Water **2013**, *5*, 643-658; doi:10.3390/w5020643

OPEN ACCESS

water

ISSN 2073-4441

www.mdpi.com/journal/water

Article

Evolution of Water Management in Shanxi and Shaanxi Provinces since the Ming and Qing Dynasties of China

Xiaohong Dang [1], Michael Webber [2], Dan Chen [3,*] and Mark Yaolin Wang [2]

[1] College of Humanities and Social Sciences, Qingdao Agricultural University, Qingdao 266109, China; E-Mail: dxh0830@126.com

[2] Department of Resource Management and Geography, The University of Melbourne, Victoria 3010, Australia; E-Mails: mjwebber@unimelb.edu.au (M.W.); myw@unimelb.edu.au (M.Y.W.)

[3] Key Laboratory of Efficient Irrigation-Drainage and Agricultural Soil-Water Environment in Southern China (Ministry of Education), College of Water Conservancy and Hydropower Engineering, Hohai University, Nanjing 210098, China

* Author to whom correspondence should be addressed; E-Mail: cherrydew@hhu.edu.cn; Tel.: +86-025-8378-7210; Fax: +86-025-8378-6921.

Received: 26 March 2013; in revised form: 22 May 2013 / Accepted: 26 May 2013 / Published: 4 June 2013

Abstract: This article examines some of the forms of water management in Shanxi [山西] and Shaanxi [陕西] provinces during the Ming and Qing dynasties. Facing serious water shortages and shrinking state power for water management, the local society in Shanxi and Shaanxi took over water management and gradually formed a local self-government system for the water resources. Depending on water management organizations in which the local gentry were the core power, the water rules were based on natural topographic conditions, historical water practices in the locality, traditional moral-ethical ideas, and even water policies and water laws. This water management system played a positive role in mobilizing the participation of members, preventing opportunistic behavior such as free riding and rent seeking, while decreasing the probability of water conflicts and the costs of litigation. However, this water management system was also subject to endemic corruption because of the lack of effective monitoring from the local government. As similar problems appear to exist in China today, this article analyzes the features of this water management system, and examines the problems that faced those systems so as to provide a warning from history for modern society.

Keywords: water management; local self-government; Shanxi; Shaanxi; Ming and Qing dynasties

1. Introduction

It is self-evident that in an agrarian society such as China, water resources play an important role in both agricultural production and daily living. However, the annual per capita water supply in China (2200 m^3) is only 25% of the world average: China is a country with severe water shortage [1]. In addition, the distribution of water resources is uneven both temporally and spatially, due to the varied topographic features and monsoon climate: the south has ample rainfall and many lakes and rivers; on the contrary, the north is arid [2]. Moreover, China is a country with frequent natural disasters such as drought and flood. The Yellow River, for example, which is the second longest river in China, has flooded nearly 1600 times in the last 3000–4000 years [3]. So, despite being described as "the Land of Rivers" by James Fairgrieve in 1917, water is still a critical constraint on social stability and economic development in China in the long term. Therefore, it is essential to establish an effective system of water resource management in China.

Unfortunately, the management of water resources has always posed problems in China, and it continues to do so. Firstly, governments at different levels focus excessively on economic development whilst ignoring protection of water resources; on seeking new water resources and constructing large-scale water projects whilst neglecting maintenance and sustainable use of the former or smaller water projects; on technological innovation whilst ignoring the construction of morals, ethics, social institutions and institutional capacity to manage existing resources [4]. In the past, this was to do with raising the output of grain, itself crucial to state power [5], but now provinces compete for industrial development. Under the effect of this priority, water communities also compete with each other for water resources rather than organizing effective cooperation. Without close cooperation between water communities, some farms receive more water than needed; others do without [4]. Further, when China's peasants lacked control over water availability and could not participate in the processes of water resource management, they were (and remain) unwilling to contribute resources to maintenance of water works and conservation of water; on the contrary, facing perverse incentives and substantial temptations, they used illegal practices so as to obtain more water [6]. These problems both confused the system of water management and aggravated the already-degraded water environment. How to manage water resource effectively has long been a critical need of China's governments and people.

The management of common-pool resources, especially in the developing countries in which agricultural production is the foundation of national economies, already created a wide argument in the 1960s. In 1968, Garrett Hardin published the influential article "The Tragedy of the Commons". In this article, he argued that the users of common pool resources are caught in an inevitable process of over-exploitation that leads to the destruction of the very resources on which their society depends. Hardin's proposed solution was either socialism or the privatization of free enterprise [7] Although this concept was used by many scholars and policy-makers, it came under increasing criticism [8] and in the 1990s, the American political scientist, Elinor Ostrom, found that both government ownership and

privatization were themselves subject to failure in some instances, such as northern China (Inner Mongolia and Xinjiang) and southern Siberia [9]. On the other hand, in some places such as Mongolia, traditional self-organized group-property regimes showed evidence of much less degradation of common-pool resources [10]. So, Ostrom argued that there exist more solutions for the management of common-pool resources than Hardin proposed, including self-organized group-property regimes under which the common-pool resources are managed by the local community [9].

