive of farming rice. We are not in the zone, but most of our farms are growing double-cropping rice.”⁵⁷ The secretary remarks came against the background that more and more peasants in the county gave up double-cropping rice for single-cropping rice to save on labor. Peasants grow single-cropping rice for self-consumption rather than for sale in the market because their income mainly derives from nonfarm employment. To create the false impression for visitors from

⁵⁷ Interview date: May 15, 2013.

upper-level governments, the local government ordered that all farms within the production base must grow double-cropping rice. Dragon B irrigated farmland with water from a nearby river, and a dam was used to divert water from the river to farms. However, due to sand mining in the river and poor coordination,⁵⁸ the water level decreased to the point that the dam was no longer able to divert water to farms. In recent years, the village had to pump water from the river to the canals first. As the canals were also broken down, peasants must use electric pumps to move water from canals to their farms. This greatly increased irrigation cost and became a major source of complaints from the peasants. The leadership of Dragon B was reshuffled in 2010 due to the corruption of the former party secretary. The secretary contracted the project of village road to a company, and allegedly took bribes from the company. As a result, the newly built road was in a very poor condition. The corruption case had badly shaken the faith of villagers in village officials.

Villages of Mountain C and Mountain D are located in Mountain Township. Mountain C is located in the downstream of Field Reservoir, and its farmland is irrigated by water from the reservoir. However, Mountain D is located higher than the reservoir, and it cannot take use of the water from the reservoir. Mountain C has a population of 2,764 and 776 households. Farmland per capita in the village is 0.8 mu, similar to other villages. As the village is located far away from the county town, many peasants migrated outside the county in search of work. The major destinations of migration are Guangdong Province, Changsha and the county town. Previously 60 percent of migrant laborers from

⁵⁸ Sand is a crucial construction material for housing, and plays an important role in urban expansion in China.

the village went to Guangdong. In the recent decade, as economic opportunities in the county grew due to rapid urbanization and economic growth, some of the migrants returned and found nonfarm work within the county. At the time of my fieldwork, about 40 percent of the rural laborers were working in Guangdong Province. Since many peasants were working far away, land transfer was widespread in the village. Village officials estimated that 60 percent of farmland was transferred to other households. The government project also accelerated the process. The village is located in the zone of tobacco farming. Two hundred and forty mu of land, about one fifth of the total, was transferred to seven households to grow tobacco. Interestingly, six out of the seven households were village officials while another received the government contract. The party secretary was farming 70 mu, the largest of all tobacco farms. According to him, the households that ran tobacco farms previously made a loss, and after that, no households wanted to take the risk. However, tobacco farming is a political task which must be fulfilled, thus village officials had to take over these farms themselves. The tobacco farms, which can generate much more local revenue than grain crops, also received generous funds from the local government. Around two million yuan were invested in the infrastructure (land levelling and irrigation) for tobacco farms in the village, and irrigation facilities for these farms are the best. In addition, the farms located near Field Reservoir can receive stable water supply, but those far away suffer irregular water supply due to the poor maintenance of canals and ditches.

Mountain D is about 10 kilometers away from Mountain C. It has a population of 2,680 and 672 households. Due to the construction of Field Reservoir, a significant proportion

of farmland was flooded in the early years. As a result, farmland per capita is small in the village, about 0.4 mu. In addition, the quality of land is substandard since the remaining land is usually located on hills. However, the village has large woodlands which can be used to grow medical herbs. And it is much more profitable than rice farming. A rich villager contracted 1,000 mu of woodland to grow medical herbs and was hiring 20 villagers as seasonal workers, who were paid on a daily basis, 50-60 yuan a day. Many households also grow medical herbs themselves. The risk of farming herbs is high. The harvest comes three years after the initial sowing, and market prices are highly unpredictable in such a long period. As in Mountain C, many peasants migrated from Mountain D to elsewhere in search of work. The difference is that Mountain D is located near a market town and thus villagers can find some nonfarm jobs nearby. For example, there is a meat-processing factory near the village, and it hires about 50 local laborers. In addition, the village is also running a few stone mines that produce construction materials for the city. These mines, which are all leased to private investors, also employ a small number of local laborers. Irrigation in the village relies mainly on dozens of ponds, but most of the ponds are silted up and their irrigation capacity is substantially reduced. To irrigate their farms, some households use electric pumps to draw water from the reservoir, but it is very costly.

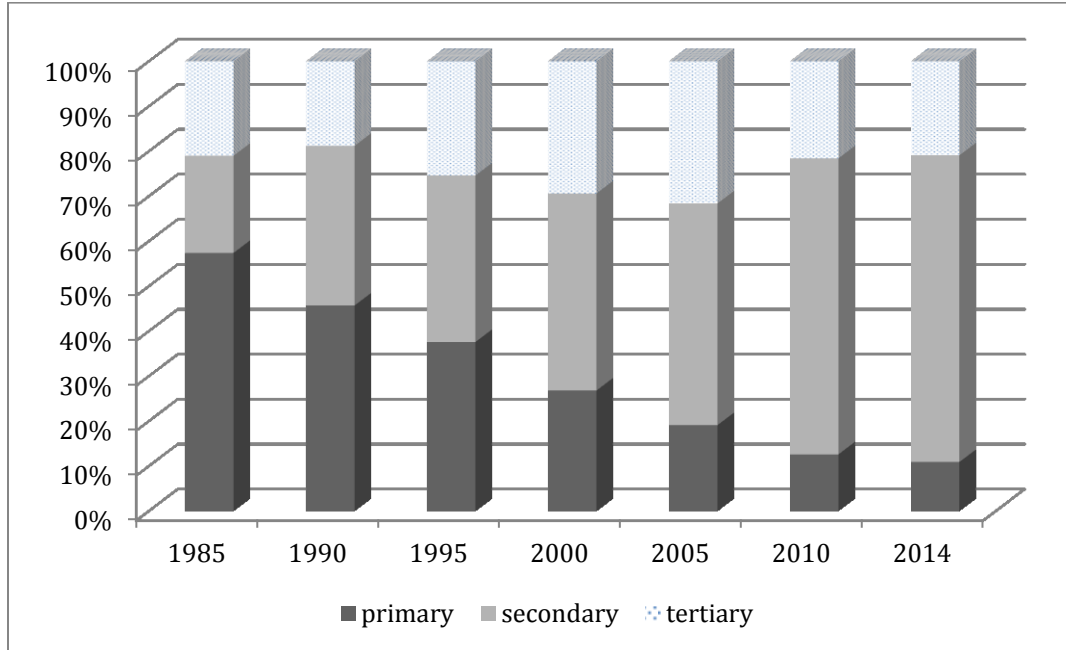
In summary, the four villages differ from each other in terms of distance to the county town, migration patterns, local nonfarm opportunities and crop structure. There are also similarities. For instance, farmland per capita in all villages is small, and thus most rural households cannot rely entirely on farmland for income and must engage in nonfarm

activities. With respect to irrigation, all villages are tapping surface water, and their irrigation facilities have deteriorated to varying degrees in the past three decades. In recent years, the villages received funds from the government to improve irrigation facilities. Except for Dragon A, the funds are insufficient to repair all irrigation facilities. The four villages cannot represent all villages in Southern County, but the diversity enables me to investigate the actions of rural communities and households in a rapidly changing rural society. The findings from the four villages can also shed light on agricultural water use in the region, the Middle Yangtze Region, or the south at large, where farmland per capita is small and peasants engage in a wide range of economic activities. The next section will draw on my questionnaire survey and interview data to show the patterns of rural differentiation and stratification in the villages.

5.2 Rural Differentiation and Stratification

The aforementioned switch from double-cropping rice to single-cropping rice implies reduced effort on grain farming from peasants. According to my interviews with local officials, about half of the farmland in Southern County switched to single-cropping rice. The change derives from the diminishing share of agriculture, grain farming in particular, in both local economy and household income. In 1985, the share of agriculture (primary sector) in local GDP was 57.4 percent, but it declined to 19.1 percent in 2005 and further down to 10.9 percent in 2014. Meanwhile, the share of secondary sector (mainly industry) rose from 21.6 percent to 68.2 percent (Figure 5-1).

Figure 5-1 Composition of local GDP in Southern County: 1985-2014⁵⁹



The share of agriculture in rural income has also declined considerably. According to the county's official statistics, rural income per capita in 2014 amounted to 19,500 yuan. However, only 4,224 yuan, 21.7 percent derived from agriculture, while wage income amounted to 9,155 yuan, 46.9 percent of the total and income from nonfarm business amounted to 13.2 percent. In other words, only one fifth of rural household income came from agriculture while more than 60 percent of income derived from wage employment or nonfarm business. The share of grain farming is even lower as agricultural income comprises incomes from animal husbandry and cash crop farming.

My questionnaire respondents reported an even lower proportion of agricultural income. Table 5-2 shows that agricultural income accounts for only 14.8 percent, and farming

⁵⁹ *Southern County Statistical Yearbook 2015.*

income was 8.1 percent. The numbers were probably underreported because some of the respondents excluded income from the grains that were self-consumed. The share of farming income should fall somewhere between 10 and 15 percent. At any rate, the share of farming in household income is low. According to an agricultural official, farming has become a sideline activity for peasants in the county.⁶⁰ In addition, out of 105 questionnaire respondents, only 26 reported that agricultural income, which includes income from both farming and animal husbandry, is important to their family. Only seven respondents stated that the importance of agricultural income had increased over the last 30 years, while 52 answered that it had declined.

Table 5-2 Composition of household income in Southern County⁶¹

Southern County (N=105)				
	Farm income	Income from Animal husbandry	Nonfarm income	Total
Amount	5,839	4,794	61,104	71,737
(yuan)				
%	8.1	6.7	85.2	100

Along with the declining importance of agriculture comes occupational diversification. Take the household as a unit of analysis. It is rare that a household engages only in agriculture. Of 105 respondents, only eight households were engaged solely in agriculture. Most of the households were engaged in agricultural and non-agricultural activities at the

⁶⁰ Interview date: May 3, 2013.

⁶¹ Data source for Table 5-2, 5-3, 5-4 and Figure 5-2, 5-3: survey data in Southern County.

same time. I further classify occupations within a household into four categories: farming, animal husbandry, wage employment and nonfarm business. Table 5-3 shows the number of households with different combinations of occupations.

Table 5-3 Combination of occupations by rural households in Southern County

Occupations within the households	Frequency	Cumulative percentage
Farming; wage employment	24	22.9
Farming; animal husbandry; wage employment	19	41.0
Farming; wage employment; nonfarm business	13	53.4
Farming; animal husbandry; nonfarm business	11	63.9
Farming; animal husbandry; wage employment; nonfarm business	8	71.5
Wage employment; nonfarm business	7	78.2
Farming	5	83.0
Farming; nonfarm business	5	87.8
Farming; animal husbandry	3	90.7
No working member	3	93.6
Animal husbandry; wage employment	3	96.5
Wage employment	2	98.4
Nonfarm business	2	100.3
Total	105	

The table reveals that most of the households combine agricultural and non-agricultural activities. The largest category is the households that combine farming and wage employment, followed by those that take up the two plus animal husbandry. A large number of households run small nonfarm businesses, totaling 46 households or 43.8 percent. In addition, 76 households are engaged in wage employment, accounting for 72.4 percent, that is, nearly three quarters of the households have members who earn wage income. It should be noted that this survey may have underreported the number of households that had the entire family migrating to the city because the survey only targeted the households that still had members in the countryside.

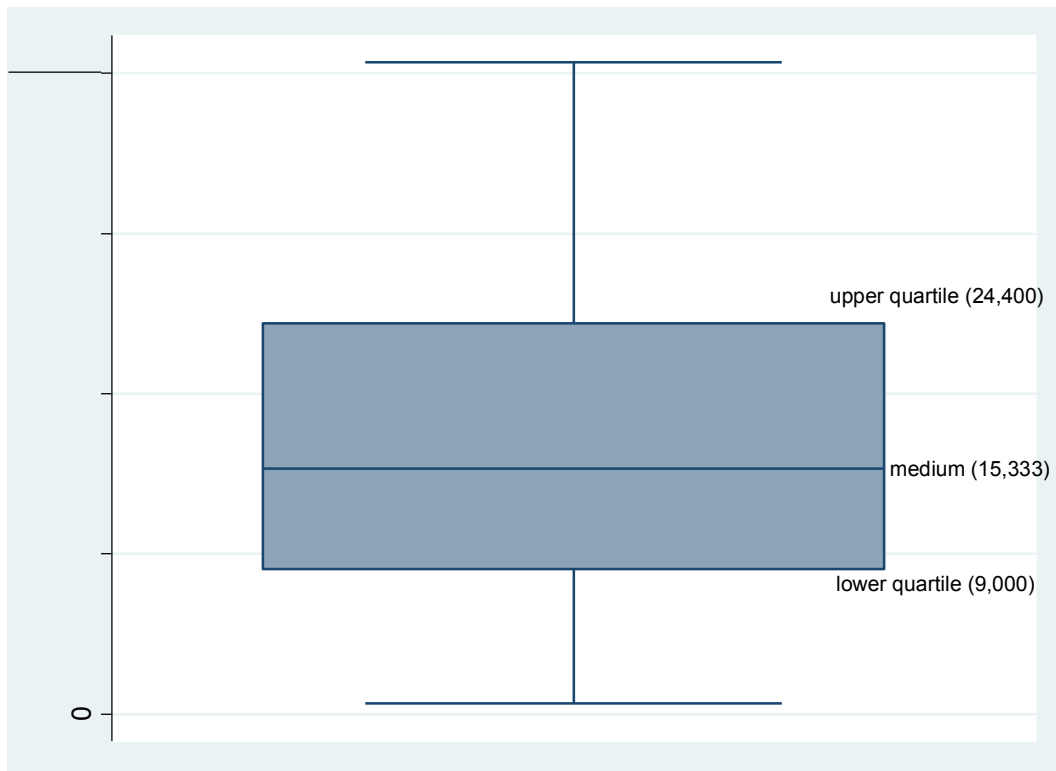
Within a household, the members whose age is above 50 usually take up agriculture, while the younger members work for wages or run small business. Mr. Chen⁶² in Dragon A village, 62 years old at the time of interview, was farming 14 mu of rice paddy, of which seven mu was leased from fellow villagers. The rent is 100 yuan per mu/year. He was living with his son's family. His son, 40 years old, was working as a house remodeling worker in the nearby township. He earned about 200 yuan a day and worked for 320 days in 2012, which made his annual income 64,000 yuan. His daughter-in-law worked in a raincoat factory with a monthly salary of 2,000 yuan. By comparison, income from rice farming was much lower. Mr. Chen told me that the net income from one mu of rice was only 600 yuan. That is, he could only earn 8,400 yuan a year from growing rice. The largest expense of the household was children's education. His granddaughter attended a high school in the county town, and all expenses added up to

⁶² Household interview No.18 on May 13, 2013.

15,000 yuan a year. His grandson was attending a middle school in Dragon township, which cost 6,000 yuan a year.

