

Article

The Socio-Technical Aspects of Water Management: Emerging Trends at Grass Roots Level in Uzbekistan

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Abstract: In Soviet times, water management was presented generally as a technical issue to be taken care of by the state water bureaucracy. Due to structural changes in agriculture in the two decades post-independence, irrigation water management has become an explicitly political and social issue in Central Asia. With the state still heavily present in the regulation of agricultural production, the situation in Uzbekistan differs from other post-communist states. Water management strategies are still strongly ‘Soviet’ in approach, regarded by state actors as purely ‘technical’, because other dimensions – economic, social and political – are ‘fixed’ through strong state regulation. However, new mechanisms are appearing in this authoritarian and technocratic framework. The application of a framework for socio-technical analysis in some selected Water Users’ Associations (WUAs) in northwest Uzbekistan’s Khorezm region shows that the WUAs are becoming arenas of interaction for different interest groups involved in water management. The socio-technical analysis of Khorezm’s water management highlights growing social differences at grass root level in the study of WUAs. The process of social differentiation is in its early phases, but is still able to express itself fully due to the strict state control of agriculture and social life in general.

Keywords: water management; socio-technical; water control; Uzbekistan; state quota

1. Introduction

Societal problems are multi-faceted and complex. For instance, natural resources management (NRM) has several components and dimensions that influence each other. Solutions for NRM problems require an understanding of both natural resources systems and their interactions with human (management) systems [1]. The response to a growing number of NRM problems, particularly in the water sector of Central Asia, has been one of “normal professionalism” [2] from water sector researchers and engineers. “Normal professionalism” is a standard, disciplinary, limited response to problems, which is reproduced in the education system. This has contributed to the reproduction and continuation of problems, and has been generating limited approaches for addressing water management. A more comprehensive, inter- and trans-disciplinary approach to water management (1) acknowledges the complexity and heterogeneity of problems and organizations, (2) accepts the relevance of the local context and uncertainty, (3) implies interactive action and is intersubjective, and (4) has to make linkages across disciplinary boundaries [1].

The need for such a change in perspective is especially pertinent in Central Asia, where water management in the past decades has changed from a centralized issue considered purely technical, to a widely debated and contested trans-boundary, socio-political endeavour [3-5]. Disciplinary and government-directed research efforts from the Soviet period no longer suffice for water management in the modern Central Asian context for the following reasons.

1. Due to major geopolitical change following the collapse of the Soviet Union, the governance and management of trans-boundary water resources among five newly independent Central Asian countries became an explicit political process. During Soviet times, water governance and management could be presented as a purely ‘technical’ matter, because the other dimensions were under strict control and unchangeable.
2. Post-Soviet changes in agricultural policies have brought significant social changes in rural areas. The ensuing social differentiation of the rural population has been captured by different research studies [6,7]. The issue of unequal distribution of water has made its entry into the regional political economy.
3. The environmental consequences of the previous “hydraulic mission” [8] have been catastrophic for the region [5]. Therefore, research that speaks to a series of concerns, notably ecology, equity and governance, and not just to ‘development’ in the earlier sense, is required.

This paper presents a framework for the socio-technical¹ analysis of water management and the results of its application in a Water Users’ Association (WUA) in the Khorezm region, Uzbekistan.

2. Research Framework and Methodology

2.1. Research Framework

The socio-technical study of water management was conducted within the framework of the BMBF-funded project “Economic and Ecological Restructuring of Land and Water Use in the Region

¹ Socio-technical analysis was borrowed from [9] for describing two interlinked parts of water management systems: one is infrastructure and the second is the human factor in managing water.

Khorezm (Uzbekistan): A Pilot Project in Development Research”². The objective of the water management work package of the project is “to consolidate and adapt the framework for the socio-technical analysis of water management, intensive application of this framework for studying of field-farm, WUA and main system level irrigation management practices, the identification of options and approaches on restructuring existing water management towards IWRM, developing suggestions for innovations on irrigation and drainage management in close consultation with a network of stakeholders (agricultural producers, WUA officer bearers and relevant government officials), the close monitoring of the evolution of drainage and irrigation management approaches at the provincial (Khorezm), national (Uzbekistan) and regional (Central Asia) levels”³.