Local self-government of water resources is not a new idea. In fact, it appeared in some water shortage regions of north China in the Ming and Qing periods (1368–1911 AD). Facing severe water shortages and bureaucratic inefficiency, the local societies in some parts of north China established spontaneous organizations without the intervention of government. These non-official organizations undertook responsibility for water allocation and the maintenance of water projects, using traditional moral and ethical guidance and even some social institutions. In 1949, accompanying the foundation of the People's Republic of China, the policy of "the ownership and management of natural resources both belong to nation" was formulated and enforced; as a result, these localized systems of managing water resources that had existed for hundreds years disappeared in most places. However, this old management system still deeply affects the water-using ideas and behavior of local people. So, this paper describes some of the forms of water management in Shanxi [山西] and Shaanxi [陕西] provinces during the Ming and Qing dynasties, analyzes the features of their water management systems, and examines the problems that faced those systems. In addition to providing an example of the local self-management of a common-pool resource that is outside the pastoral regions of East Asia, the paper also provides a warning from history about the availability of alternatives to technological, capital-intensive systems of water management in modern society.

2. Brief History of Patterns of Water Management in China

The history of water management in China dates back to the 20th century BC. At that time, facing serious floods on the Yellow River, *Shun* [舜], the emperor of China, delegated *Yu* the Great [大禹] to bring the Yellow River under control. Shun did manage to control flooding. Even now, the story of "*Yu* the Great bringing the Yellow River under control" is still circulated widely. In general, the history is conveniently divided into two stages, separated by the transition from the Ming to Qing dynasties in 1644 [11]. Before the Ming and Qing dynasties, all works relating to water resources were done by the central government, which built many large scale hydraulic engineering works and maintained them regularly, set up specific water management administrations in central and county levels, and formulated a series of water laws [12]. During and since the Ming and Qing dynasties, the status changed radically. Except for some large-scale water projects, the state gradually withdrew from routine water management, and local societies became more and more involved in and undertook responsibility for local water management [13]. Water resource management became localized. The reasons for this change included:

(a) The central government was busy with external military incursions and internal rebellions, both of which led the government to neglect the monitoring of the local water officials. This neglect provided an opportunity for local water officials to engage in illegal behavior, such as embezzling water projects' funds and imposing fees on local people. The governor of the

Southern Metropolitan Area lamented that "evil government clerks have burrowed in" [14]. As a result, the administrative capacity of the state declined [15].

(b) Since the late Ming, the policy of collecting tax purely in accordance with population and households was changed to taxation according to farm land areas. In 1712, the emperor *Kangxi* [康熙] declared that people born after 1711 need not pay tax, which decreased the tax burden of the ordinary farmers. However, it also directly resulted in the rapid growth of population, as a result of which, the cost of managing water resources increased.

(c) The central government cut down the financial investment available to local governments because of the rapidly increasing military expenditure. This meant that local governments lacked the finance to undertake every water project, so they had to delegate voluntary organizations to ensure the construction and maintenance of waterworks for irrigation as well as daily living.

(d) Since the late Ming period, the *Lijia* system [里甲制度], a system of rural administration, broke down rapidly. Therefore, the control of the state over rural society decreased, which provided a space for local autonomy to develop, under the leadership of the local gentry. Accompanying the growth of local autonomy, the new rural powers sought to become involved in the work of local water management.

Facing these problems, the central government transferred the general powers for managing water resources to the local society. On the one hand, the special official who managed water resources withdrew gradually from the concrete management of local hydraulic engineering; the management work was done by the local administrative officer as his part time job [16]. On the other hand, the governments encouraged local society to self-organize and manage water resources. Under these social circumstances, the local societies of Shanxi and Shaanxi participated in the management of water resources and gradually became the primary power in water management (at least until Mao's revolution).

3. Water Management in Shanxi and Shaanxi

3.1. Water Environment and Water Organization

Shanxi [山西] and *Shaanxi* [陕西] are located in arid and semi arid areas of China. Figures 1 and 2 provide location and environmental data about these provinces. Their water environment is fragile because of topography features and climate conditions. For example, *Shanxi* is a water shortage province which is located in the eastern part of the Loess Plateau. Its topography divides Shanxi into three different areas from east to west, including mountains (72%), basins (16%) and plateau (12%) [17]. At the same time, the strata mostly covered by loess are 200–300 m deep, so groundwater is buried deep too. In some areas, the buried depth of groundwater reaches 300 to 500 m or more [18], so it is difficult to raise and use groundwater with traditional technology. As the Qing gazetteer *Xian Ning Xian Zhi* [咸宁县志] described it: "Wells must be dug until hundreds meters and carrying groundwater is very difficult" [19]. Moreover, influenced by the temperate-warm temperate climate, Shanxi's average annual rainfall is only about 500 mm, falling in some areas to only 200–400 mm. In addition, rainfall is not equally distributed over the year. In general, 60% of rain falls in summer and relatively

little in winter and spring, so drought often occurs in winter and spring. Similar conditions also exist in Shaanxi, which is, though, generally wetter and warmer than Shanxi.

Figure 1. Map of Shaanxi province in 1735. Source: *Shaanxi Tong Zhi* [陕西通志] (1735) [20].

Figure 2. Map of Shanxi province in 1734. Source: *Da Qing Yi Tong Zhi* [大清一统志] (1734) [21].