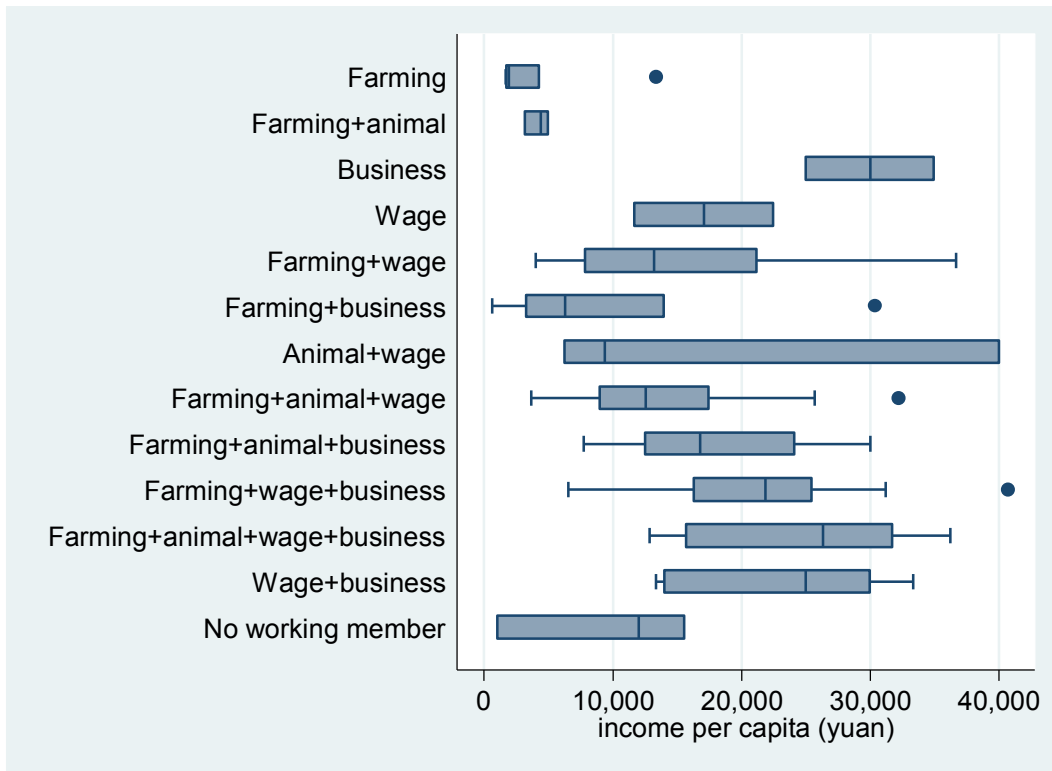
In addition, the rural society was highly stratified, with rich households pulling far ahead of poor households. Figure 5-2 shows the distribution of income for the 105 households. Median income per capita was 15,333 yuan in 2012. The lowest was 650 yuan while the highest reached 40,700 yuan. There were one quarter of the households earned less than 9,000 yuan while another quarter of the households earned higher than 24,400 yuan.

Figure 5-2 Distribution of income per capita for 105 surveyed households



Social stratification is highly correlated with occupations within a household. Figure 5-3 shows that households with members engaged in nonfarm business receive the highest medium income. When a household is solely engaged in nonfarm business or combines nonfarm business and wage employment, the household is most likely to be among high-income households. By contrast, households that are only engaged in agriculture are more likely to position in the low-income range. Figure 5-3 also shows that wage employment is highly stratified, and can result in either high income or low income, as implied by the income distribution of the households that are engaged in “farming and wage employment” or “farming, animal husbandry and wage employment.”

Figure 5-3 Distribution of income by occupation



The survey above does not include two powerful and high-income occupations. One is the contractors (*baogongtou*), who contract large infrastructure projects such as road construction and irrigation projects. These contractors often have connections with government officials and can secure contracts through these connections. I did not interview any large contractors formally, but I met with a few of them when I was conducting interviews with government officials. In addition, my interviews with peasants also verified that they were among the richest in the countryside. The other group of rural elites are village officials such as party secretary and village head. Party secretaries are appointed by the township government while village heads are elected by villagers every three years. The salaries they receive from the government are low, 920 yuan a month. This is even lower than the wage rate of a factory worker in the county, which was 1,500 yuan per month in 2013. However, party secretaries and village heads often own businesses. In addition, they can derive income from other sources, which are not acceptable by law or government regulation. My fieldwork found two common ways to do so. One way is to take kickbacks when contracting village infrastructure projects to contractors. For example, I was told that the former village party secretary of Dragon B took kickbacks when contracting out the project of village road construction. The other way is that they receive a percentage when they lease out common village resources such as land. In Mountain D, it was widely believed that village officials took money when leasing stone mines and collective woodland out. In recent years, village official corruption has become widespread. For example, it is an open secret that village officials take a cut when the village receives government funds. These blatant corruptions increase village officials' income but undermine the trust of villagers on the village administration.

Other remunerative occupations in Southern County include factory owners, shop owners, enterprise managers, skilled technicians who own means of production such as trucks and excavators, and farmers who are engaged in large-scale animal husbandry and cash crop farming. These high-income occupations are often related to the booming industrial and urban sectors. For example, as the housing sector has expanded greatly in the recent decade, new high-income occupations such as excavator operators emerged. Mr. Wang⁶³ in Dragon A, 41 years old at the time of interview, has a family of five. He and his wife must support his mother's eldercare and two daughters in middle school. In 2011, he and a fellow villager took loans and purchased a Japanese excavator, which cost them 1.1 million yuan. They hired an excavator operator with a monthly salary of 4,000 yuan. His job was to find businesses for the excavator. As there are so many construction sites in the county, there is a high demand for the excavator. In 2012, the excavator brought a profit of 250,000 yuan. In addition, he purchased a used truck in 2012 to transport earth and stone for construction sites, and earned 30,000 yuan. His wife worked for six months in 2012 as a domestic helper in the county town with a monthly salary of 1,800 yuan. In 2013, she must stay home because she had to take care of her mother-in-law. Thus the household leased five mu of farmland from fellow villagers and farmed eight mu of rice in total.

Low-income households are mainly engaged in small-scale farming and low-wage employment. For example, Ms. Hu, 40 years old at the time of interview, stayed home and took care of farms and families.⁶⁴ Her mother-in-law was 81 years old and her

⁶³ Household interview No.8 on May 13, 2013.

⁶⁴ Household interview No. 93 on June 3, 2013.

daughter was in middle school and son in primary school. The size of her farm is very small, only 2.8 mu. Her husband migrated with a construction team and worked in various provinces. He could earn about 30,000 yuan a year, given that he did not suffer any work injury. He was injured when working in coal mine previously, and after the incident, his physical conditions no longer allowed him to work as a miner. In 2012, the household was in the bottom quarter of the income distribution, 6,200 yuan per capita.

With regard to farming, the farm size of most households that were surveyed was small. A third of the households farmed three mu or less, and two thirds of the households farmed 6.5 mu or less. In addition, 91.1 percent of the households farmed one hectare (15 mu) or less. Only three households I interviewed in the county farmed more than two hectares, with the largest farm size being four hectares. The small size of land holding limits the amount of income from agriculture, and it is particularly so if the land is used for grain farming. Some households are able to generate a relatively high income by using the farm to grow cash crop. For example, Mr. He in Dragon B, 44 years old at the time of interview, leased 40 mu of land to grow vegetables.⁶⁵ Previously, he was working in Changsha as a meat vendor. As the vegetable market was booming, he decided to return home and farm vegetables on a large scale. In 2012, his vegetable farm generated a profit of about 120,000 yuan. However, vegetable farming was also a high-risk business, depending on the market and weather. In 2011, his vegetable farms made a loss due to low market prices and an insect disaster.

⁶⁵ Household interview No.43 on May 16, 2013.

In a nutshell, the rural society in Southern County is highly differentiated and stratified, with most of households taking up nonfarm economic activities. This has profound impact on the agricultural water system at the village level. The next section will document how social stratification and differentiation has affected the maintenance of irrigation facilities in the four villages.

5.3 Diverse Interests in Agricultural Water

Villages in Southern County are supposed to take responsibility for two kinds of irrigation facilities: small canals and ponds. There are 65,000 ponds in the county, that is, 176 ponds for each village on average. These ponds store water from rain, which can be used for irrigation during the dry season. Small canals are the last part of a large irrigation system, which sends water from reservoirs, lakes, rivers through artery canals, large canals and small canals to farm field. If small canals were broken down, water would not reach farms even though other facilities are in good shape. They are called “the last mile” of the irrigation system in China. After the Chinese state invested enormously to fix large water facilities such as large reservoirs and river embankments, the problem of “the last mile” started to surface.

The conditions of ponds and small canals in Southern County are no better than those of large facilities. Most of the ponds are silted up due to a lack of dredging. In the Mao period, villages organized peasants to clear mud out of the ponds every year so that the ponds could store more water for irrigation. In addition, the mud removed from the ponds was a good fertilizer and thus were taken to nearby farms. However, in the post-reform

period, villages were unable to organize peasants to dredge the ponds. This was primarily due to the aforementioned factor that farming was less profitable as compared with nonfarm activities. In addition, chemical fertilizers were widely used, and thus there was no demand for pond mud as fertilizer. As a result, nearly all ponds in the county were silted up, and their irrigation capacity was significantly diminished. Mr. Wang⁶⁶ in Mountain D, 63 years old, farmed six mu of farmland. Besides farming, he and his wife were raising pigs and working for the large farm of herbal medicine in the village. He told me that a pond near his farm could irrigate 20 mu of farmland in the past. However, the pond was silted up due to lack of dredging, and it could irrigate less than 10 mu in 2013.

Small canals must be constantly maintained; otherwise they would be silted up, blocked or broken down. As these canals are an integral part of the larger irrigation system, the breakdown of a small canal upstream would affect a wide area downstream. Interviewees in all four villages complained about the poor conditions of small canals. Ms. Zeng,⁶⁷ 47 years old, farmed nine mu of land, of which five mu were leased from a fellow villager. She and her husband owned a relatively large pig farm and raised 200 pigs a year. Their only son was working in Changsha after graduating from college. Ms. Zeng lamented about the poor conditions of canals. "Irrigation in our production team is the worst as we are located in the downstream of the canal. No one takes responsibility. Every household contributed a few workdays to maintain the canal in the past, but no one does it now. In the past four years, we had to use an electric pump to get water from the river, which is

⁶⁶ Household interview No.73 on May 21, 2013.

⁶⁷ Household interview No.45 on May 16, 2013.

100 meters away from the farm. The canal is blocked by mud and trash, and water cannot flow through. My neighbor leased his five mu of land to us because farming is too much a trouble due to poor irrigation.”

Except for those in Dragon A, most of the households, 53 out of 74 respondents or 71.6 percent, agreed that irrigation in their village had been getting worse in the past three decades. Only eight respondents, or 10 percent of the total, held that irrigation was getting better. This might be due to the fact that the government allocated some funds in recent years to dredge the ponds, which I will discuss below.

As noted in the introduction, a widely accepted notion is that the disintegration or weakness of village organizations is responsible for the decline of irrigation facilities at the village level. Some of my interviewees also blamed the problem on village officials who did not organize villagers to maintain irrigation facilities. However, village officials held that they did try to organize villagers, but many villagers resisted. Chinese scholars also attributed the problem to the policy that abolished the compulsory labor contribution (Luo 2005; Luo and He 2008). As noted in Chapter 3, the central government mandated in 1991 that each rural laborer must contribute a few workdays every year to public works including irrigation facilities. However, the policy was abolished in 2006, as a part of the policy shift under the Program of “Building a Socialist Countryside.” As a result, village officials were no longer able to force villagers to contribute workdays. Thus it was argued that the abolishing of compulsory labor contribution led to the decline of irrigation facilities at the village level. However, what happened in Southern County was

at odds with this argument. The fact that village officials were unable to mobilize peasants existed long before the policy was abolished in 2006. It was seen in the 1980s, and particularly so in the 1990s.

My research revealed that the abolishing of agricultural taxes in 2006 had a negative impact on agricultural water system. It made it very difficult for water management agencies to collect water fees. Water management agencies were set up to manage large and medium-sized reservoirs, pump stations and artery canals so that water could be sent from reservoirs and rivers to farms. To cover the cost of water supply, peasants were required to pay. The rates were not high, however. It was 26 yuan per mu in Southern County, less than five percent of agricultural output. Previously, the township government collected water fees along with agricultural taxes. However, after agricultural taxes were abolished, water management agencies must collect water fees themselves. It is a very difficult task to collect water fees from every household. And a number of households refused to pay water fees. In 2010, I was told that the management agency of Field Reservoir could collect only one third of water fees. And the situation was getting worse since more households were following suit when they saw other households not paying the fee. By 2013, I was told that some water agencies stopped collecting water fees. Without water fees as an extra income, water management staff lost the incentive to maintain reservoirs and canals. As a result, some large canals broke down.

My research showed that the lack of collective action on agricultural water and the difficulty in collecting water fees had much to do with the differentiation of the rural

society. Although many rural households in Southern County are still engaged in grain farming, its share in rural income has declined to less than 15 percent, as noted earlier. In addition, the rural society is highly stratified, with the higher strata relying much less on agriculture than the lower strata do. Furthermore, even the lower strata must devote great efforts to nonfarm activities, notably wage employment, to avoid falling into poverty. This affects agricultural water at the village level in two ways: the importance of irrigation facilities has diminished as it contributes a marginal share of rural income; households have diverse interests in agricultural water as their degree of engagement in agriculture is different, and the divergence in interest has rendered collective action very difficult.

Most of my interviewees, including village officials and ordinary villagers, agreed that the importance of irrigation had declined to the extent that peasants were unwilling to devote effort to it. However, there is difference between the four villages. Dragon A and Dragon B are located close to the county town and many of the villagers find nonfarm employment nearby. It is convenient for them to take care of farming while working as wage workers or small business owners at the same time. Therefore, a significant proportion of households were still engaged in farming and attached some importance to irrigation. In Dragon A, 14 out of 31 respondents answered that fellow villagers paid more attention to irrigation than 30 years ago, whereas six respondents answered that fellow villagers paid less attention. Others answered “no change” or “do not know.” In Dragon B, six respondents out of 21 chose “more attention” while eight chose “less attention.” The difference between Dragon A and Dragon B was derived from the fact

that Dragon A was located in the core demonstration zone and received a much greater amount of irrigation funding. The government intervention led some villagers unwilling to express their opinion for fear that it would jeopardize what they already had. Six respondents answered “do not know,” the highest proportion among the four villages.