The main element of the framework used in this research is the boundary concept⁴ “water control” [9,1], which was applied to capture three interlinked processes in water control: physical, organizational and socio-economic/political. Socio-technical research analyzes the linkages among these three dimensions of water management, as depicted in Table 1. A range of research methodologies such as surveys, measurements, data collection and institutional analyzes are applied within the framework for socio-technical analysis.

Table 1. Research framework and methodology for the socio-technical analysis of water management.

	<i>Dimension</i>	<i>Means</i>	<i>Research object</i>	<i>Research techniques</i>
WATER CONTROL	Physical control (technical)	By means of physical infrastructure or technology	Physical shape, type and state of irrigation and drainage system and technologies	Walk-through surveys Direct measurements surveys Expert interviews
	Organizational control (managerial)	By means of skill, authority, command or domination	Institutions, organizations, management	Institutional mapping and analysis surveys Participatory observation
	Socio-economic and political control	By means of law, policy, regulations, incentives, or force	Social and governance structure (local and higher scale levels)	Surveys Stakeholder workshops FTI activities

² The goal of the project is: “This project specifically aims at providing a comprehensive, science-based plan for restructuring at three nested intervention levels: policies, institutions and technologies” (Economic and Ecological Restructuring of Land and Water Use in the Khorezm Region (Uzbekistan). *A Pilot Project in Development Research. Proposal for Project Phase III: Change – Oriented Research for Sustainable Innovation in Land and Water Use (2007-2010)*).

³ Operational work plan for work package 320 - Integrated Water Resource Management (IWRM) for Khorezm: BUIS, WUA and farm-level operation of an I&D system in practice.

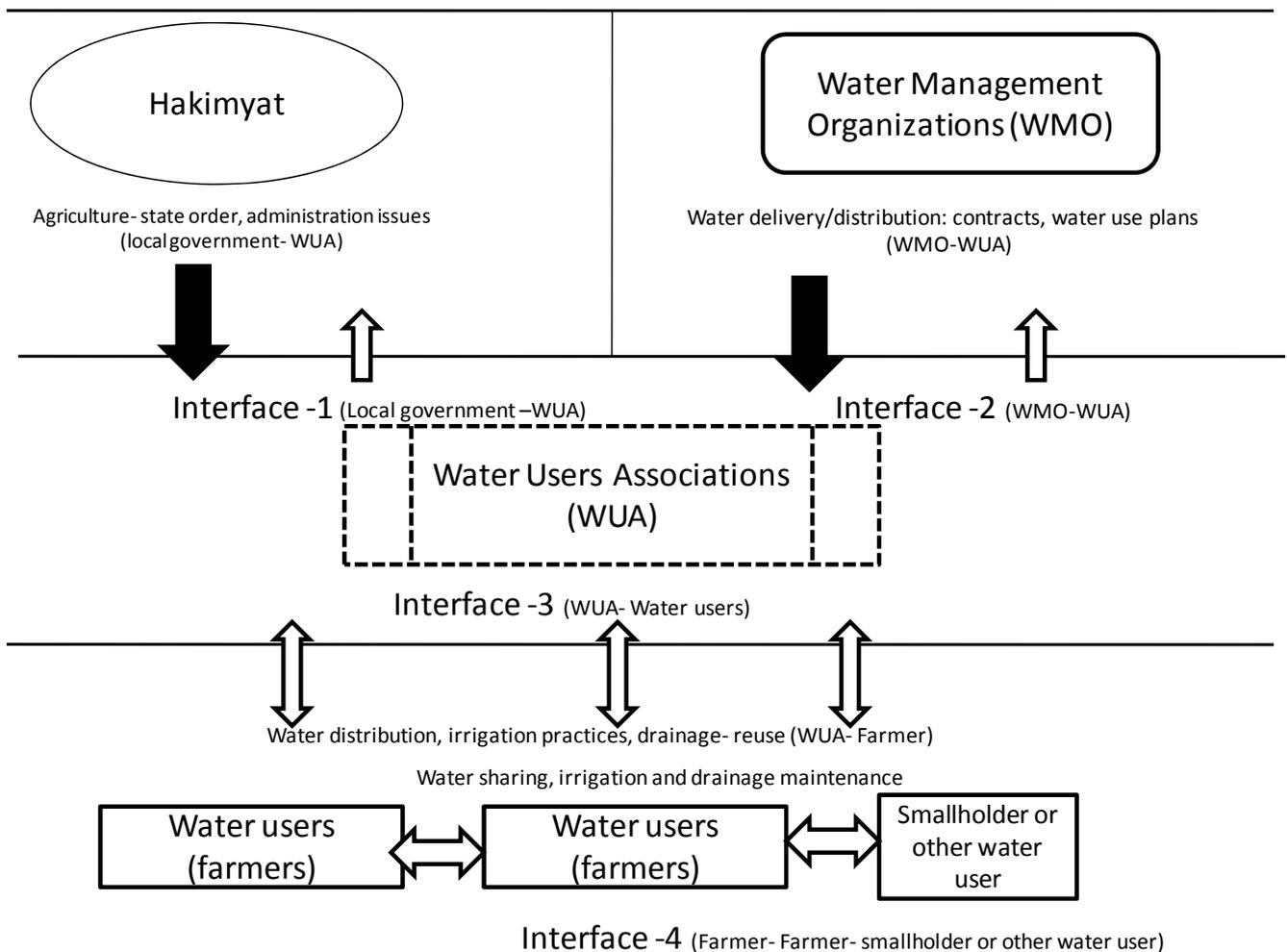
⁴ “Boundary concepts are words that operate as concepts in different disciplines, referring to the same object, phenomenon, process, or quality of these, but carrying different meanings in those different disciplines” [9].