During the Ming and Qing periods, following the rapid growth of population, extension of land clearance and reduction of forest because of excessive cutting, the water environment of these two regions worsened continually. For example, there were two rivers, *Bagu* [巴谷水] and *Angu* [安谷水], which are located in the north of *Liquan* County [礼泉县], Shaanxi. In the Ming dynasty, these two rivers could irrigate nearby farmlands. However, by the mid Qing dynasty, they could no longer provide irrigation water, because of the decreased flow of water [22].

Facing serious water shortages and shrinking state power for water management, the local society of *Shanxi* and Shaanxi established special organizations so as to manage water resources more effectively. These organizations managed water resources in a hierarchical framework according to the boundary of the water resource and the scale of the water works. In general, the larger the scale of hydraulic engineering and the more villagers and counties involved, the more managerial levels there were in the organization. In smaller-scale water projects, there were fewer levels of organization. For instance, the managerial organization of *Tongli Ditch* [通利渠], across *Hongdong* [洪洞], *Zhaocheng* [赵城] and *Linfen* [临汾] counties (Shanxi province) had three levels of organization. According to the record of *Chong Xiu Tong Li Qu Qu Ce* [重修通利渠渠册] (compiled in 1908) [23]:

> Set up the highest leader named *Du Quzhang* [督渠长, or supervising canal leader] to manage all things about *Tongli* Canal [通利渠]. In addition, select three persons from each of these three counties, named *Jieshui Quzhang* [接水渠长, or receiving water canal leader], *Zhishui Quzhang* [治水渠长, or control water canal leader], *and Xinggong Quzhang* [兴工渠长, or encourage work canal leader] to settle the things about the canal within the county. Below them, every village chooses one to two persons named *Goushou* [沟首, or canal chief] to conduct all things about the canal within the village [23].

In this case, the highest level was a leader who undertook responsibility for all things about this canal, especially supervision and coordination of water use between the three counties. In the middle level, three persons were selected from every county. Their main duty was to manage all things about this canal in their own county and to safeguard the interests of their county when water disputes occurred between the three counties. Under this level, one or two people were selected from each village in the three counties to manage the use of the canal within their own village. Thus, it formed a stable "pyramid-shaped" system in which the relationship within the same level was parallel and the relationship between three levels was vertical (Figure 3). This is the tiao-kuai structure of administration so familiar today [4].

In contrast to *Tongli* Canal, there were many shorter canals which did not need anyone to supervise and coordinate the use of water between different counties in *Shanxi* and *Shaanxi*, so the organization was relatively simple. For example, *Nanhuo* Canal [南霍渠], a water work in *Hongdong* [洪洞] county, which was dug in the Tang dynasty could irrigate 13 villages of *Hongdong* County. Within this water organization system, there were two managerial levels: the highest level was *Quzhang* [渠长, or canal leader] and under him were *Goutou* [沟头, or canal chiefs], who were selected from these 13 villages (Figure 4).

Figure 3. The organization system of *Tongli* Canal.

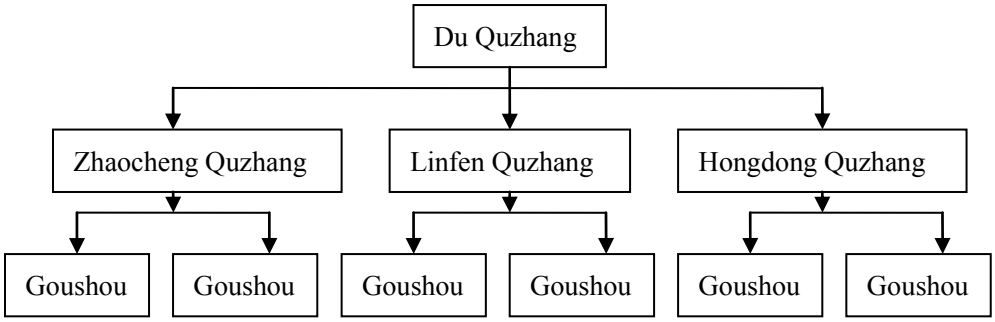
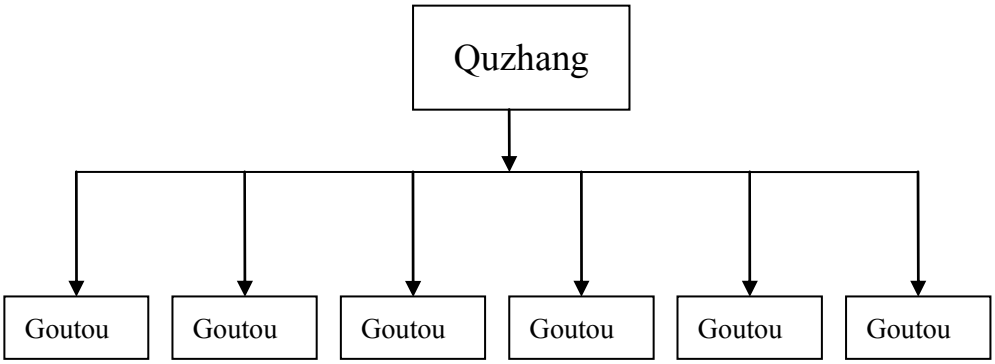


Figure 4. Organization system of *Nanhuo* Canal. In this water community, the actual executors of the water organization system were styled Goutou [沟头], whose duties were the same as those of Tongli Canal's Goushou [沟首].