Table 5-4 Attention paid to irrigation over the past 30 years

Village	A		B		C		D	
	Count	%	Count	%	Count	%	Count	%
More attention	14	45.2	6	28.6	0	0.0	2	7.1
Less attention	6	19.35	8	38.1	18	72.0	21	75.0
No change	5	16.1	5	23.8	4	16.0	4	14.3
Do not know	6	19.35	2	9.5	3	12.0	1	3.6
Total	31	100.0	21	100.0	25	100.0	28	100.0

By contrast, Mountain C and Mountain D are located far away from the county town, and thus villagers must migrate in long distance to find nonfarm employment. As noted, many of the villagers migrated to Guangdong Province to work as factory workers. Therefore, there is a tradeoff between farming and nonfarm employment, and most

villagers have chosen nonfarm employment over farming. As a result, much less attention has been paid to irrigation in the villages due to long-distance migration, as compared with Dragon A and Dragon B. In Mountain C, no respondent agreed that fellow villagers paid more attention to irrigation than 30 years ago, whereas 18 out of 25 respondents opined that fellow villagers paid less attention. In Mountain D, two respondents suggested that more attention was paid to irrigation while 21 respondents argued otherwise.

Despite the difference among villages due to the availability of local nonfarm employment opportunities, the interest in irrigation has declined generally along with the contribution of agriculture to household income. Mr. Yan⁶⁸ in Mountain C, 66 years old, was farming four mu of land with his wife. His son worked in Changsha and supported them with 4,000 yuan a year. Other sources of income included farming income and 960 yuan of pension from the government. He told me that his farm used to receive water from Field Reservoir. However, the canal was broken down in the past ten years, and he had to rely on ponds for irrigation. But the ponds were also silted up and lost much of their capacity. He said that it was difficult to organize villagers to repair the canal or dredge the ponds because most of the youngsters were working further away, and remaining villagers were unwilling to do it. The daily rate of wage was over 100 yuan, and no one wanted to work on irrigation for free.

⁶⁸ Household interview No. 81 on June 3, 2013.

Irrigation is of little importance to higher income households that are not engaged in farming. Mr. Li⁶⁹ in Mountain D, 44 years old, owned a truck and drove it himself. His wife was running a hair salon in a nearby town. His family was among the highest income in the village and had not been engaged in farming for more than ten years. His answer was a definite “no” when I asked him whether he was willing to donate money or free workdays to irrigation. He has two daughters. One daughter was working in the county town as an accountant and the other was a student in middle school. The family owned one apartment in the county town and two houses in the nearby town. Their future plan for residence was open but definitely not returning to agriculture.

Diverse interests in agricultural water have rendered collective action on irrigation very difficult. Some households did not farm at all. In Mountain C and Mountain D, it was estimated that one quarter to one third of households left agriculture for nonfarm sectors. In Dragon A and Dragon B, the ratio was less than one quarter, but the importance of agriculture declined significantly. Among the households that were still engaged in agriculture, many did not see agriculture as a substantial source of income but a source of food for self-consumption. Among 105 households I surveyed in the four villages, only 26 household or 24.8 percent regarded farming as an important source of income, and among them, only six respondents regarded it as extremely important. These respondents were either specialized households that contracted farmland for large-scale farming or poor households that depended solely on farming. As many as 44 households regarded farming as an unimportant source of income, and the other 35 households took the position in between. In other words, rural households in Southern County have varying

⁶⁹ Household interview No. 69 on May 21, 2013.

degrees of interest in farming, and this undermined the basis for concerted action on irrigation.

Mr. Deng⁷⁰ in Mountain C, 28 years old, was running a small business installing security doors, and earned an income much higher than that farming would generate. He had been a production team leader for two years at the time of interview. He told me that it was difficult for the management agency of Field Reservoir to collect water fees. Some households refused to pay the fee on the excuse that they did not use water from the reservoir. Some did not pay because they did not farm their land. More and more households followed suit and refused to pay water fees. As a result, no one maintained the canal in the past ten years, and the canal was broken down, cutting off irrigation for 40 mu of land in his production team. Peasants had to give up growing rice and shift to drought-resistant crops.

Therefore, the lack of collective action at the village level was derived from diverse interests in agricultural water. This is not to say that the disintegration of village organizations did not have any impact. My fieldwork observed a general decline in collective efficacy in the villages. As noted, the former party secretary of Dragon B was removed due to a charge of corruption. In the other three villages, peasants complained about the corruption and misconduct of village officials. The most common accusation is that the village officials embezzled government funds that were supposed to be used for public projects. This reflected a general distrust of village officials even though villagers did not have concrete proof of corruption.

⁷⁰ Household interview No.101 on June 6, 2013.

However, the lack of trust does not suggest that the villages are unable to take collective action to pursue their common interests. The following section will examine the case of road construction. It shows that all villages were able to take collective action when their interests converged.

5.4 Divergent Paths of Agricultural Water and Village Roads

Roads, like irrigation facilities, are a kind of infrastructure requiring large investments and constant maintenance. However, unlike irrigation facilities, roads serve fast-growing sectors such as the automobile industry, transportation, commerce, tourism and real estate, and thus occupy a central position in the rural economy of southern China, which has been expanding its nonfarm sectors over the past three decades. This difference has produced divergent outcomes of investment in irrigation and road construction at the village level.

After 2005, along with the overall strategy to stimulate the rural economy, the investment in rural roads increased greatly. Between 2006 and 2009, the central government invested 166.1 billion yuan, which, together with other sources of investment, constructed and reconstructed rural roads in the length of 1.56 million kilometers (Xinhua Net 2010b). In the 12th Five Year (2011-2015), the central government provided 326.5 billion yuan for rural roads, and mobilized other sources of funding for up to 1.3 trillion yuan, which mainly came from local governments and rural households. By 2015, 99.9 percent of

administrative villages nationwide had access to paved roads, and the length of all paved rural roads reached 4 million kilometers (Xinhua Net 2016).

As a usual practice, the central government only provides partial funding for rural roads, and requires local governments and beneficiary households to supplement at least an equal amount of funding. According to an official at the Bureau of Transportation of Southern County, the central and provincial governments provided 100,000 yuan for the construction of every kilometer of village road, and the prefectural and county government supplemented 30,000 yuan and 10,000 yuan respectively.⁷¹ That is, a village can receive 140,000 yuan for every kilometer of road it builds. However, the cost of one kilometer of road was 300,000 yuan before 2010, and it increased to 350,000 yuan in 2013. In other words, a village must invest 160,000 yuan for every kilometer of road before 2010, and 210,000 yuan in 2013. However, such a large cost did not dampen the enthusiasm of villages to upgrade their roads. In the five years of 2006-10, the county built 2,700 kilometers of village road. That is, the villages contributed 432 million yuan to village road construction. All four villages built paved roads when I conducted fieldwork in 2013, and nearly all households I interviewed contributed to road construction, and all of them agreed that the contribution was justified.

There are four ways for villages to seek supplementary funds for road construction. First, a village may ask for donations on a per capita basis from every household in the village. Dragon A built its road in 2008-09, every resident in the village contributed 200 yuan, and some poor households were allowed to contribute less than the amount. The

⁷¹ Government official interview on May 8, 2013

contribution in Dragon B was 15 yuan per person, but it asked the households near the road to contribute more. Each of these households contributed about 3,000 yuan, and some rich households contributed as much as 20,000 yuan. Mountain C built its road in 2009, and every resident was asked to contribute 600 yuan, but the poorest households could waive the contribution. Mountain D built its main road in 2006 with a poverty reduction fund, and did not ask for contributions from villagers. But many households donated money to build branch roads, usually 100 yuan per person.

Second, a village may ask for extra donations from wealthy villagers and former residents of the village, including business owners, civil servants and high-wage professionals. In Dragon B, a villager who works for a local bank donated 20,000 yuan while another former villager working as a policeman donated 10,000 yuan. In Mountain C, every former villager who work in the government was asked to donate 20,000 yuan. And the rich villagers who are usually business owners or professionals were also solicited for donations. Some villages erected a stone tab and inscribed on it the names of donors and donation amounts. These stone tabs were an honor and recognition for the donors, and would enhance their reputation in the village community.

Third, a village seeks extra government funding to supplement the road construction cost through any social/political connection they could obtain. The party secretary of Dragon A told me that he spent 75 percent of his time nurturing good relationships with government officials in the county town or the capital city of the province in order to get more funding for his village. If the village has any former villagers who hold powerful

government positions, the village officials will ask him/her to help the village get extra government funds. This is commonly practiced in the county. In Dragon B, a former villager was promoted to the head of the Department of Armed Force (wuzhuang buzhang 武装部长) in a neighboring county, and he helped the village receive a large government fund to supplement the funding for road construction.

Last, a village may take loans to build the village road, and pay off the debt later. Village B made a debt of 1.2 million yuan after it built its main road, and Mountain C made a debt of 500,000 yuan. In many cases, the village would not take loans from the bank but owed the payment to the construction company. Local construction companies often allowed late payment because they were eager to contract the project. These villages hoped to pay off the debt with future government funds.

In a contrast to irrigation, villagers, no matter they are engaged in farm or nonfarm sectors, hold a common interest in roads. As the market has penetrated into the rural economy, households are in much need to transport people and goods. Farming households need a good road to purchase agricultural inputs and sell agricultural produce or farm animals. Roads are also crucial to non-agricultural activities such as rural industry, local commerce and labor migration, not to mention truck driving, which are among the most profitable undertakings in the county. Road transportation is thus in a much more central position than irrigation in the rural economy. In the 1990s and early 2000s, well-off villages in Southern County started to pave their roads with hard materials such as cobble, asphalt and concrete. With increased funds from upper

governments in the past decade, more and more villages upgraded their roads to concrete roads. The enthusiasm for road was further fueled by the increased use of motorized vehicles. Of 105 households surveyed, 93 owned motorcycles, 30 owned a truck, and 19 owned a car.

All four villages were much more enthusiastic to build roads than to repair irrigation facilities. Of 105 respondents, 57 held that fellow villagers attached more importance to roads than to irrigation, and only nine respondents answered the other way around. And 25 respondents suggested that fellow villagers paid equal attention to roads and irrigation. Many respondents remarked that they were not willing to donate for irrigation. However, when asked whether they were willing to donate for roads, 98 respondents gave a positive answer while only seven respondents answered otherwise. As a matter of fact, all four villages successfully mobilized villagers to contribute to the construction of the village roads.

The divergent paths of agricultural water and roads in the four villages demonstrate two points. First, a major reason for the lack of collective action on agricultural water has been the divergent interests in irrigation in rural areas of Southern County. When villagers' interests converge, they can take collective action toward a common goal, as in the case of rural roads. Second, although the decline of collective efficacy did take place in the reform period, it is still hasty to suggest that village communities are unable to take collective action. The four villages in this study, as well as many other villages in the

county, were able to mobilize villagers to donate for village roads and activate social resources through community and kinship networks.

5.5 Conclusion

Due to the dire situation of the agricultural water system at the village level, the central government in the past five years allocated funds for the reparation of small irrigation facilities, such as small reservoirs, branch canals and ponds. By the time of my fieldwork in 2013, every village in the county, including the four villages in this study, received government funding to dredge ponds and repair branch canals. This made a positive impact on agricultural water use. However, government funds fell far short of the actual demand. There are 176 ponds in each village on average. At the time of fieldwork, fewer than 10 ponds had been dredged in each of the four villages. Thus it would take many years to dredge all ponds. In addition, the policy has not addressed the fundamental problem of irrigation: diverse rural interests have rendered any collective action on irrigation very difficult.

The diversity of rural interests has been derived from the pursuit of profitability. The imbalance in economic returns between farming and nonfarm sectors has led rural laborers to leave agriculture (grain farming) in masses. As a result, social economic status in the rural society is highly associated with nonfarm activities. Rural residents, including village officials, could gain little if they devote efforts to grain farming and irrigation. It is against this background that village officials are unwilling to organize peasants for irrigation and that peasants are unwilling to devote efforts to irrigation. The contrast with

roads throws this into sharp relief. Due to its central position in the rural economy, the construction of the village road would not only generate greater economic returns but also bring honor and reputation to village officials and the village community as a whole.

The top-down push on grain production was also diluted at the village level. The local government concentrated water funds in a few villages (for instance, Dragon A) rather than distributed them equally and fairly. Villages that did not receive much funding support held strong grievances, and this further undermined their incentives in irrigation. I was told that village officials who asked villagers to donate for irrigation would be seen as incompetent and unqualified because they were not able to get government funds for it. This further prevented village officials from taking initiatives on irrigation.

The situation in Southern County reflects in many ways the situation in much of southern China, where the expansion of nonfarm sectors in the rural economy has marginalized or is marginalizing agriculture and grain farming. However, it does not represent places where farming still assumes an important role in the rural economy. The next chapter will examine the case of Northern County, a water-scarce area where rural households still derive from agriculture a major share of their income.

Chapter Six

Deep Wells and Dying Trees:

Water Extraction, Rural Stratification and Ecological Crisis in Northern County

On March 25th, 2013, I went to X village in Northern County to meet with the village party secretary, Mr. Feng, in his office. In the middle of our meeting, several farmers came to the office to discuss a plan to establish large family farms. I was surprised by how quickly they responded to the concept of “family farm” (*jiating nongchang*), which had been raised by the central government only a couple of months before.⁷² The farmers who intruded into our meeting were all rich farmers who already leased a few hectares and desired to further expand their farms. They saw the party secretary as their ally because he was a rich business man and wanted to expand his farm as well. These farmers regarded the policy of promoting family farms as a good opportunity. The obstacle, however, was low-income households in the village that did not want to give up their land. According to Mr. Feng, they accounted for about 30 percent of all households in the village. In the meeting, Mr. Feng and other rich farmers suggested that the government should terminate the land policy which contracted the village land to all households on a 30-year lease. They argued that the best way to develop agriculture was to consolidate all village land and lease the land to whoever bid for it with the highest price. As a scholar introduced by the county government, they saw me as someone who might be able to influence the local policy, thus Mr. Feng and these farmers tried to convince me that the local government should support their project of land consolidation

⁷² The term family farm (*jiating nongchang*) was raised in the 2013 No.1 Document.

because it was in accordance with central policy. In addition, according to them, after the land was consolidated, they could apply for government funds or use their own funds to sink tube wells and turn more farmland into irrigated land, which would further increase agricultural productivity. These farmers were drafting a proposal to be submitted to the local government while I was doing fieldwork in the village. As this chapter will show, the competition for land has intensified in Northern County as rich farmers who possess financial capability to control water resources have sought to lease in more farmland and expand the scale of production.

This chapter examines the dynamics of agricultural water use within Northern County, and investigates how grain production and water use have interacted with social differentiation in the countryside. In addition, it will assess the impact of intensified grain production and water extraction on local environment, and examine rising water demand from industrial and urban sectors. The chapter shows that access to water is a crucial factor in social differentiation, and vice versa. Other scholars' works argue that agricultural capital, embodied in large farms and agribusiness companies, has become increasingly powerful in Chinese agriculture sector (Andreas and Zhan 2016; Schneider 2017; Yan and Chen 2015; Zhan 2017; Zhang and Donaldson 2008). This research shows that large farms and agribusiness companies are in a more advantageous position of controlling water, whereas small farmers tend to lose out and have to seek employment elsewhere. In addition, the demand for water in urban/industrial sectors in the recent decade has increased even in an agricultural county like Northern County, placing greater pressure on water supply.