The research framework described above was applied to the day to day practices of irrigation water management in Uzbekistan's Khorezm region in the 2008 and 2009 irrigation seasons (March–October). The research studies the interactions of different groups in their planning, distribution and use of water, with a focus on (1) the creation of hydraulic property and (2) the emergence of collective action. Changing agricultural production systems from collective to individual production has made irrigation and drainage network ownership, as well as use rights, a central issue of water control. The new arrangements made for the operation, use and maintenance of the irrigation and drainage infrastructure predetermine water control strategies for the different groups. Analysis of the collective action process helps to understand how different actors are strategically engaged with each other in the arena of the everyday irrigation practices of Khorezmian water management. Methodologically, the study of this so-called 'everyday politics' [1] of irrigation was undertaken through applying the main principles of Long's actor-oriented approach [10], which starts from "... the capacity of actors to process their and others' experiences and act upon them." To capture the processes of water control it is very important to select specific *locales* or sites where the capacity to process and act can be observed concretely. Transformations in Uzbekistan since the 1990s have created new interfaces and discontinuities in water management. Two processes that have generated these are the restructuring of collective farms into smaller units, and the establishment of new organizations such as Water Users' Associations (WUAs), which were created at the former collective farm level in the last decade. The uniqueness of WUAs is that they are located at the level where the state meets with water users [11,12]. Four specific interfaces can be identified at WUA level: local government-WUA, water management organizations (WMO)-WUA, WUA-water users (farmers), and water users (farmers)-water users (Figure 1).

Actors⁵ involved in the everyday politics of water management can be divided into four groups: (i) water users, (ii) state bodies, (iii) the irrigation and drainage infrastructure, (iv) social and natural environment (Figure 2). Although the categorization of actors is helpful, it does not present the heterogeneity within each group. For instance, in the water users' group, different water uses and users with different water consumption patterns are found (Figure 2).

It is important to note that in this research human and non-human actors are treated symmetrically. The actions and water control strategies of human actors are shaped by the social and natural environment, the irrigation and drainage infrastructure, as well as by state policies and regulations. In socio-technical research, authors do not allocate any predetermined weight to any of the actors; their strength, role and impact on water management are measured through field research on everyday water management.