The *Quzhang* was the core power in both these organization systems. As the representative of the water rights of the entire community and the highest leader of water management organization, the fairness or not of the *Quzhang* directly affected the water interest of every member of the community. So, strict selection criteria for the *Quzhang* post were formulated by many water communities in these regions. As for the selection of *Quzhang*, *Chong Xiu Tong Li Qu Qu Ce* [重修通利渠渠册] (compiled in 1908) [23] it was recorded specifically:

> The candidates of *Quzhang* must be persons who are knowledgeable, wealthy, right-minded, prestigious and capable… The gentry assembled together and voted for *Quzhang* from those candidates... The poor people are not entitled to be selected for *Quzhang* or even *Goushou* [23].

Such records indicate that the selection criteria for the posts of *Quzhang* were strict. They included social status, property, educational level, social prestige, *etc.* However, the process of selecting *Quzhang* also reflected the fact that the rights of leadership of water organizations were tightly controlled by the elites, especially the gentry of the community. As for this characteristic, Smith observed that:

> Perhaps no more important exemplification of this principle is to be found in Chinese society than that embodied in the local self-government of the small communities of which the greater part of the empire is composed. The management of the village is in the hand of the people themselves. At first this condition of affairs is liable to be mistaken for a pure

> democracy, but very slight inquiry is sufficient to make it evident that while all matters of local concern are theoretically managed by the people as a whole, they are upon the shoulders of a few persons [24].

In other words, local societies established forms of organization to self-manage the use of water. "Local" and "transparent" or "open", however, are not to be confused with "democratic" or "popular participatory", and in this respect this form of organisation violated one of Ostrom's [25] rules for effective self-government of common resources—resource appropriators should be able to participate in decision making processes. In effect, the self-governing society comprised the gentry of a district; the peasants followed their lead. Nevertheless, these organizations were responsible for formulating and administering systems of rules about who could use water, and when.

3.2. Water Rules and Shuice [水册]

To manage water resources effectively, many of the water organizations established by the local communities made a series of water rules that reflected a comprehensive consideration of the natural topographic conditions, historical water practices in the locality, traditional moral-ethical ideas, and even water policies and water laws.

In order to prevent water conflicts, the boundaries of households which had rights to use water from a water project had to be clearly defined. So many water communities compiled a handbook in which every member's land area, land level, irrigation time and the starting and finishing time for irrigation were registered in detail. This kind of handbook was named *Shuice* [水册, or water book], sometimes styled *Quce* [渠册, or canal book]. In most cases, the *Shuice* was held by the local government after having been formulated and after the governor had put his seal on it. Thus, although formulated by the local water community, *Shuice* were supported by the local government and accepted widely by the members of the community because of its legality. Giving a clear allocation of water rights, on the one hand, it was enforced strictly by the water organization and obeyed by most members so as to prevent free-riding and rent-seeking behavior; on the other hand, it became legal evidence about the local water organization and the local government when water disputes occurred. In the Ming and Qing dynasties, *Shuice* was prevalent. In some communities, these rules were written on stone tablets, called *Shuili bei* or water conservancy stele. Unlike the stone tablets, *Shuice* were held only by the organization leader. Whether they were stone tablets or books, the main content of these water rules included four principal items.

First the rules specified how the cost of building and maintaining the water project was to be collected from the community. In the Ming and Qing dynasties, because of the withdrawal of state power from water management in these two regions (apart from some large-scale water works), the cost of constructing and maintaining small-scale water projects was paid by water communities themselves. In operation, many water communities adhered to egalitarian principles, in which costs were allocated according to household resources—either labor (the number of male members or family members), area of farmland or number of livestock. Many water stone tablets of Shanxi described such taxes:

> There are 700 villagers in the village, and everyone pays 380 *Wen*…
>
> —*Taoqu Cun Chong Xiu He Dong Jing* [桃躯村重修河东井] (in 1658) [26].

> All the families that are near the well which will be dug must pay money for digging well in accordance with the number of the family members…
>
> —*Shang Kuanyu Cun Chong Xiu Jing Ya Ji* [上宽裕村重修井崖记] (in 1778) [26].
>
> Paying money and providing labors for digging the well in accordance with the number of male villagers…
>
> —*Tumen Cun Zao Jing Bei Ji* [土门村凿井碑记] (in 1788) [26].
>
> There are 390 *mu* of farmland and each *mu* must pay 22 *Wen*…
>
> —*Liugou Cun XinJian DongLang Bing Zao Jing Ji* [柳沟村新建东廊并凿井记] (in 1865) [26].