The chapter is organized as follows. First, I will provide a brief description of two townships and three villages where I carried out field investigation. Second, I will describe social differentiation and various employment choices, including agricultural work, local nonfarm employment and long-distance migration. Third, I will investigate how a number of factors, particularly social differentiation, have affected access to water, setting in motion a downward spiral of water extraction. Finally, I will examine the impact of intensified grain production and water extraction on the environment and assess the effectiveness of the water-saving program by taking into account the growing demand for water from urban and industrial sectors.

6.1 Profile of the Townships and Villages

Like its southern counterpart, Northern County merged its villages in the early 2000s, and the number of villages decreased from 323 in 1998 to 228 in 2012, which are included in 16 townships. As a result, the average population of a village increased to 2,200. The merging magnified intra-village variations because it sometimes combined two villages with very different geographical, economic and social conditions into a new one.

Most of my fieldwork in the county took place from January to March in 2013. I selected three administrative villages in two townships for investigation. Of the two townships, one (New Township) is where the county town is located, and the other (Wood Township) is located 70 kilometers away from the county town. Many rural laborers in New Township took up nonfarm jobs in the county town. By contrast, nonfarm employment in Wood Township was very limited, and many laborers migrated long

distances to find employment. Table 6-1 shows that New Township has a larger population and slightly smaller per capita landholding than Wood Township.

Table 6-1 Two townships in comparison

	New Township	Wood Township
Distance to the center of the county town (kilometers) ⁷³	5	70
Number of villages	26	16
Population (persons) ⁷⁴	58,150	37,091
Total rural labor force	40,125	22,165
Farmland (hectares)	19,408	14,452
Farmland per capita (hectare)	0.33	0.39

I selected one village in New Township (X village), and two villages in Wood Township (Y and Z villages) to conduct in-depth investigation. Similar to the research I conducted in Southern County, I interviewed village officials and selected about 30 households in each village to conduct semi-structured interviews and fill out a questionnaire. In total, I collected 96 survey responses in the three villages, covering various types of households with different combinations of undertakings such as farming, nonfarm employment and labor migration.

⁷³ For New Township, I use the distance of the village I visited to the county town urban area.

⁷⁴ This only includes the rural population.

X village is located about five kilometers away from the center of the county town. The village comprises 14 production teams (*zu*) and 450 households with a total population of 1,800. The net income per capita was 7,000 yuan in 2013,⁷⁵ and the size of landholding is about eight mu per person. However, the size of landholding varies among the production teams, ranging from less than six mu to 11 mu per capita. The village owns another 12,700 mu of woodland, some of which can be used to grow crops. However, farming income depends not only on farm size but more importantly, on the size of irrigated farmland. This is so because irrigated farms are much more productive than those with no access to irrigation. A total of 4,100 mu of farmland is irrigated in the village, less than a third of the total, 14,200 mu. Within the village, production teams 4, 5 and 11 have the largest share of irrigated farmland. Some households in these production teams can farm as much as 40 mu of irrigated farmland and they often concentrate their effort on agricultural production.

For the households with less irrigated farmland, they usually have members taking up local nonfarm jobs or migrating outside the county. Approximately 20 percent of laborers in X village migrated while the rest stayed in the village farming or working in nonagricultural sectors nearby, mostly in the county town. Of those who took up local nonfarm jobs, many worked in the construction sector in the county town due to the booming real estate industry. The daily salary for an unskilled construction worker was more than 100 yuan in 2013, and skilled workers could earn more than 200 yuan a day. In

⁷⁵ This number was reported to the upper level government and was underestimated. The average income per capita among the surveyed households in the village was 14,717 yuan for 2012.

addition, villagers also worked as factory workers, miners, taxi drivers and small traders in the county.

Some households in X village grew caterpillar fungus (*chongcao*) in greenhouses. A few households started this in 2006, and more households followed suit thereafter. At the time of my interviews, about 80 households built greenhouses for caterpillar fungus. Each household grew about 10,000 to 20,000 pots, and a few households, the village party secretary for example, expanded the scale to 60,000 pots. The fungus can be harvested four times a year, but the prices had been fluctuating widely, suggesting a high risk of the business. Between 2010 and early 2012, a pot of this fungus could bring a net income of three yuan, and one household could make a total of 120,000 yuan (18,460 US dollars) a year if it grew 10,000 pots, assuming four harvests a year. However, this business requires a very large investment, particularly in the initial stage. The investment covers building greenhouses with stable supply of water and electricity, seeding, planting, monitoring, and hiring seasonal labor for planting and harvesting. For example, planting and harvesting 10,000 pots requires six laborers working 16 days in one season. Approximately each labor-day cost about 80 yuan, thus the total labor cost alone could be as high as 7,680 yuan for one harvest. When the price of the fungus was high, every household could make a decent profit. However, the price sharply dropped in late 2012. By the time of my interview, the price decreased by 80 percent in a few months, and growing this fungus could hardly make any profit. The farmers were deciding whether they should continue the business.

Y and Z villages are located in Wood Township which is 70 kilometers away from the county town. Y village is inhabited by 520 households with a total population of 1,853. The village comprises eight production teams, of which two belong to a separate natural village, which I call the Reservoir-side village. The separate natural village is six kilometers away from the main village. Y village as a whole owns 8,600 mu of farmland, of which about 4,000 mu is irrigated. It also has 17,000 mu of woodland. Near the village is a medium-sized reservoir named the Green Mountain reservoir. The village can use water from the reservoir for irrigation, but the Reservoir-side village has much better access than the main village due to its proximity to the reservoir. In the Reservoir-side village, each person has six mu of irrigated farmland on average, while in the main village the figure is less than three mu. The Green Mountain reservoir was built in the 1970s. Due to low levels of precipitation, the overuse of water and chronic silting up, its irrigation capacity greatly declined in the past decade. The reservoir could still irrigate the farmland of Y village in the spring but it often ran short of water in the summer. Y village has a total of nine tube wells, which are all privately owned. The wells can irrigate about 2,000 mu in the summer when there is no sufficient water from the reservoir. Sinking these tube wells, which are approximately 40 meters deep, is very expensive, with each well costing more than 30,000 yuan. In actuality, many shallow wells were sunk in the village, but they were quickly abandoned as these wells were no longer able to supply water due to the falling groundwater table. The nine deep wells were mostly sunk in the recent years. At the time of interview, the villagers were planning to sink even deeper wells to reach underground water. The use of reservoir water for irrigation was

priced at 50 yuan per mu, but the cost of well irrigation was 80 yuan or even more in 2013.

Whether a village can have access to water has an effect on migration. The Reservoir-side village, where more farmland is irrigated, saw much less out-migration than the main village where one third of households left the village, and most of the remaining households had members migrating long distance. Their main destinations are cities such as Chifeng (the prefectural city), Shenyang (the capital of neighboring Liaoning province) and Beijing. Although farming grain crops such as corn is the main undertaking for the remaining households, they also took up other economic activities. Many households were engaged in animal husbandry, such as raising sheep and pigs. More than 20 households raised pigs on a relatively large scale. Some households grew cash crops such as sugar beets and medical herbs.

Z village has 520 households with a population of 2,000. It has been recognized as a model village by the county government due to its strong village leadership and economic performance. As a model village, it has received more government funds than others, and this has further improved its agricultural conditions. The median annual income of my sample from the village was 20,600 yuan per capita, significantly higher than the previous two villages, which had a median income of 10,750 yuan (X village) and 9,333 yuan (Y village) respectively. Z village was merged with another smaller village in 2006, which is named the Hillside village in this paper. The main Z village is located near a river, but the Hillside village is five kilometers away and located on the

hills with no access to river water. As I will show below, this has made a crucial difference between the two.

The economic success of the main Z village should be attributed to multiple factors. The first and foremost is access to irrigation water. The village has 7,700 mu of irrigated farmland. With a population of 1,300, each resident in the village has nearly six mu of irrigated farmland. The village can irrigate its farms with both surface water from the river and groundwater. According to my interviews with irrigation experts, being located near the river contributes to the availability of groundwater in the village.

The success of the village should also be attributed to government development funds. Although all villages in the county received some funds, the main Z village was particularly favored. It received 500,000 yuan in the early 2000s, with which it sunk 11 tube wells. These 11 collective deep wells, plus another two collective wells sunk in the 1990s, provided a stable water supply for its farmland. In addition to multiple small funds, it received another large fund, two million yuan, to develop greenhouse vegetables in 2008.

Last but not least, the village has a strong and stable leadership. Unlike the previous two villages where village officials did not win broad support and had a high rate of turnover, the leadership of the main Z village had not changed since the late 1990s. The village head, Mr. Zhang, is famous for his agricultural knowledge and acumen in marketing. He organized the households to grow profitable commercial crops and raise domestic

animals on a relatively large scale, while establishing a village cooperative to provide technological and marketing support for all households. In the past decade and a half, households in the village grew tobacco, corn seeds, sugar beets, rice and greenhouse vegetables, and raised farm animals such as pigs, chickens, geese and sheep.

Some of the villagers also migrated, but the proportion of migrants was smaller compared with the other two villages. Rural laborers who migrated accounted for about 15 percent in the main Z village, whereas this figure was more than 40 percent in Y village. In addition, the main Z village hired hundreds of seasonal workers from nearby villages to harvest commercial crops such as tobacco and greenhouse vegetables. The main Z village is also a contrast to the Hillside village, where farmers have very limited access to water, with less than one mu per person of irrigated land. This is because the village is located far away from the river and does not have much underground water. Many people in the village migrated out to look for jobs. Similar to Y village, one third of households left the village, and most of the remaining households also had family members working as migrant workers. The proportion of migrant workers accounted for half of the labor force in the village.

The comparison of the three administrative villages (X, Y and Z) as well as natural villages within (such as Reservoir-side village and Hillside village) reveals patterns of inter-village differences in the county. First of all, access to water has the most significant impact on a village's economy and household income. As compared with its southern counterpart, the size of landholding in Northern County is relatively large. With irrigation,

farmers can grow profitable commercial crops such as high-yield corn. Second, the variation in access to irrigation also affects out-migration: while rural households in villages without sufficient irrigation must seek employment elsewhere, those with good irrigation can choose not to migrate and concentrate on agricultural production. Finally, a village's economy is also influenced by the distance to the county town and the strength of the village leadership. The villages such as X that are near the county town would find more local nonfarm opportunities, and a strong leadership could help a village improve agricultural conditions and compete in the market, as was seen in Z village.

The next section will draw on my questionnaire surveys and interview data to describe economic differentiation and social stratification at the household level.

6.2 Social Stratification and Occupational Diversification

Agriculture provides a main source of household income in the county. According to official statistics, annual income per rural resident in the county amounted to 5,707 yuan in 2011, of which 3,192 yuan came from farming and animal husbandry, accounting for 56 percent. In addition, rural households derived 1,792 yuan from wage employment, of which 654 yuan came from out-of-county migration and 1,138 yuan from local wage jobs, including agricultural wage jobs. In addition, income from nonfarm business was 298 in the year.⁷⁶

My respondents reported a similar proportion of agricultural income (Table 6-2). Agricultural income from both farm and animal husbandry accounts for 59.8 percent of

⁷⁶ *Northern County Statistical Yearbook* 2012: 304.

the total, of which farming alone accounts for 39.3 percent.⁷⁷ Both numbers are much higher than those in Southern County, 14.8 and 8.1 percent respectively. In addition, out of the 96 questionnaire respondents, 73 said that agricultural income was important or very important to their family, accounting for 76 percent. Only 11 people, or 11.5 percent, held that agricultural income was unimportant. Further, 46 respondents stated that the importance of agricultural income had increased over the last 30 years. All these numbers revealed that agriculture was a much more important source of income in the county compared with its southern counterpart.

Table 6-2 Composition of household income in Northern County⁷⁸

Northern County (N=96)				
	Farming Income	Income from Animal Husbandry	Nonfarm Income	Total
Amount (yuan)	23,273	12,117	23,816	59,226
Percentage (%)	39.3	20.5	40.2	100

Within agriculture, farming is the most important to rural households' livelihood in Northern County. My survey data shows that 93 out of the 96 households were engaged in farming, which contributed an annual income of 23,273 yuan, 39.3 percent of household income, 59,226 yuan per household (Table 6-2 & Table 6-3). Animal husbandry is another important undertaking. The county has a large area of woodland and

⁷⁷ It should be noted here that the income from growing the fungus is considered as income from animal husbandry. The Chinese caterpillar fungus is hard to decide whether it is plant or animal, but the reason here that I categorize it as animal husbandry is because households normally build the house to grow the fungus in their front or back yard without using much of their farmland.

⁷⁸ Data source for Table 6-2, 6-3, 6-4 and Figure 6-1, 6-2: survey data in Northern County.

grassland for grazing sheep and goats. In addition, farmers raised pigs, chicken and cows. Table 6-3 shows that 48 households engaged in animal husbandry, 50 percent of the total. On average, animal husbandry contributed 12,117 yuan, 20.5 percent of household income for the 96 households.

Wage employment and nonfarm business constitute other sources of income. As we can see from table 6-2 above, the 96 households earned 23,816 yuan on average from nonfarm sources, 40.2 percent of the total. Table 6-3 shows that 60 households were engaged in wage employment and 17 in nonfarm business.

Table 6-3 below classifies the households into different categories based on a combination of jobs that members in each household were taking. Of the 96 households, 26 were engaged in agriculture exclusively including both farming and animal husbandry. In addition, 93 households engaged in farming, with 67 households involved in both agricultural and non-agricultural activities at the same time. This suggests that agriculture is still of crucial importance to households in the county. It is a contrast to Southern County where the significance of agriculture as a source of income has diminished substantially.

Table 6-3 Combination of occupations by rural households in Northern County

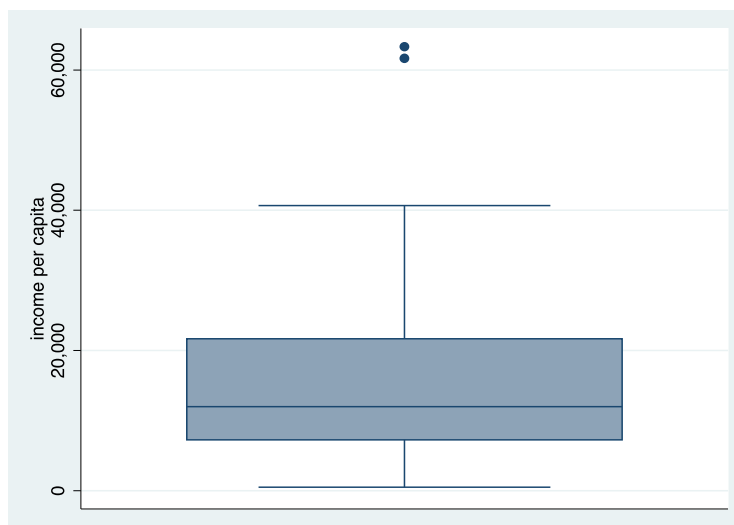
Occupations within the household	Frequency	Cumulative percentage
Farming	14	14.58
Farming; animal husbandry	12	27.08
Farming; wage employment	21	48.96
Farming; nonfarm business	4	53.13
Farming; animal husbandry; wage employment	30	84.38
Farming; animal husbandry; nonfarm business	4	88.55
Farming; wage employment, nonfarm business	6	94.8
Farming; animal husbandry; wage employment, nonfarm business	2	96.88
No working member	1	97.92
Wage employment	1	98.96
Nonfarm business	1	100
Total	96	

Of various occupational combinations, the largest category is the one that combines farming, animal husbandry and wage employment, accounting for 30 households. The second largest category of the households took up farming and wage employment at the same time, accounting for 21 households. This suggests that the rural households tended

to diversify their economic activities and combine different sources of income. Such a strategy can increase household income and reduce economic risks as the loss from one source of income could be offset by others. This is similar to my findings in Southern County as well as many other studies (Zhan and Huang 2013; Knight and Song, 2003). However, behind this similarity lies the crucial difference between the two counties, that is, agriculture accounted for a much large share of rural income in Northern County than in Southern County.