⁵ The word 'actors' in this paper is understood as in the actor-network theory (13), including both human and non-human actors, both having agency/causal powers, and both playing an active role in irrigation management. The actor network theory distinguishes, in French, *acteurs* (human actors) and *actants* (non-human actors).

Figure 1. Water Users' Association levels: interfaces in everyday water management.

2.2. Site selection

WUAs, being at the state-water user interface, were the central focus area for the socio-technical analysis of water management systems. For the broader socio-technical research of the project, five WUAs, located in different biophysical, social and institutional conditions, were selected by applying the following criteria:

- (i) Remoteness from the water source [14]: distance varying from less than 30 to more than 60 km from the source;
- (ii) Relative water scarcity: actual water supply varying from 100% to less than 70% of the allocated water share (limit⁶);
- (iii) Social situation, living standards and diversity of agricultural activities: ranging from relatively high income levels with rice cultivation and diversified agriculture, to very low living standards

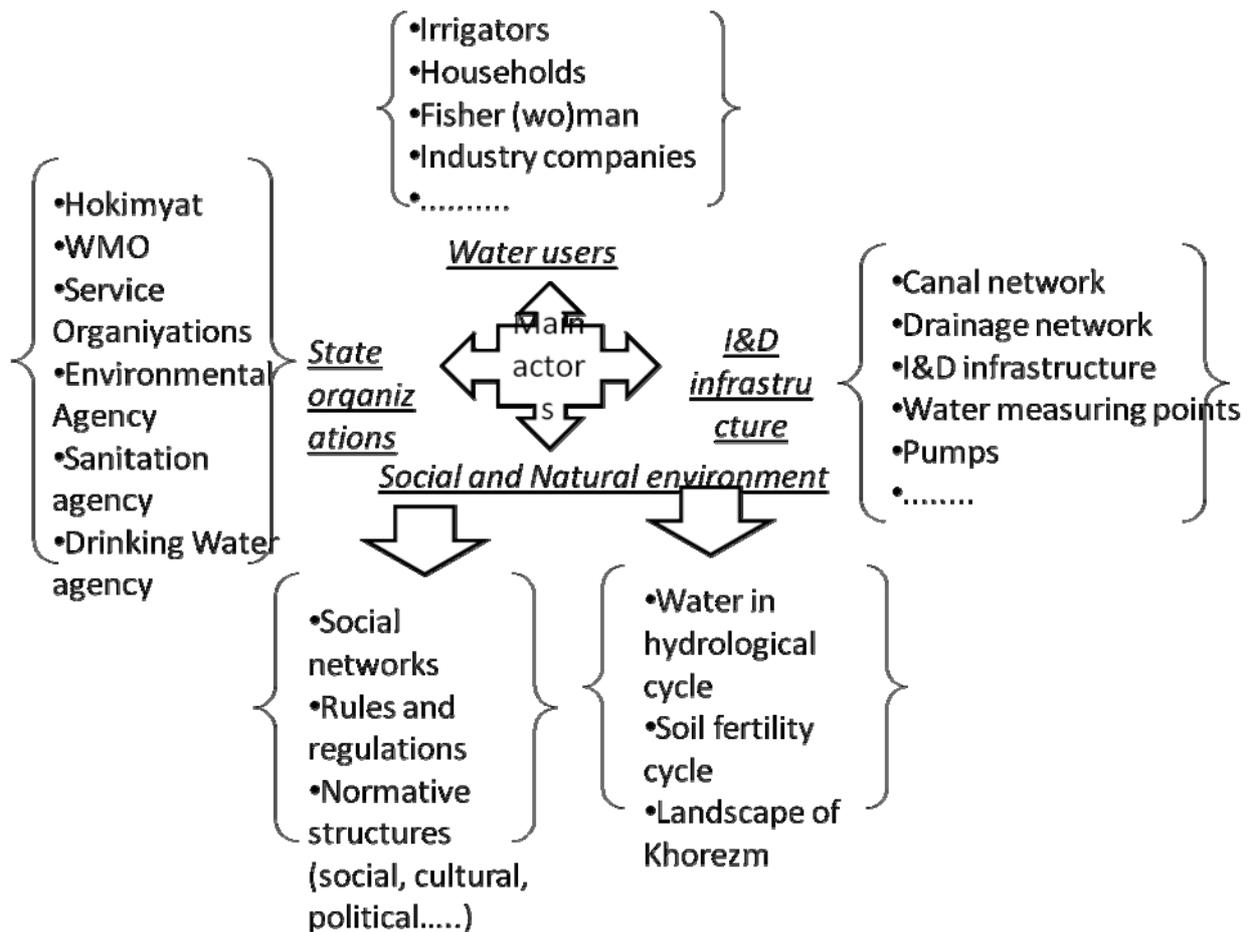
⁶ In Central Asia, water “limits” were introduced in the 1980s as an alternative to water shares and water rights existing elsewhere. Limits are allocations by state Water Management Organizations to water users, but do not guarantee delivery of this amount to these water users. The limits are used mostly for calculations of water allocation plans