The second set of rules concerned the application of the water resource. Taking into account the shortage of water and the significance of agricultural production, many water communities stipulated that irrigation had priority over other water-using activities. On this point, *Chong Xiu Tong Li Qu Qu Ce* [重修通利渠渠册] [23] recorded particularly that:

> All lands needed for building *Runyuan* Canal [润源渠] must be sold at a lower price by the local government of the water community, and then the work of digging the canal will be done immediately regardless of crops. Any person who disobeys this rule will be punished by local government…. Water mills benefit people's self-interest; on the contrary, water resources relate to the survival of the community. So, the activity of using water mills will be forbidden from 1 March every year to the last day of September, and will only be permitted during the winter-spring period in which farmlands need not be irrigated. Those water mills which have been destroyed are prohibited forever from using water, in order to ensure irrigation is successful. [23]

The third issue for water rules was the order of using water. In general, the head (higher) areas receive water first, relying on their better initial position than lower areas. However, in the Ming and Qing periods, the order of using water in many water communities was reversed: the lower areas received water first, and the upper areas last. The following records come from *Jingyang Gazetteer* [泾阳县志] of Shaanxi which was compiled in *Xuantong's* [宣统] (1908–1912) reign:

> The order of irrigation is from the downstream to the upstream. Specifically, the villagers of the tail village irrigate their lands first and then close the sluice gate after irrigating for the stipulated time; then the middle villages begin irrigation like this; the head villages will irrigate their land last...

Simultaneously, this water organization also provided additional preferences for the villages which were near the water source, as a reward for voluntarily transferring the water resource to the lower villages. These preferences included: (1) permitting them to use water without any limit of time and quantity; (2) absolving them of all obligations involving the water project, such as sharing the cost of constructing and maintaining water projects, providing foods for the laborers who constructed and maintained water projects, sending one individual to help construct and maintain water projects [27].

Finally, the rules stipulated the allocation of irrigation water. Theoretically, the optimal scheme of water allocation for irrigation should be based on the actual demand of crops. However, in times of serious water shortage, during the Ming-Qing periods, the allocation of irrigation water was based on the area and grade of land instead of actual demand. Furthermore, the irrigation time was measured with incenses (that is, the length of time taken for an incense stick to burn). In other words, the quantity of irrigation water was allocated according to the area and fertility of farmlands and was limited by the time, which was measured with incenses.

These water rules, written in *Shuice* and stone tablets, reflected several principles of water management:

(a) Sharing the costs of water works is in keeping with the traditional ideas of egalitarianism, which exist in agricultural society, and can stimulate the members of a community to provide low-cost monitoring of how resources are used, so that such opportunistic activities as free riding, rent seeking and corruption will decrease.
(b) The stress on irrigation as a priority can maximize agricultural production, thus helping to guarantee food safety and social stabilization.
(c) The order of irrigation "from the tail area to the head area" means that the villages with the greatest degree of control over the resource receive water the latest. Villages with the least control receive water first. This safeguards the water interests of the middle and low-lying villages. At the same time, the preferences granted to the villages near the water source compensated them for transferring the water resource voluntarily. These rules sought to balance the water using interests of upstream and downstream villages within a water community.
(d) The formulation and execution of *Shuice* can clarify water rights, avoid unnecessary water conflicts and offer proofs of rights during water disputes; thus, the incidence of water disputes and the costs of lawsuits can be minimized.
(e) In addition, the practice of elite control over the lead posts in a water community can motivate those elites to support the activities of water management; to the extent that they were more educated, had more free time and were held in greater regard than common people, the work of water management was facilitated.

However, in actual operation, what effect did this form of management have?

3.3. The Multiple Effects of This Water Management System

As Ostrom pointed out, it is impossible to evaluate the efficiency of a water management system precisely, especially a water management system which existed for hundreds of years and vanished almost sixty years ago [6]. So, on the one hand, we cannot assess accurately this form of water management quantitatively, and on the other hand, we can only grasp roughly the effectiveness of this water management system through some historical documents.

In the Ming and Qing era, many small scale hydraulic projects were built in these two regions (Table 1). In addition, many wells were constructed at this time. Most water projects were built and maintained by water communities under the self-organized water management system. The boom in water projects reflects both strong demands for water resource because of the rapid increase of population and the efficiency and order of this form of water management.

Table 1. The number of water projects in Shanxi and Shaanxi in the Ming and Qing dynasties. *Source*: Chi (1936) [28].

Provinces	Ming(1368–1644)	Qing(1644–1912)
Shanxi	97	156
Shaanxi	48	38

More direct evidence about the efficacy of this system of water management derives from such documentary evidence as law suits. We begin by describing two lawsuits about water which took place in Shaanxi province.

The first occurred during the reign of *Kangxi* [康熙] (1712 AD). Two members of the same water community of *Weinan* County [渭南] came into conflict over the use of water and sued the local government office (*Yamen* [衙门]). The governor of *Yamen* immediately required the *Quzhang* of this water community to formulate *Shuice* in which land acreages, land level and the length of time of irrigation were registered, and required every member of this water community to use water resources in accordance with this *Shuice.* However, in 1784, the descendants of the two disputants again came into conflict over the use of water, and in 1785, they appealed to a higher level of government, which adjudicated according to the *Shuice* and the water rules it specified for this water community [29].

The protagonist of the second lawsuit was a businessman, *Liu Siru* [刘丝如]. The irrigation right of his family had for several decades been forcibly usurped by *Liu Taizhong* [刘太忠], another member of the same water community of *Sanyuan* County [三原]. In 1812, *Liu Siru* accidentally found the local *Shuice* in his home. He appealed to the *Quzhang*, who adjudicated that the descendents of *Liu Taizhong* must return the irrigation back to *Liu Siru* in accordance with the records of the *Shuice* [30].