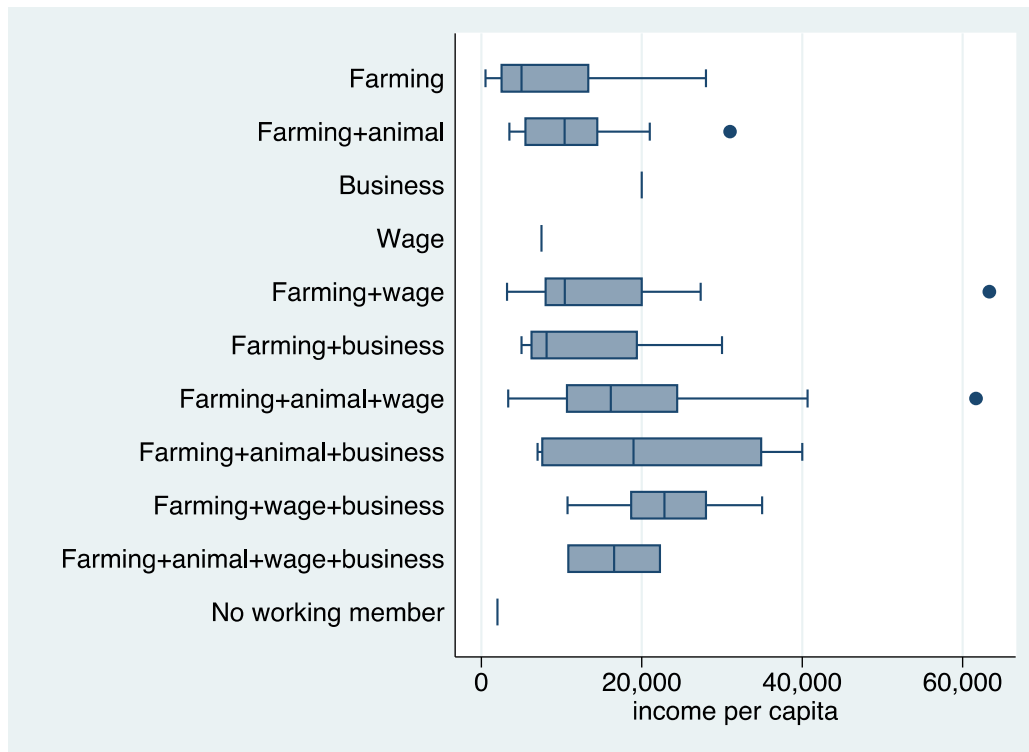
My data also shows a highly unequal income distribution among the households in the county, with rich households pulling far ahead of poor ones. The figure 6-1 below shows the distribution of income per capita for the 96 households. It has a median income per capita of 11,750 yuan. However, the lowest is only 500 yuan while the highest reaches 63,333 yuan. The lowest quarter of the households earned 7,000 yuan or less while the highest quarter earned 21,667 yuan or more.

Figure 6-1 Distribution of income per capita (yuan)



The combination of occupations within one household is also an indicator of its economic status. Figure 6-2 below shows that households with members engaged in farming, wage employment and nonfarm business at the same time received the highest median income, 21,667 yuan. In general, households that combine farm and nonfarm sources of income are most likely to be among high-income households rank. By contrast, those that only engaged in farming are more likely to be positioned in the low-income range. However, the figure also reveals that the farming-only households can also reach a high income. And the variation of income from farming is due to farm size, particularly the size of irrigated farmland, as I will discuss below.

Figure 6-2 Distribution of income per capita by occupation



My interviews further corroborate the importance of agriculture in income generation. According to the party secretary of Y village,⁷⁹ who was in his middle 50s and had previously worked as accountant for the village committee, there were three types of rich households in his village: the households that farm a large size of irrigated farmland, the households that take up with well-paid migrant jobs, and the households that runs a large business.

Mr. Jia,⁸⁰ for example, a 33 years old farmer in Z village, farmed 91 mu irrigated land including 75 mu leased from others in 2012. He cultivated 45 mu of corn, 26 mu of tobacco, 10 mu of sweet beets and another 10 mu of sorghum, from which he earned a net income of 80,000 yuan. He told me that farming could be more profitable than doing migrant work in the city. Mr. Jia had been staying in the village farming ever since he was 22. His success was due to the fact that he was able to farm a substantial size of irrigated farmland. In addition to his own land, he leased 75 mu of irrigated land from other households in the village.

Farmers in the county can lease land from three sources. First, they lease farmland from the villagers who migrate out. Around 30 percent of the households farmed little or no land and instead concentrated on migration. Second, they lease collective land from villages or state owned farms. In Northern County, many villages still own a certain amount of collective land, mostly woodland and grassland, some of which have been reclaimed for farming. These lands are all in large size, but they usually do not have good

⁷⁹ Interview date: March 21, 2013.

⁸⁰ Household interview No. 116 on March 17, 2013 in Z village.

access to irrigation. Some rich farmers have sunk wells to irrigate this kind of land if groundwater is available. Finally, due to the declining level of surface water, land near rivers and reservoirs, which were previously submerged under water, had become available for reclamation. This kind of land is ideal for farming since it is generally large in size with good irrigation access.

The importance of irrigation has motivated farmers to extract more water for irrigation. A common way to do so is to sink tube wells. The next section will show the correlation between irrigation and household income as well as examine how rural households compete for water in the villages.

6.3 Deep Wells: Unequal Water Access and Intensified Water Extraction

The extraction of groundwater for irrigation has been the major contributing factor to the increase in grain production in the county. The adoption of high-yield crops, most importantly, hybrid corn, as well as profitable cash crops such as tobacco and sugar beets, is highly dependent on well irrigation. As noted in Chapter 4, Northern County started to sink tube wells on a large scale in the 1990s and intensified well sinking in the past decade due to the growing profitability of farming. By 2014, the irrigated area of Northern County reached 76,000 hectares, nearly four times that in 1986.

The return from farming irrigated land is much larger than that from farming the land without irrigation, which is called “dry land” (*handi*) in the county. Dry land only permits drought-resistant crops, which are usually of low yield. These crops include millet,

buckwheat, sorghum, beans (including red beans, black beans, mung beans, etc.). The return from farming the dry land is usually less than 300 yuan per mu. It would even incur a loss if the level of precipitation is particularly low. Thus the risk of farming dry land is very high. By contrast, farming irrigated land can generate a high income and is less affected by the weather. One mu of high-yield corn can produce approximately 1,000 yuan in net return, and it could reach as high as 2,000 yuan if the land was used to grow tobacco.

The importance of irrigation in Northern County had prompted active responses from farmers. My survey data shows that 84 out of the 96 households, 88 percent, held that fellow villagers had been paying increasing attention to irrigation over the last thirty years, compared to only 21 percent in Southern County. When asked if they were willing to contribute money or labor to constructing or repairing collective irrigation facilities, 76 percent answered they would donate money, and 78 percent answered that they would donate labor, whereas these figures in Southern County were 58 percent and 68 percent respectively.

Farmers in Northern County also attached more importance to irrigation than to roads, whereas the opposite was true in Southern County. Of the 96 responses, 63 were more willing to invest in irrigation facilities than in road construction, and only seven held otherwise. Similarly, 61 interviewees held that irrigation played a more important role than roads in their livelihoods, but only 10 people held otherwise. Miss Lu,⁸¹ 38 years old, from Y village, cultivates 75 mu of farmland including 20 irrigated farmland. Her

⁸¹ Household interview No.149 on March 21, 2013 in Y village.

husband worked as a migrant laborer but had to return due to a work injury to his waist. They have two school children and an elderly to support. The household relies on agriculture exclusively. Of their irrigated farmland, ten mu is irrigated by the reservoir and the other ten by a well jointly sunk by her family and another three households. Each household contributed more than 4,000 yuan to sinking this well. Miss Lu said, “It is fine as long as the road is walkable or drivable, but water is so important, especially to people like us who cannot migrate, since we completely depend on agriculture, and agriculture completely depends on irrigation.”

In the 1980s and early 1990s, irrigation in Northern County still overwhelmingly relied on the facilities harnessing surface water such as reservoirs and pumping stations, most of which were built in the Mao Era. This started to change in the mid-1990s, with increasing attention and effort devoted to groundwater. My fieldwork showed that farmers were keen on pumping groundwater and turning dry land into irrigated land. However, whether a village or a household is able to do so depends on three factors: geographical location, the conditions of the village irrigation system, and financial capability. The first two factors contributed to variation at the village/production team level while the third factor contributed to variation at the household level.

Geographic location

As noted previously, well irrigation is only possible in places where ground water is available. Thus the location of a village or a production team has a strong effect on its access to irrigation. The contrast between the main Z village and the Hillside village, and

the contrast between the main Y village and the Reservoir-side village, and the differences among production teams within X village, all point to the importance of geographical location. Among all villages I visited in the county, the main Z village and the Reservoir-side village are the most fortunate in that they are located near surface water sources. Thus the villages not only could tap surface water for irrigation, which is usually less expensive than well irrigation, but are also endowed with good groundwater sources due to the proximity to the river or the reservoir. By contrast, the Hillside village is the least fortunate being located in an area where there is neither access to surface water irrigation nor much groundwater. The village had tried to sink more wells, but could not find any good location with adequate groundwater. The village has the largest size of landholding, 20 mu per capita, but there was only 600 mu of farmland which had access to irrigation, less than one mu per capita.

Access to collective irrigation facilities

Another factor is whether a village or production team has built collective irrigation facilities, and this is particularly important to farmers who do not have financial resources to sink wells themselves. In the 1980s and early 1990s, farmers in the county relied on the collective irrigation system built in the Mao Era, which mainly delivered surface water from reservoirs or rivers to farms. Although the supply of surface water had decreased since the mid-1990s due to the wearing down of irrigation facilities and the shrinking of surface water sources, this old collective irrigation system, including reservoirs, pump stations and canals, has continued to benefit a number of villages, including Y and Z villages where I conducted fieldwork.

A new collective irrigation system, which exploits groundwater, started to emerge in the county after the mid-1990s. The new system was built with government funding. Starting from the mid-1990s, the government of Northern County shifted attention to underground water, and provided funding for villages to sink tube wells. For instance, the main Z village received funds to sink two tube wells in 1996. The financial support from the government increased greatly in the early 2000s. On the one hand, a severe drought in 1999-2001 had made underground water irrigation more important than ever; on the other hand, the central government had increased financial support for Western regions like Inner Mongolia under the project of “Develop West” (*xibu dakaiifa*) and for rural development under the strategy of “Building a Socialist Countryside.” As a result, the county government was able to finance a large number of tube well projects with funds transferred from the central government. As noted in Chapter 4, irrigation capacity in the county had expanded rapidly between 2003 and 2010.

Government funds were usually allocated to a village or a production team, and the tube wells built with these funds belonged to residents in the village collectively. All villages I visited received government funding to build collective wells, but the amount of funding varied among the villages. The main Z village sank 13 collective tube wells, the Hillside village two tube wells, Y village three, and X village nine. All farms that are located near these collective wells could receive irrigation. Farmers only need to pay direct cost of irrigation such as electricity and management fees since the cost of construction was covered by government funds. However, the new collective system only lasted a few years, and it broke down in many villages due to the privatization of collective wells.

Among all villages, only the main Z village still maintained a collective system of well irrigation at the time of my fieldwork. The main reason of privatization in the other villages was that village officials wanted to sell collective wells for money to cover administration cost or repay village debt. For instance, Y village received government funds to sink three tube wells, of which only one well was usable. The village owed 300,000 yuan in debt by 2013 and had to cover administration costs on their own (about 50,000 yuan a year). Thus village officials sold the usable well to a farmer in the village for 80,000 yuan in 2011. In X village, the village officials also sold all nine wells at the price of 50,000 yuan a well to repay the village debt. In the Hillside village, the village officials controlled both the wells and the well-irrigated land, which was about 500 mu. They leased the irrigated land out to the villagers at a rate of 100 yuan a mu per year, and the rent (50,000 yuan a year) was used to cover the administration cost of the village. The system in the Hillside village was the costliest for farmers because they had to pay not only for irrigation but also for the use of the land, whereas farmers in other villages only need to pay for irrigation.

The main Z village still maintained the collective irrigation system. The village assigned the management of the 13 collective wells to 13 individual farmers, who were responsible for the daily maintenance of the wells and the coordination of irrigation. Water prices were set by the village, and a manager received 3,000 yuan a year for their work. As a result, farmers in the village only needed to pay for the direct cost of irrigation. Water prices were the lowest compared with other villages. Farmers in the main Z village paid

50 yuan a mu for irrigation, whereas those in other villages had to pay at least 80 yuan a mu, and some even paid 200 yuan per mu.

Access to irrigation is more equal under this collective system than in a private irrigation system. This is because the collective system delivered water to the farms of all rural households at relatively low costs. In the main Z village, for example, every villager had four to six mu of irrigated land, depending on the production team to which he or she belongs. As a result, all rural households, including poor households in the village, could farm irrigated land. This is a main reason why the village had maintained a stable leadership since the late 1990s. By distributing water equally to all households, village officials had won wide support among villagers. Access to irrigation at relatively low costs has allowed a number of households to derive a substantial income from agriculture. In some cases, this income was even more than that one would earn from working in the city as a migrant worker. For example, Mr. Li⁸², 52 years old, farmed 30 mu of irrigated land with his wife: 20 mu of corn and 10 mu of sugar beets. They have three daughters: two daughters were married living in the county town while the youngest daughter was working for a bookstore in Beijing. The couple did not rent in any additional land. With 30 mu of irrigated land, they earned 40,000 yuan from farming in 2012. In addition, they raised 70 sheep, which generated 50,000 yuan in the same year. Mr. Li told me that they could not possibly earn such an income if they worked as migrant workers in the city. He spoke highly of the collective irrigation system, and regarded it as the main reason for people like him to stay farming in the village.

⁸² Household interview No. 106 on March 17, 2013 in Z village.

In a private irrigation system, however, access to water depends very much on a household's financial capability. This is the third factor behind unequal access to water.

Financial capability

In the county where the collective irrigation system broke down, irrigation is provided by the private system, under which individual farmers own tube wells. Those who do not own wells have to buy water from private well owners if the latter have extra water for sale. Otherwise they would have no access to irrigation. Access to water under the private system is unequal because it depends on one's financial capability to sink (and in some cases purchase) tube wells. Sinking tube wells requires a large investment, ranging from 50,000 yuan to 200,000 yuan for a well, depending on the depth and quality of the well. Only those who are already better off can afford to sink a tube well. The more financial resources a household possesses, the more likely it can harness the benefit of well irrigation. Based on financial capability, I classify agricultural producers in Northern County into three categories: small farms, large farms and agribusiness companies.

Small farms are still the largest category, accounting for more than 70 percent. A small farm usually cultivates less than five hectares (75 *mu*) of land. Although this is larger than the national average, only a small portion of its land, less than one quarter, has access to irrigation. Among the 96 households I surveyed, 70.1 percent farmed five hectares or less and 43.8 percent farmed two hectares (30 *mu*) or less. Unless small farms had access to the collective irrigation system, such as those in the main Z village, they possessed limited financial resources to secure irrigation in the private system. Among all

the small farms I surveyed, 29.4 percent had no irrigated land, and 58.8 percent had less than one hectare (15 *mu*) of irrigated land. Under the private system, small farmers have to pay water fees to private well owners or have no access to irrigation at all. For example, Mr. Bo in X village,⁸³ 46 years old, farmed 20 *mu* of land, of which five *mu* could be irrigated by private wells. The cost of irrigation was 200 yuan a *mu*. Mr. Bo felt that this was too expensive, thus the household decided not to irrigate the farm at all in the past two years before the interview, and grew low-yield sorghum instead. The household had other sources of income. Mr. Bo was working as part-time skilled construction worker, earning 150 yuan a day, but he could only work for four months a year. His only son migrated to Shanghai working as a car painter.

However, some small farmers have financial resources to sink tube wells, and aspire to expand the farming scale. Their irrigation investments are derived not from farming but from nonfarm sources of income. As noted earlier, most farming households also engaged in wage employment or nonfarm business. This also suggests that households running small farms do not necessarily earn a low income. My survey data reveals this pattern. I divided all households into four quarters based on the farm size, and computed average household income for each quarter (Table 6-4). The first quarter of the households whose size of farm was between 0 and 20 *mu* earning an average household income of 65,609 yuan, which was similar to the income of the second quarter whose farm size was between 21 and 35 *mu*. Interestingly, the third quarter of the households earned the lowest income, 54,259 yuan despite a relatively large farm size. This was so probably because these households did not earn a high nonfarm income. However,

⁸³ Household interview No. 186 on March 26, 2013 in X village.

household income would increase significantly if a household expands its farm size to a large farm. The average income of the fourth quarter was the highest, 80,072 yuan, demonstrating that a sufficiently large farm size could generate a substantial income.

Table 6-4 Farm size and household income

Farm size	1 st quarter (0~20 mu)	2 nd quarter (21~35 mu)	3 rd quarter (36~89 mu)	4 th quarter (90~320 mu)
Average household income (yuan)	65,609	68,062	54,259	80,072

There have been a growing number of large farms in the county. The size of a large farm is usually above 100 mu (6.7 hectares). The advantage of large farmers is that they can sink tube wells themselves and turn a dry land into an irrigated land. This will increase the return from farming considerably. As both central and local governments have promoted land transfer and offered support for large farms in the recent years, these farms have been further empowered and their scale of farming would further expand. Large farmers in the three field villages all expressed the desire to lease more land. In X village, for instance, large farms have controlled a growing share of irrigated land by sinking tube wells. Mr. Fu,⁸⁴ 45 years old, is such an example. He and his wife farmed 70 mu of irrigated cropland, of which 30 mu was leased from other households, and cultivated another 200 mu of land for fruit trees. All 70 mu were irrigated with their

⁸⁴ Household interview No.179 on March 25, 2013 in X village.

private tube wells. Mr. Fu worked in the city as a migrant worker in the 1990s. After he saved a substantial amount of money, he returned to the village in 1997 and sank a tube well to irrigate his land (about 40 mu). With the well, he and his wife were able to grow high-value commercial crops while at the same time engaged in profitable sideline activities such as growing caterpillar mushroom. In 2012, the household invested 120,000 yuan to sink another two wells, which were to irrigate its 200 mu of fruit trees. At the time of interview, he was planning to lease another 500 mu of land. He is one of the villagers who came to the village party secretary's office to discuss how to use the new central policy to establish large family farms.

Another player is dragonhead companies. Based on county policy documents and my interviews with local officials, it can be seen that the local government enthusiastically promoted dragonhead companies which specialize in all kinds of agricultural products including grains, beans, vegetable, sugar beets, tobacco, medical herbs and animal products. In 2010, there were nine prefecture-level dragonhead companies in the county, and this increased to 21 in 2015. If county-level dragonhead companies were included, the total number would increase to 66 in 2015. Most dragonhead companies in the county entered contracts with farmers and did not engage in agricultural production directly. Some dragonhead companies in the county leased farmland and engaged in production, but they usually chose to lease collective woodland or unused land rather than lease land directly from rural households because this way required less coordination and opposition from farmers. Thus I did not find any dragonhead companies in the three field villages. However, I learnt from official interviews about such land-leasing dragonhead companies.

As compared with farming households, the dragonhead companies usually receive more favorable policy and financial support from both local government and central governments. In terms of access to irrigation, these companies possess sufficient financial resources to sink tube wells. In addition, they could apply for government funding to do so. It can be imagined that dragonhead companies will become increasingly powerful and would lease land directly from small farmers in the future.

As groundwater irrigation has become such a crucial condition for profitable farming in Northern County, farmers, large or small, have striven to turn dry land into irrigated land by sinking tube wells. In addition, villages in the county actively applied for government funding to sink tube wells. This has intensified the extraction of groundwater. According to Mr. Cui,⁸⁵ an official of the County Bureau of Water resources who has worked for the agency for more than 20 years, the number of large tube wells in the county with a supply of 20 cubic meters of water per hour reached more than 9,000 in 2012. However, this omitted small tube wells whose number could be several times the number of large wells. In addition, many more wells have become unusable and been abandoned due to the falling ground water table. In both X and Y villages, dozens of wells had been abandoned. In only one decade and a half, the water table had fallen by dozens of meters in the county. The degree of falling varies. As a general rule, the water table falls faster in places where underground water is less abundant. Among all villages I visited, the table fell in the main Z village at a slower pace than that in the others. The most rapid fall took place in X village. It was estimated that the table had fallen by more than 50 meters. For instance, production team No.11 in X village had only one well in 2000, 30 meters deep,

⁸⁵ Interview date: February 25, 2013.

which could irrigate up to 400 mu of farmland. At the time of my interview, the team had three deep wells that were all more than 80 meters deep, but the irrigation capacity of the three wells combined is smaller than that of the old 30-meter well. In addition to the three deep wells, there are dozens of other wells in the team, which were sunk in different years. The wells that were sunk more recently were deeper than the earlier wells. The neighboring production team No. 12 faced a much direr situation. The team sunk a collective well with government funding in 2001 and the well dried up after a few years of use. Farming households of the team had tried to sink private wells but had to give up because no water could be pumped out of the ground even when the wells reached down to more than 100 meters. The farmers blamed factories nearby for the shortage of water because these factories had sunk a few very deep wells (more than 200 meters deep), causing the sharp fall of the ground water table. As I will detail below, the competition for water between agriculture and industry in the county has become increasingly intense.

As the water table fell, farmers in the county sank wells deeper and deeper to reach for water. It has become a “race to the bottom”. In some places, the depth of wells exceeded 200 meters, and many wells in the county reached down for more than 100 meters. This race to the bottom in well irrigation has adversely impacted the environment and consequently agriculture in the county.

6.4 Dying Trees: Environmental Impact and Water-Saving Program

Northern County was historically a pastoral area. Many immigrants from the North China Plain settled in and turned parts of the grasslands into farms in Qing Dynasty (1644-

1911) and the Republic period (1911-1949). The county's total population increased from a few thousand two centuries ago to more than 200 thousand by the end of 1930s. However, as more and more grassland was reclaimed into farmland, desertification and sand storms started to spread, and the situation did not improve in the Mao period, when population growth put great stress on the environment. Sandstorms in the spring became so severe that sand often blanketed farm fields, destroying crops and causing harvest failures.

In the 1980s and 1990s, the county launched a number of campaigns to restore the environment through scaling back farming areas and reverting them to grasslands and woodlands. The county was designated as one of the key locations by the State Council in the national Three-north (north-west, north-china, north-east) defensive forest project (*sanbei fanghulin*), which was initiated in 1979. The forestation rate in the county had risen up from 11.2 percent in 1977 to 35.3 per cent in 1994, and the frequency of sandstorms was significantly reduced.⁸⁶ According to my interviews with farmers and local officials, ecological improvement are widely regarded as one of the most important changes in the history of local development.

This ecological restoration in the 1980s and 1990s to some extent improved agricultural conditions of Northern County. However, the intensification of grain production, as noted previously, has placed the still vulnerable environment in peril. The increase in grain production has been achieved mainly through over-extracting water resources. This section will show how the intensification of grain production based on the overuse of

⁸⁶ The data was obtained from the Northern County Bureau of Forestry.

water has led to a number of environmental problems and undermined the foundation of future grain production. I will also introduce the recent water-saving program pushed by the local government and assess its effectiveness and constraints, considering not only agricultural water use but also the extraction of water for urban and industrial purposes.

The intensification of grain production first affected surface water sources. For example, the river running by the main Z village used to run out of water for only a couple of months in a year in the 1990s. However, over the last ten years, it has been dry for six months a year. Y village has been using water for irrigation from the Green Mountain reservoir since the 1970s. The water storage of the reservoir had diminished over the past 10 years to the extent that the farmland of the village could not receive water during the summer. The drying up of surface water sources has been a widespread phenomenon in the county. Many rivers in the county have dried up and so have small reservoirs and swamps, which provided the source of irrigation as well as a factor sustaining the ecological system. The other consequence of intensified grain production is the falling of the ground water table, which has already been discussed. Moreover, as the surface water is exhausted for crops, it does not recharge the water table. In addition to water-related environmental problems, the intensification of grain production has led to soil degradation and environmental pollution due to the increased use of chemical fertilizers, pesticides and plastic mulches.

The drying-up of water sources has also threatened the survival of trees, bushes and grass that were planted in the 1980s and 1990s. The trees have started to wither and it is

estimated that one third of the trees in the county have died or are dying due to lack of water. When I was in the county, I saw many withered trees. In Y village, for example, the party secretary told me that the trees in the village had withered on a large scale. Bushes and grass, which are less vulnerable than trees, were also affected. The party secretary was concerned about this worrying trend because the trees and bushes played a crucial role in fighting desertification, preventing sand storms, and preserving local environment in the county. In the past decade, the desertified area in the county had started to expand, reversing the trend in the 1980s and 1990s.

The drying up of surface water sources and the falling of the ground water table have affected grain production and farmers' livelihood. The first group of people that bore the brunt were small farmers who could not afford sinking deeper tube wells. For example, Mr. Fu in X village,⁸⁷ 39 years old, was married with two children. The household farmed 24 mu of land, of which 10 mu used to have access to well irrigation. Due to the falling of the groundwater table, however, the well had dried up and was no longer able to irrigate his land since 2012. Desperate to find irrigation for his land, the household, together with another three households, spent 18,000 yuan to sink a 66-meter well in 2012, but the well was still too shallow to tap sufficient groundwater. Mr. Fu had to grow low-yield sorghum in his farm ever since. The shortage of water has also affected large farmers, although the impact is modest. For instance, Mr. Hu in the main Z village⁸⁸, 43 years old, leased 800 mu of land in another village prior to 2012. With the land he grew 500 mu of sugar beets, which is a profitable commercial crop. He hired two full-time

⁸⁷ Household interview No. 174 on March 25, 2013 in X village.

⁸⁸ Household interview No. 123 on March 18, 2013 in Z village.

workers to manage his farm as well as dozens of seasonal laborers. He told me that the number of hired laborers had reached as high as 120 in the harvest season and paid these workers 60 yuan per person per day. However, due to the falling water table, he had to give up this large farm, and returned to Z village to run a much smaller farm, 120 mu in 2012. Mr. Hu told me that he was looking for more land to lease and would rent more land if he found a good farmland. Mr. Hu is among the richest farmers in the county. The annual income of his household was 190,000 yuan in 2012, even though his farm size was reduced. He was married with a 21-year-old son, who worked as a skilled excavator operator in the county town.

Water saving program

The rapid depletion of water in the county has alarmed the local authorities. As noted in Chapter 4, the county started to introduce drip irrigation in 2010. By 2015, the farmland that adopted drip irrigation had increased to 917,000 mu, 80.6 percent of the total irrigated land. My interviews with farmers and village officials showed that the drip irrigation is effective in saving water, and many rural households were willing to adopt this method.

However, drip irrigation is a costly investment. After the initial installment, every year farmers need to replace the drip tape, which costs another 120-130 yuan per mu. At the time of my fieldwork, the county government subsidized 100 yuan for the replacement of drip tape per mu, and individual households only needed to pay 20 yuan. However, once the subsidy stopped, farmers would have to bear the cost on their own. This would be an

economic burden on low-income households. Thus the application of drip irrigation favors large farmers over small ones because the costs are less of a financial burden for the former than for the latter. For example, the aforementioned Mr. Fu,⁸⁹ a rich farmer in X village, held that drip irrigation is the future of irrigation and agriculture in the county. He planned to install drip irrigation for his 200 mu of fruit trees. The cost of drip irrigation did not appear to be a problem for Mr. Fu, but he would welcome subsidies provided by the government. In addition, drip irrigation is more efficient when being applied to farmland on a large scale, and it requires that the land with the equipment to be sowed and harvested at the same time. This again favors large farms over small farms. It is likely that the local government will push to turn small farms to large farms in order to maintain the system of drip irrigation.