The resolution of these two lawsuits shows that *Shuice* and water rules which had been formulated by the local water organization were legal evidence for the adjudication of disputes by the local water organization and government. Undoubtedly, this water management system was accepted and used widely. At the same time, the rules made it likely that water conflicts could be resolved faster and more cheaply by shortening the investigation time and decreasing the litigation costs. These examples also indicate, however, that these were not entirely self-governing societies: disputants did have access to state institutions to resolve conflicts.

There is other documentary evidence of the success of some of these local water rules. Another historical document comes from a no-irrigation community of south Shanxi, including 15 villages of *Hongdong* County [洪洞], *Zhaocheng* County [赵城] and *Huo* County [霍县]. This water community depended on rainwater accumulated on *Huo* Mountain [霍山]; it had less water than any other community that depended on *Huo* Mountain for its water. In the Ming and Qing times, every member of this water community could extracted unlimited water on four days every month, on average; in some villages far from the water source, every villager could only obtain water freely one day every month. Facing the serious shortage of water, this water community compiled a strict no-irrigation water-using principle. Even though the limited water resources were to be used only for daily living and the water-using behavior of every member was strictly controlled, some villages far from the water resource still often became short of water. In 1766, *Liu Jia Zhuang* [刘家庄] of *Huo* County [霍县], far from the water resource, entered into a contract with *Kong Jian Cun* [孔涧村] a head village nearby:

> In this collective-choice arrangement, the right to use water resource is divided into two stages within each half month. The water resource is first used by *Kong Jian* for 11 days, and then voluntarily transferred to *Liu Jia Zhuang* for four days, so as to ensure their daily life. But the transferred water resource is only to be used for basic living instead of irrigation [31].

This contract indicated that the order of using water in this community was relatively harmonious in spite of the existing and unprecedented pressure on water use. In 1998–2003, some scholars from China and France did a field investigation in this water community and surprisingly found that the no-irrigation pattern was still executed strictly under the lead and supervision of the local water organization. Furthermore, the water-using behavior of every villager was still obviously affected by the traditional water rules and ideas [31]. Undoubtedly, the self-government system of water management was successful in this water community. Of course, this example may be a special case, but it still demonstrated that the pattern of self-government of water management was effective within the water community.

However, some events also show that this system of water management faced problems. In some water communities, the post of *Quzhang* was continuously controlled by a prestigious clan or family, which resulted in interaction between the *Quzhang* and his prestigious clan or family. On the one hand, the *Quzhang* obtained excessive power from the support of his clan or family; on the other hand, the clan or family received extra water-using privileges from the *Quzhang*. In addition, as a representative of local water interests, the *Quzhang* played a double role. On the one hand, he played a positive role in dealing with internal water disputes; on the other hand, he often was a participator of water conflicts—even fights—with external communities rather than a mediator. To illustrate, we quote three water cases of conflict from Shanxi province.

The first water lawsuit occurred on the south bank of the *Jin* River [晋河]. In 1729, *Yang Ting Xuan* [杨庭璇], a gentleman of a water community of this region, accused the *Quzhang* in front of the local *Xianya* [县衙, county office] of changing the allocation of water rights. The governor discovered that the status of water management in this community was in a critical condition. On the one hand, this *Quzhang* had occupied the post for nearly 16 years from 1714 to 1729, relying on the repute and power of his family. On the other hand, in addition to breaking the order of using water, the *Quzhang* had given priority to his family in using water and was involved in other corrupt activities, including privately selling water rights and embezzling the funds collected for water projects. The governor judged that the *Quzhang* was breaking the law [32].

A similar malpractice occurred in a water community on the north bank of the *Jin* River [晋河]. In the Ming dynasty, a prestigious family in this community used the official status of its members to control the post of *Quzhang* continuously. However, in the reign of *Hongzhi* [弘治] (1488–1505), *Zhang Hongxiu* [张宏秀], the *Quzhang* of this water community, privately sold the night water right to two armies. This both directly resulted in all members of this water community losing the right to use water in the evening and exacerbated the water shortage of some villages far from the water source. The villagers of this water community appealed to the local government and sought a reallocation of water rights; the local government repeatedly required that the *Quzhang* correct this misallocation. Unfortunately, until the reign of *Wanli* [万历] *(*1573–1620), this situation did not change [33].

Another water conflict occurred in *Hongdong* [洪洞] County. In 1842, three villages—*Guxian* [古县村], *Dongcun* [董村] and *Libao* [李堡村]—privately dug a small canal, which violated the water interest of another village called *Fancun* [范村]. Prompted and led by the *Quzhang*, hundreds villagers from *Fancun* used hoes, rods and even self-made guns to repel intruders from those three villages. In the process, both sides fought fiercely, which resulted in an intruder from *Guxian* being killed by the *Quzhang* of *Fancun.* Finally, this *Quzhang* was sentenced to death by the local government [23].

These water law suits show that sometimes *Quzhang* disturbed the normal water-using order of the internal community and played a negative role in the relationship between external communities because of their self-interest.