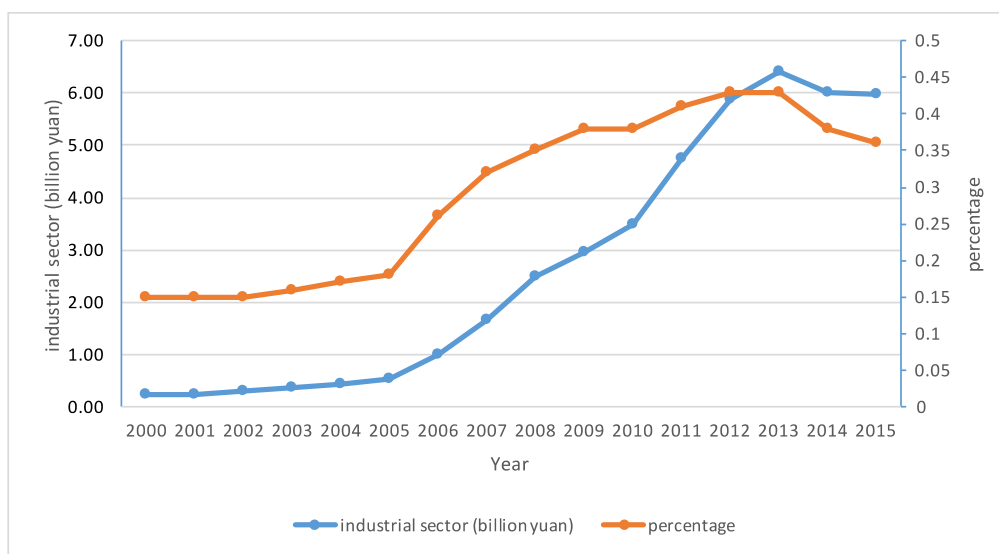
However, even if drip irrigation is successfully implemented, it is unlikely to solve the long term problem of water shortage in the county. On the one hand, the structural dilemma identified in this dissertation has not been solved. If grain production continues on the current scale or even expands, the shortage of water can hardly be alleviated. On the other hand, agriculture is only one sector that exploits water in the county, and in recent years the use of water for urban and industrial purposes has increased greatly, placing further stress on the water system.

Industrial growth has accelerated in the recent decade. The expansion of the local industry can be attributed to two factors. On the one hand, the local government issued policies to draw industrial enterprises from outside to invest in the county. On the other

⁸⁹ Household interview No. 179 on March 25, 2013 in X village.

hand, mineral resources in the county attracted external investors. The industrial GDP increased from around 230 million yuan in 2000 to more than 5.98 billion yuan in 2015. In the meantime, the share of industrial sectors in total GDP increased from 15 percent to 36 percent (Figure 6-3). Agriculture still accounts for a significant share of local GDP, but the percentage decreased gradually from 46 percent to 25 percent for the same period.

Figure 6-3 Industrial growth in Northern County: 2000-2015⁹⁰



The largest industry in the county is mining. Factories that process gold, iron, phosphorus, copper, coal, lead, zinc and nonferrous metals have flourished due to the growing demand in the domestic market. The chemical industry, including the mining and refining of oil shale deposits and fluorine chemicals, and the industries related to urban real estate, such as cement and furniture, have also been growing. Because the county produces large

⁹⁰ Data source: *Northern County Statistical Yearbooks*

amounts of grains and animal meat, the food and meat processing industry occupy an important position in the local economy. To attract more investors, the county government offers built-up land and generous tax exemptions or deductions. It has built two large industrial parks to house industrial enterprises with good infrastructure such as water supply, electricity and roads. In addition, seven townships built their own “development districts” to house industrial enterprises.

Rapid industrial growth has exerted extra pressure on local water resources. Industries such as mining, refining and chemicals all require the use of a large amount of water. In X Village, as noted previously, farmers complained that cement and beverage factories nearby sank deep wells causing the groundwater table to fall beyond the reach of irrigation wells. Many industrial activities such as mining and the production of chemicals have polluted water and soil. The county has a large molybdenum ore mine. The villagers nearby complained that trees stopped growing in the area. I was told when I was doing fieldwork in X village that working in the mine would even harm one’s reproductive capability.

Water demand for urban uses has grown even faster. As noted in Chapter 4, the county government has enthusiastically embraced urbanization and promoted the real estate industry with great vigor in the recent decade. According to official statistics, investment in real estate in the county was 30 million yuan in 2000, and this increased dramatically to 300 million in 2011. Rapid urbanization has pushed up demand for water considerably, and the local government has started to transfer agricultural water to meet growing urban

demand.

Therefore, although the implementation of the water saving program enables the county to economize on water consumption for agriculture, it cannot reduce water use overall because of the increasing extraction of water for urban and industrial uses. The water transfer project will continue to intensify water extraction in the county. Thus, it is safe to say that, unless the county is able to cut back the overall water consumption, it will continue slipping toward a water crisis.

6.5 Conclusion

This chapter shows the dynamics of agricultural water use in Northern County under the structural contradiction between economic growth and food security. The case of Northern County, in sharp contrast to Southern County, has seen the intensification of grain production under the pursuit of food security. This is because the county has a relatively large farming area while urban and industrial sectors are less developed than those in its southern counterpart. However, the county, like many other northern regions, is severely short of water. The intensification of grain production has thus led to the over-extraction of groundwater. The process is closely related to the economic interests of farmers in the county. As farming irrigated land can generate a substantial income, which in some cases is even higher than income from labor migration, villages and farmers have competed to sink tube wells to tap groundwater. This has led to a race to the bottom in water extraction. In this race, large farmers are in an advantageous position because they have financial resources to sink tube wells or purchase collective wells. Small farmers

tend to lose out and are forced to migrate. However, some small farmers are able to earn money from nonfarm businesses or jobs, with which they can invest in well sinking to expand the scale of irrigated farming.

The case of Northern County reveals another dimension of the agricultural water crisis in China. While the crisis in the south is characterized by the breaking down and negligence of water facilities, in the north it is caused by the over-extraction of water for grain production. However, as this dissertation shows, these different manifestations of the agricultural water crisis have been derived from the same structural contradiction between the pursuit of profit and food security. The over-extraction in the north has not only undermined the water system but also exerted adverse impacts on the environment as a whole. As this chapter has shown, the drying up of surface water and the dropping of the groundwater table have affected trees, bushes and soils, rendering animal habitat and human environment unsustainable in the long term.

Besides the differences between the two county cases, the comparison also reveals two similar trends. On the one hand, despite different levels of urbanization, both counties have accelerated the pace of urban expansion in the recent decade as a measure to promote economic growth and boost local revenue. This has drawn resources including money, water and labor into urban sectors. In both counties, water investments were first allocated to urban sectors or to serve the purpose of urban development. In addition, both give priority to water supply for urban sectors. This has seriously affected agricultural water use in Northern County, as water is a scarce resource. On the other hand, large

farms, including agribusiness companies, have become increasingly powerful in both counties. In Southern County, the government tried to replace small farming households with large farms because the former have not devoted sufficient efforts to grain production. In Northern County, large farms and agribusiness companies possess more financial resources to control water resources and thus out-compete small farms. These two common trends hold implications for the future development of the agricultural water system and also for social stratification in the countryside.

Chapter 7 Conclusion

In nearly seven decades since the founding of People's Republic of China in 1949, the agricultural water system has experienced tremendous changes. As noted in the introduction, this long period can be roughly divided into two periods: the developmentalist era (1949 to 1978) and the neoliberal era after the market reform (1978 to present). In the first period, the agricultural water system experienced rapid expansion, with irrigated area increasing from 15.93 million hectares in 1949 to 48.05 million hectares in 1978. In addition, the country completed 50,000 multifunctional large water projects and 20 million small irrigation projects. Such an impressive record of expansion was impossible without the intervention of the Chinese state. Although irrigation expansion occurred in many countries in this period, which can be regarded as a feature of the developmentalist era, the progress made in China was particularly dramatic given its low level of economic development, lack of foreign aid and the magnitude of expansion. The achievement should be attributed in large part to the collectivist system in the Mao period under which the state was able to mobilize millions of rural laborers to participate in water infrastructure construction and maintenance.

As it shifted to the neoliberal era, however, this expansionary trend stalled, and the agricultural water system declined. In the first decade of the market reform (1980s), the Chinese state withdrew much of its support for the agricultural water system by cutting irrigation investment and relegating the responsibility of agricultural water to local governments, rural communities and farmers. This also fits into the global trend of

irrigation stagnation in the neoliberal era. The main cause for this is that the pursuit of profits has become the dominant principle that governs the behavior of the state and private investors while other development goals such as welfare, wellbeing and food security are downgraded and even sacrificed. In the 1980s and 1990s, the agricultural water system in China was underinvested, and many of existing irrigation facilities were worn out or broken down. This was particularly the case in coastal and southern provinces where the profitability of urban and industrial sectors far outstripped that of the agricultural sector, and thus the investment in agricultural water made little sense under the neoliberal principle of profit maximization.

However, as the agricultural water system declined, the capacity of grain production was also threatened since irrigation has been a crucial factor for China to feed such a huge population (20 percent of the world population) with such a limited area of farmland (seven percent of the world total). Thus the concern for food security forced the Chinese state to increase investment in agricultural water. In the past two decades (1998-2017), the investment in agricultural water has been multiplied. If only taking into account monetary investments, the share of agricultural water in total infrastructure investment in recent years has been on par with that in the developmentalist era.

This contradiction between profitability and food security constitutes what I call the structural dilemma of agricultural water in China. However, shifting back to food security in the neoliberal era suggests in no way that it would reverse the declining trend of the agricultural water system. Rather, it has produced mixed results at best, with more

investment in irrigation facilities but less attention to the sustainability of the system, as I showed in this dissertation. To illuminate this issue, I conducted a multilevel analysis and examined the changes in agricultural water over the past four decades at national, local and community levels. In what follows, I present main findings, theoretical implications, and a discussion of important issues that would merit future research.

Summary of Findings

The manifestations of the structural dilemma and its impacts are different at national, local and community levels. At the national level, I focused on the changes in government investment in agricultural water, and the regional impact of these investments. At the local level, I examined the response of local governments at the county level to the shift in central policy. At the community level, I analyzed the impacts of rural transformations, particularly the transformation to agricultural capitalism, on the incentives and actions of villages and farmers on agricultural water.

There are three main findings at the national level. First, the central government has greatly increased water investment in the past two decades, but only a small proportion, about 10 to 20 percent, was devoted directly to agricultural water. The majority of water investment was either allocated to enhancing the comprehensive water system such as large rivers and lakes or used to finance water supply to the city or hydropower. Thus the increase in agricultural water investment is not as large as official data suggests.

Second, the increase in agricultural water investment has facilitated the northward

movement of grain production, exacerbating the grain-water mismatch. The water-scarce north has produced a growing share of grain due to the investment in irrigation infrastructure. If grain is seen as commodities containing virtual water, it is the water-scarce north that exports water to the water-rich south rather than the other way around. This mismatch has caused the falling of water tables and the depletion of aquifers in many northern regions. In other words, the concern over food security has intensified grain production in northern regions where the contradiction between food security and profitability is less intense than that in economically developed southern regions, leading to the over-extraction of groundwater in the north.

Finally, both the pursuit of profit and the concern over food security contributed to water pollution, another serious problem with the agricultural water system. In regions where urban and industrial sectors are developed, for example, many coastal provinces, water is polluted by urban and industrial waste discharges. In regions where grain production is intensified, such as northeast provinces, the overuse of pesticides and chemical fertilizers has also polluted both surface and ground water. Thus, from the perspective of water pollution, a shift of priority back to food security would not alleviate the problem. This is so because the official perception of food security in China is still to produce more grain to meet growing demand rather than to develop a sustainable agricultural system that is premised on the sustainable use of water, land and other natural resources.

The strong push from the center to increase agricultural water investment has met different responses from local governments. Some local governments have followed this

central policy more closely than others depending on the degree to which their interest is in line with the center. This dissertation used two case studies to illuminate the difference. In Southern County, the county government gave priority to urban and industrial sectors rather than agricultural water because the latter could contribute relatively little to revenue. The local government refused to provide the counterpart funds to match agricultural water investments from upper-level governments. In addition, it allocated water funds to build facilities serving urban and industrial interests. In Northern county, by contrast, the government made great efforts to promote agricultural water use and grain production, but this caused the over-extraction of groundwater. In recent years, the county started to promote water-saving technologies based on the funds received from the central government. This suggests that the county has largely followed the central policy on grain production and agricultural water development. However, there are signs that the interest of the county started to diverge from the center. As the real estate boom and urban expansion became a major way of local revenue generation, the county started to promote real estate development and expanded the size of the county town. To meet the water demand of a growing urban population, the county implemented a large water transfer project to transfer water from agricultural areas to the county town. This will further stress the local water system and reduce the availability of water for agriculture and grain production.

In short, the interest of local governments is oriented toward economic growth and revenue generation in the neoliberal era. In such a context, the central government has tried using incentive funding, administrative order and political control to bring local

governments into the line of central policy. However, this is not always effective. Local government has a certain degree of leeway to adjust central policy based on local conditions. In the case of agricultural water, the central policy is often diluted at the local level. That is to say, although the central government has raised the funds for agricultural water considerably, it remains an open question to what degree the funds have been channeled to improving the agricultural water system at the local level.

At the community level, this dissertation research investigated seven villages of diverse conditions, four in Southern County and three in Northern County. In general, I found that the rapid transformation of the rural society exerted profound impact on rural households' incentive and action on agricultural water. Three main findings are discovered. First, the efficacy of the villages to take joint action on agricultural water has declined. A major cause for the decline is that rural households have engaged in diverse economic activities. A growing proportion of rural households rely on nonfarm employment rather than farming for the main source of income. This is more so in Southern County than in Northern County. As a result, while some households would like to have better access to agricultural water, others are reluctant to contribute because agriculture is of little importance to their livelihood.

Second, although there are still a significant proportion of rural residents who rely on farming for food supply and livelihood, their perspective is different from either the pursuit of profit or the official definition of food security. On the one hand, many rural households do not regard farming as the most important source of income. Thus they do

not pursue maximizing profit from farming. On the other hand, many households do not produce grain for the market but for self-consumption, thus they tend not to produce a maximum amount of grain for the country's food security. In other words, these households either engage in subsistence farming or use farming to absorb their surplus labor such as the elderly and women who must at the same time take care of children. This kind of small-scale farming assumes many social functions and is a manifestation of household economic strategy, but it is at odds with the capitalist logic of profit maximization or the state's goal of food security. With regard to agricultural water, these households hope to have a good agricultural water system, but they can only contribute a limit amount of money or labor to maintaining the system.

Third, farmers are differentiated. While there are part-time subsistence farmers as noted above, a small but growing number of large farmers emerged to take on capitalist farming. This is more so in Northern County where farmers could lease large tracts of land, but this trend is also emerging in Southern County. Capitalist farming fits into both the neoliberal principle of profit maximization and the government goal of food security because these capitalist large farms pursue the maximum output from the land, be it either grain or commercial crops. With regard to agricultural water, these large capitalist farms are also in an advantageous position: they could either invest in agricultural water themselves or apply for government funding to do so. However, the expansion of capitalist farms does not necessarily have a positive effect on the agricultural water system. On the one hand, the profit-motivated extraction of water resources would damage the already vulnerable water system, as is seen in the case of Northern County.

On the other hand, the expansion of capitalist farms would exclude small farms from accessing agricultural water, thus exacerbating the problem of unequal distribution of water.