In summary, the effect of this water management system was multiple: (a) The boom in water projects indicates that this manner of local self-government mobilized the enthusiasm of members of communities to develop their water resources. (b) The adjudication of water lawsuits indicated that the traditional water rules, especially *Shuice*, formulated by the local water organization, played important roles through which many water conflicts were resolved faster and more cheaply by shortening the investigation time and decreasing the litigation costs. (c) The example of the no-irrigation community showed that local self-management both restrained the water use of individuals and ensured the sustainable use and development of water resources. However, (d) the corruption of some *Quzhang* indicates that the system of local self-government without effective monitoring provided an opportunity for the staff of local water organizations to behave illegally, including privately selling water rights and embezzling the funds collected for water projects, which directly impaired the water interest of every member of the water community. (e) The activities of some *Quzhang* during water conflicts with external communities demonstrated that this water management system rested on a strong idea about local water rights, which both resulted in competition for water resource between different water communities and sharpened water use contradictions, even triggered bloodshed.

4. Conclusions

As the water management system has disappeared, we cannot cause history to reappear and so cannot evaluate accurately the effects of the system. However, through historical documents and records, we can still draw some conclusions about the characteristics of this water management system.

Firstly, the change in the role of the state was critical. In the Ming and Qing dynasties, the state authority did not intervene directly in the activities of water management. On the one side, the work—including the establishing of water organization, the allocation and management of water resource, the construction and maintenance of water projects—was undertaken by the local society itself. On the other side, the state simply adjudicated the water conflicts which could not be solved successfully by the local society itself according to the local water rules and *Shuice*. Thus, the state became an arbiter instead of a manager. Furthermore, with the participation of the elites of the local society in water management, direct conflict between the state and the local community over water resources decreased. However, lack of effective monitoring by the local government provided incentives for some leaders of the local community to adopt opportunistic strategies in order to obtain extra benefits.

Secondly, the elites of the local community played core roles. As founders of this water management system, they devoted themselves to such actions as formulating and enforcing water rules, voting and selecting the leader of the water organization. They thus encouraged the sustainable development of this water management system. Yet they perennially controlled the leadership positions of the local water community, relying on their knowledge, wealth, and prestige. Without effective monitoring, some of them adopted opportunistic, self-interest behavior. Such behavior weakened the authority and effectiveness of this water management system.

Thirdly, the ordinary members of the local water community remained an underclass. While they had the right to reject a project that they did not think was worthwhile, they could not enter leadership positions in the local water community because of their poor knowledge, wealth, and prestige. Their right to participate was still low. Inevitably their right to use water was infringed repeatedly.

Fourthly, this water management system had been established under the conditions of a serious shortage of water resources and ineffective management by the state. It was a pattern of self-government of local people under the leadership of the local gentry. In general, most of the water communities were regional mini-units. Since they lived in small-scale communities where most opportunities for future, mutual gain were based on good reputation, the members of the community generally prized their reputation and feared adverse gossip, which might be sufficient to prevent most members from disregarding the rules and decreased the probability of opportunistic activities. At the same time, the use of water by members was monitored by each other; thus the costs of internal monitoring were low. In addition, under the pressure of limited technology and capital, this water management system focused on the construction of small scale water projects as well as sustaining the use of former water works; thus the expenditure of capital and the waste of water resource were both low. However, there was malpractice within some water management organizations caused by the lack of supervision by the local government, which both harmed the water interests of all members of the water community and weakened the authority and effect of this water management system. Additionally, the prevalence of water projects was spurred by population growth and this local water rights idea caused competition for water resources between different water communities and even triggered some violent disputes.

While Ostrom pointed out that learning by doing is increasingly difficult, as past lessons are less and less applicable to current problems [9], this does not mean that history lessons are ineffective. On the contrary, the water management practices of Shanxi and Shaanxi in the Ming and Qing periods can provide some useful lessons for modern society: (1) The state should play an appropriate role in managing water resources of rural areas. On the one hand, the state authority intervenes directly in the activities of water management as little as possible in order to ensure the local society can exercise fully its powers of self-government. On the other hand, the state authority must strengthen effective monitoring for the local water management organization so as to ensure its healthy development; (2) During this process, the state should guide the local elites in the management of water resources and help them to play a positive role through some policies and laws; (3) As main users of water, the ordinary peasants should be assured of effective participation in water management by designing effective institutions for participation and education about decision making. In summary, smooth relationships and the correct allocation of functions between the state, elites and ordinary peasant is perhaps an effective choice for modern water management in China.

Acknowledgements

This study was supported by the Social Science Fund for the Universities of Shandong Province (No. J13WE05), the Startup Fund for Distinguished Scholars of Qingdao Agricultural University (No. 631120), Australian Research Council Discovery grant (No. DP110103381) and the National Natural Science Foundation of China (No. 51109056).

Conflict of Interest

The authors declare no conflict of interest.