Finally, the governments at both central and local levels have increasingly seen capitalist large farms as a reliable agent of policy implementation for it could both promote the growth of agriculture and produce more grain to meet the goal of food security. Thus the shift of government support toward large farms would put small farms at a disadvantage in accessing agricultural water. However, the government must ensure the livelihood and food supply of small farmers, thus it will have to provide some protection of these farmers' access to water. As was seen from the village case studies, all the villages have collectively received some amount of government funding for building or improving irrigation facilities.

Theoretical Implications

My dissertation research challenges as well as adds nuances to existing theories, and contributes a new perspective to understanding the agricultural water crisis worldwide. The community organization theory emphasizes the importance of effective organizations at the village level. This study has shown that the villages with effective organizations are indeed more capable of maintaining the collective irrigation system and distributing water equally and fairly. The main Z village in Northern County is such an example. However, the effectiveness of collective organizations is affected by large political and market forces. In the developmentalist era, the effectiveness of village organizations in

China was derived from the support of a socialist state and the collective system. As a result, village organizations could mobilize millions of peasants every year to participate in large-scale irrigation campaigns. However, as it shifted to the neoliberal era, the Chinese state dismantled the collective system, and most Chinese villages were no longer able to mobilize peasants to contribute to irrigation. Furthermore, social differentiation in the post-reform period diversified interest in agricultural water, which made intra-village collective action even more difficult. Many rural households shifted attention to nonfarm activities that could generate greater economic returns, while paying little attention to agricultural water.

The marketization theory approaches the issue from the angle of property rights. It argues that water problems are caused by the ambiguity of property rights and that the solution is to privatize irrigation facilities. However, the theory is based on two assumptions that are often untrue even in the neoliberal era. One is that the users of agricultural water are rational actors who pursue the maximization of economic interests. This study found that many rural households, particularly those in Southern County, are subsistence farmers in that they only farm their land for food for self-consumption while deriving main income from nonfarm sources. As a result, they do not aim to maximize the output from the land, and thus do not regard irrigation water as a commodity. The other assumption is that agricultural water is a factor of production that can generate profit. However, the use of agricultural water is often unprofitable. And this is the case even in the United States, one of the largest exporters of agricultural commodities. In many cases, the agricultural water system, and the farm sector at large, is highly subsidized by the state. In this study, I

found that many peasants are reluctant to shoulder the cost of agricultural water due to the low profitability of agriculture.

The Marxist theory of capitalist transformation predicts the demise of the peasantry and the rise of large capitalist farms. Along with this process, the irrigation system that serves the peasantry would decline while a new system that serves capitalist farms would emerge. This dissertation did find that the class differentiation of the peasantry and outmigration of rural laborers have greatly undermined the village-based irrigation system. However, the demise of the peasantry has not led to the emergence of a working class in much of the Global South. Rather, the displaced peasantry was turned into precarious workers in the city without formal wage jobs or the sufficient support of social security (Standing 2016). This is also the case in China. In view of uncertainty and precariousness of employment in the city, most rural households are reluctant to sever the relations with land (Andreas and Zhan 2016; Zhan 2017). My fieldwork shows that, although the village-based irrigation system is undermined, many peasants still want to maintain the rights to the land and hope to have access to village-based irrigation. Thus the replacement of the village-based irrigation system by one that serves only capitalist farms would be a process fraught with struggles and resistance. It is very likely that the triumph of the capitalist system would not be a natural outcome but one forced through by the power of the state (Luo, Andreas and Li 2017). This brings our attention to the urban bias theory and the role of the state.

The urban bias theory focuses on state-class relations and argues that the state would issue policies favorable to urban and industrial classes because of the latter's political influence. This dissertation also shows that the Chinese state's urban-biased policies diverted human, material and financial resources away from agricultural water to urban and industrial sectors. However, the theory has not paid enough attention to the contradictions within capitalist development. With regard to agricultural water, although profitability has been a key principle determining the actions of the state, the concern for food security as well as for subsistence has pulled state policy toward agricultural water and grain production. Thus, it glosses over the tensions between profit and state legitimacy and complex central-local relations.

My dissertation foregrounds the contradictions of capitalist development with regard to the agricultural water system in the neoliberal era. It reveals how agricultural water has caught in the structural dilemma between profitability and food security. The research would make three contributions to the literature. First, it advances the Marxist analysis of agricultural water by highlighting the contradictory role of the state. In the Chinese case, the agricultural water system experienced great expansion in the developmentalist era due to state intervention, but it was neglected in the initial decades of the neoliberal era. As capitalist development undermined agricultural production and pushed up the demand for food, the state was forced to support the agricultural water system again.

Second, it draws attention to the spatial dynamics and uneven development of capitalism with regard to agricultural water. The pursuits of profitability and food security do not

impose on localities uniformly. Rather, it pushes low profitable grain production into less developed regions, in many cases causing the over-extraction of water resources and the degradation of environmental conditions. This also entrenches the previously uneven patterns of economic development, perpetuating spatial inequalities.

Finally, although it largely holds true that the Chinese countryside has been undergoing capitalist transformations characterized by the rise of large farms and agribusiness, it is not a natural outcome as indicated in much of the literature but pushed strongly by the state due to both the pursuit of profitability and the concern for food security. In addition, the rise of large farms and agribusiness companies would be hampered by the existing, village-based agricultural water system. To overcome the obstacle, they must rely on the state to transform it to one serving capitalist farms, which requires the state's enormous sums of financial investments and strong arms to break the resistance from small farming households.

Issues and Future Research

Two important issues have arisen. One is the transition of the community-level irrigation system; the other is the spread of urbanization nationwide and its impact on agricultural water.

Rise of a capitalist irrigation system

The Chinese rural society consists of tens of thousands of villages, and the irrigation system at the community level is designed to meet the need of irrigation for the village as

a whole. Such a system is essentially a collective system, and it was also built with collective effort.

Rise of large capitalist farms entails the transformation of the collective system into a new one. The preliminary investigation of this issue in this dissertation research shows that there are two ways for large capitalist farms to control agricultural water. The first way is to rely on the government to consolidate farmland and build a new irrigation system. As noted above, the government supports large farms for their role in both economic growth and food security. The case of tobacco farms in Southern County shows that the government can consolidate small plots of land into a large farm and build an irrigation system for it. The other way is to privatize village irrigation facilities and use these facilities to serve private large farms. Many villages in Northern County have privatized collective wells, and as a result, the previous collective wells are now controlled by private owners and irrigate private farms.

The transformation to a capitalist irrigation system would solve the problem of collective coordination on agricultural water. However, this change will raise at least two questions that merit future research. First, the rise of the capitalist irrigation system would take decades to complete. Thus there will be a long period when the capitalist system coexists with the village-based system. It is worth investigating how the two systems interact with each other, and this will provide a novel perspective on agrarian transformations in the Chinese countryside. Second, the rise of the capitalist irrigation system would not be possible without the support from the state, which provides the institutional framework

and funding for the former to emerge. It is worth investigating the interactions between the state and large farms with regard to agricultural water in the neoliberal era. This would challenge the popular perception that the neoliberal state tends to withdraw from building public infrastructure. In the case of China, however, the state has actively built water infrastructure in the new phase of the neoliberal era, but it is only large capitalist farms that have privileged access to the infrastructure facilities.

Urbanization and agricultural water

The Chinese state has so far paid much attention to the encroachment of urbanization on farmland to maintain a sufficient grain production. For example, the central government set up a red line which requires maintaining at least 120 million hectares of farmland. However, as the case of Northern County shows, water is an even more scarce resource for grain production. Urbanization in the north has already placed great stress on the water system. For example, megacities such as Beijing and Tianjin have exhausted water resources in the region, forcing the Chinese state to initiate the South-North Water Transfer Project to quench the thirst of these cities.

The further urbanization in areas such as Northern County will transfer water from agriculture to the city, which will undermine grain production in the north. The impact of urbanization in China's northern and hinterland regions on agricultural water use has not received adequate attention. Thus further research should be conducted to assess the impact, and evaluate whether water-saving programs, which are widely practiced but

largely aimed at saving agricultural water in the north, is effective if taking into account growing demand for water from urban and industrial sectors.

In addition, if grain production in the north and hinterland regions is undercut due to a shortage of water resources, China would have no other areas at home to relocate grain production. As such, it will have to further increase food imports from the international food market and/or increase overseas agricultural investment to secure food supply. Thus the linkage between water scarcity in north China and the country's reliance on overseas resources for food supply can be further explored in future research.

Finally, urbanization has interacted with the rise of a capitalist irrigation system. On the one hand, urbanization will move a growing rural population to the city, causing the further disintegration of the village-based irrigation system; on the other hand, the rise of the capitalist system will transfer agricultural water from small to large farms, accelerating the concentration of farmland. As a result, small farmers are forced to leave for the city due to the cutoff of access to agricultural water. Further research should be conducted to examine how the policy of promoting urbanization and the expansion of large farms would be mutually reinforcing from the perspective of agricultural water use.

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Curriculum Vitae

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Education

Institution and Location	Degree	Year	Field of Study
The Johns Hopkins University (Maryland, USA)	PhD	2017	Sociology
The Johns Hopkins University (Maryland, USA)	MA	2010	Sociology
The China University of Political Science and Law (CUPL) (Beijing, China)	BA	2002	Public Policy and Law

Positions and Employment

- Spring-Fall 2015 & Spring 2017, Teaching Assistant, Division of Sociology at Nanyang Technological University (NTU)
- Fall 2008- Spring 2014, Fall 2016- Spring 2017, Research and Teaching Assistant, Department of Sociology at the Johns Hopkins University (JHU)
- July 2002-December 2006, Public Administration Officer, Dongcheng District Community Development Office, Beijing, China

Teaching Experience

- Spring, Fall 2015 & Spring 2017: HS3002 Intro Statistics, with Professor Shaohua Zhan and Professor Premchand Dommaraju at NTU
- Fall 2011:
AS.230.225 Population, Health and Development, with Professor Stan Becker at JHU
AS.230.302 Social Structure and Personality, with Professor Mel Kohn at JHU
- Spring 2011: AS.230.199 Criminal Justice and Corrections, with Professor Stephen E. Harris at JHU
- Fall 2010: AS.230.225 Population, Health and Development, with Professor Stan Becker at JHU
- Spring 2010: AS.230.341 Medical Sociology, with Professor Kate Smith at JHU
- Fall 2009: AS.230.302 Social Structure and Personality, with Professor Mel Kohn at JHU

Honors and Awards

2012 Johns Hopkins E2SHI Dissertation Research Grant (2012-2013)	\$25,000
2012 Johns Hopkins Sociology Department Summer Research Funding	\$3,000
2012 Johns Hopkins East Asian Studies Program Summer Research Grant	\$1,800
2012 Johns Hopkins Global Water Program for Scholarly Travel Grant	\$500
2011 Johns Hopkins East Asian Studies Program Conference Travel Grant	\$750
2010 Johns Hopkins East Asian Studies Program Summer Research Grant	\$1,500
2010 Johns Hopkins Institute for Global Studies Research Fellowship	\$1,750
2010 Johns Hopkins Program in Global Social Change Travel Grant	\$1,500

Presentations

2013 “GDP Growth or Food Security: Structural Dilemma of Irrigation in China”, Workshop on “Agrarian Development in China: Legacies and Prospects” (organized by the East Asian Studies Program, Arrighi Center for Global Studies, and Political Science department of the Johns Hopkins University), Baltimore, November 1.

2012 “Food Security, Industrial-Urban Bias and Irrigation Decline in China”, the Student Symposium of the East Asian Studies Program at JHU, Baltimore, April 13.

2012 “Central Mandates and Local Interests: Conflicts over Irrigation Investment in China”, the Annual Meeting of the Eastern Sociological Society (ESS), New York, February 23-26.

2011 “Land Rights and Migrant Labor Shortage in China: A Market Path for Labor Empowerment”, the Annual Meeting of the American Sociological Association (ASA), Las Vegas, August 20-23.

2011 “Between Economic Growth and Livelihood Security: The Structural Dilemma of Irrigation in China”, the Northern America Chinese Sociologist Association Annual Conference, Las Vegas, August 19.

2010 “Land Rights and Labor Power in Contemporary China: A Market Path for Labor Empowerment”, the 34th Annual Conference (PEWS) The Political Economy of the World-System Section of the American sociological association (ASA), Land Rights in the World-System, Florida Atlantic University, April 22-24.

Publications

(Forthcoming) 2017. “Internal Spatial Fix: China’s Geographical Solution to Food Supply and its Limits” *Geoforum* (With Shaohua Zhan).

(Forthcoming) 2017. “Grassroots Organizations and Local Governance in Singapore”, book chapter in *Local Governance in Comparative Perspective*. Beijing: China Society Press.

2014. “Relative Deprivation and Collective Action: A Comparison between Laid-off Workers and Migrant Workers in 1990s and Early 2000s China”, *Hopkins East Asian Forum & Review* Vol.1: 12-20.

2013. “Rural Roots of Current Migrant Labor Shortage in China: Development and Labor Empowerment in a Situation of Incomplete Proletarianization”, *Studies in Comparative International Development*, 48 (1): 81-111 (with Shaohua Zhan).

2012. “GDP Fetish, Irrigation Decline and Precarious Food Security in Contemporary China.” *Global Water Magazine of Johns Hopkins University*. June 12, 2012.

2011. *Between Economic Growth and Livelihood Security: The Structural Dilemma of Irrigation in China*. Johns Hopkins University Master Thesis.

2011. “Labor Migration and Social Integration in Ethnic Western China”, in Ping Huang ed., *Bentu Quanqiuhua: Dangdai Zhongguo Xibu de Shehui Wenhua Bianqian (Glocalization: Social and Cultural Change in Western China)*, Beijing: The Economic Management Publishing House (with Shaohua Zhan).

2009. “Poverty and Poverty Reduction in Inner Mongolia”, in Xiaojun Zhang ed., *Village Reports of Poverty Reduction in China*. Beijing: The Social Science Literature Publishing House.

2005. “Internal Conflicts and The Roles of Residential Associations in New-rich Urban Neighborhoods”, *Beijing Society*, April 2005.

2003. “Institutional Innovations in Separation of Government and Self-governing Social Organizations: A Case Study”, *Beijing Society*, October 2003.

Research Projects

Fall 2016 & Spring 2017. China in the Era of Industrial Citizenship, research assistant to Prof. Joel Andreas at JHU

November 2013- August 2015. Food Security, Urban-industrial Bias and Irrigation Sustainability in China, Dissertation project with fieldwork and archival research in China funded by E2SHI at JHU

Spring 2012. Agricultural/Rural Policies of the Chinese State in the Post-Reform Era, research assistant to Prof. Ho-fung Hung at JHU

Fall 2008 & Spring 2009. Democracy within Factories during the Cultural Revolution of China, research assistant to Prof. Joel Andreas at JHU

June-July 2008, Glocalization: Social and Cultural Change in western China, Funded by the Ford Foundation. As a research team member, I conducted interviews in Yunnan Province, together with colleagues from Chinese Academy of Social Sciences.

March-April 2006, Rural Poverty Reduction in China, funded by the World Bank. I was a member of the research team and involved in designing questionnaires, conducting interviews and writing research reports.