References

1. Schiller, S. Avoiding the problem of the commons in a communist society: The role of water rights in the enforcement of environmental law in China. *Law Policy* **2009**, *29*, 349–374.
2. Yardly, J. Beneath Booming Cities, China's Future Is Drying Up. *New York Times*, 28 September 2007.
3. Yellow River Conservancy Commission (YRCC). *The History of Water Conservation in Yellow River*; Yellow Water Conservation Publishing House: Zhengzhou, China, 2003.
4. Webber, M.; Barnett, J.; Finlayson, B.; Wang, M. Pricing China's irrigation water. *Global Environ. Chang.* **2008**, *18*, 627–625.
5. Elvin, M. *The Retreat of the Elephants: An Environmental History of China*; Yale University Press: New Haven, CT, USA, 2004.
6. Ostrom, E. *Crafting Institutions for Self-Governing Irrigation Systems*; Institute for Contemporary Studies Press: San Francisco, CA, USA, 1992.
7. Hardin, G. The tragedy of the commons. *Science* **1968**, *162*, 1243–1248.
8. Feeny, D.; Berkes, F.; McCay, B.J.; Acheson, J.M. The tragedy of the commons: Twenty-two years later. *Human Ecol.* **1990**, *18*, 1–19.
9. Ostrom, E. Revisiting the commons: Local lessons, global challenges. *Science* **1999**, *284*, 278–282.
10. Sneath, D. State policy and pasture degradation in Inner Asia. *Science* **1998**, *281*, 1147–1148.
11. Qin, S.-Y.; Chang, Y.-K. The evolution of water institutions on the Yellow River in ancient China [in Chinese]. *J. Econ. Water Resour.* **2005**, *23*, 1–4.
12. Ning, L.-B.; Jin, M.-G. The evolution of water right system in ancient China [in Chinese]. *J. Econ. Water Resour.* **2004**, *22*, 8–11.
13. Perdue, P.C. Water control in the Dongting Lake region during the Ming and Qing periods. *J. Asian Stud.* **1982**, *41*, 747–765.
14. Elvin, M. *Another History: Essays on China from a European Perspective*; University of Hawaii Press: Honolulu, HI, USA, 1996.
15. Scheineson, A. From laws to levees: Methods of water control in the Qing Dynasty. *Columbia East Asia Rev.* **1982**, *41*, 56–70.
16. Chao, X.-H. Water resource, environment and social change in the Upper Hanshui River region during the Qing period [in Chinese]. *J. Stud. Qing Hist.* **2005**, *2*, 1–20.

17. Shanxi Chorography Institute. *Shanxi Tong Zhi: Shui Li Zhi* [in Chinese]; Zhong Hua Book Company: Beijing, China, 1999.
18. Chen, Z.-X. *Zhongguo Wenhua Dili* [in Chinese]; Sanlian Bookstore: Beijing, China, 1983.
19. Mu, Z.-A.; Pan, X. *Da Qing Yi Tong Zhi, 1784 [in Chinese]*; Republished by Ancient Book Company: Shanghai, China, 2008.
20. Liu, Y.-Y.; Shen, Q.-Y. *Shaanxi Tong Zhi [陕西通志] (1735)*; LanZhou Rarebooks Publishing House: Lanzhou, China, 2000.
21. Mu, Z.-A.; Pan, X.-E. *Da Qing Yi Tong Zhi [大清一统志] (1734)*; Shanghai Rarebooks Publishing House: Shanghai, China, 2007.
22. Shu, Q.-S.; Yan, C.-M. *Xi'an Fuzhi [西安府志] (1779)*; Sanqin Publishing House: Xi'an, China, 2011.
23. Sun, H.-L. *Hongdong Xian Shui Li Zhi Bu (1917) [in Chinese]*; Republished by Shanxi People's Press: Taiyuan, China, 1992.
24. Smith, A.H. *Village Life in China*; Evangelical Literature: New York, NY, USA, 1899.
25. Ostrom, E. *Governing the Commons*; Cambridge University Press: Cambridge, UK, 1990.
26. Hu, Y.-Z. *Water Wells and Northern Rural Society: Based on Field Research on Rural Water Wells in Some Areas of Shanxi, Shaanxi and Henan Provinces [in Chinese]*. *J. Mod. Chin. Hist. Stud.* **2006**, *1*, 55–78.
27. Han, M.-L. The geography of shanxi and shaanxi and the system for protecting water rights in modern times [in Chinese]. *J. Mod. Chin. Hist. Stud.* **2006**, *1*, 40–54.
28. Chi, Ch.-T. *Key Economic Areas in Chinese History*; A.M. Kelley Publishers: New York, NY, USA, 1936.
29. Tian, D.-K. On the Justice of Water Right Disputes in Ancient China [in Chinese]. *J. Northwest Univ. Philos. Soc. Sci. Ed.* **2006**, *36*, 72–77.
30. Bai, E.-H.; Lamouroux, C.; Will, P.E. *Shan Shaan Di Qu Shui Li Yu Min Jian She Hui Diao Cha Zi Liao Ji: Gou Xu Yi Wen Za Lu [in Chinese]*; Zhong Hua Book Company: Beijing, China, 2003.
31. Dong, X.-P.; Lamouroux, C. *Shan Shan Di Qu Shui Li Yu Min Jian She Hui Diao Cha Zi Liao Ji: Bu Guan Er Zhi* [in Chinese]; Zhong Hua Book Company: Beijing, China, 2003.
32. Zhang, J.-F. Water lawsuits and the rural society of Jin River since the Ming and Qing Dynasties [in Chinese]. *J. Chin. Soc. Econ. Hist.* **2003**, *2*, 35–44.
33. Zhao, S.-Y. Public resources, power and its symbols in rural societies: Cases involving struggles for water in the Fenshui River valley in Shanxi during the Ming and Qing Dynasties [in Chinese]. *J. Soc. Sci. China* **2005**, *2*, 189–203.