due to remoteness and water shortage resulting in low agricultural productivity of mostly cotton-wheat cultivation;

- (iv) Institutional strength and type of water management: including WUAs who received considerable support from international donor-funded project and those who did not, and WUAs established following administrative boundaries and others following hydrological boundaries.

For the purposes of this paper, the analysis focuses on one of these five WUAs, which was intensely researched and illustrates well the overall developments regarding water management. The selected WUA Koshkopir Ashirmat presents the situation in almost 50% of WUAs in Khorezm inasmuch that they cope with limited or scarce levels of water availability. Detailed information on the other four WUAs can be found in [12].

Figure 2. Main actors in everyday water management.



2.3. Research Techniques

The field research used semi-structured and group interviews with the main actors, along with a study of project reports, databases, research publications, archives and mass media materials on the topic and the region for data collection. For the observation of non-human actors, walk-through surveys were used. Participation and observation techniques were applied frequently to understand any socio-institutional aspects, while attending both formal and informal meetings, and socializing through

friendship and networking, were essential methods. Participation in water distribution and drainage management activities as an observer improved the quality of the research. One other aspect that helped to conduct socio-technical research was the Follow the Innovation (FTI) activity of the project.⁷ In WUA Koshkopir Ashirmat, FTI activities on strengthening WUAs through Social Mobilization and Institutional Development (SMID) commenced during the research period. The objective of the innovation is to transform existing, weak WUAs into properly functioning WUAs through a social mobilization and institutional development approach (SMID). A series of stakeholder meetings and workshops were organized within the FTI framework, where socio-technical aspects of water management were discussed with a large group of stakeholders. This participatory exercise provided a great deal of information and insight into the day to day practices of irrigation management.

3. Socio-technical analysis of water management: Application of the research framework

A major institutional change is that the de-collectivization of farming has led to the formation of new and different interest groups in the study area, as elsewhere in Uzbekistan. There are at least three different groups of farms in rural Uzbekistan [15], the first of which is under state quota, growing cotton and wheat for the state with 10 to 20 ha of irrigated land per farm. The second group produces more commercial crops such as rice, vegetables and fruits, with land sizes around 1ha or less. The third group comprises smallholder landowners who grow crops mainly for the subsistence of their livelihoods. However, the state quota farms may also grow rice and have smallholder land in their backyard [11]. This social differentiation of agricultural producers means that interests in water management have also differentiated.

The formal institutions of state-regulated agricultural production have remained largely in place, except that a larger group of individual and differentiated producers now needs to be regulated, rather than a small number of collective units. In relation to water management, formal institutional arrangements have been created in the form of WUAs. However, the changing agricultural and political scenario has also produced new informal relations and practices in water management [10]. How this has taken shape in the WUA Koshkopir Ashirmat, the case on which we focus in this paper, is discussed below.

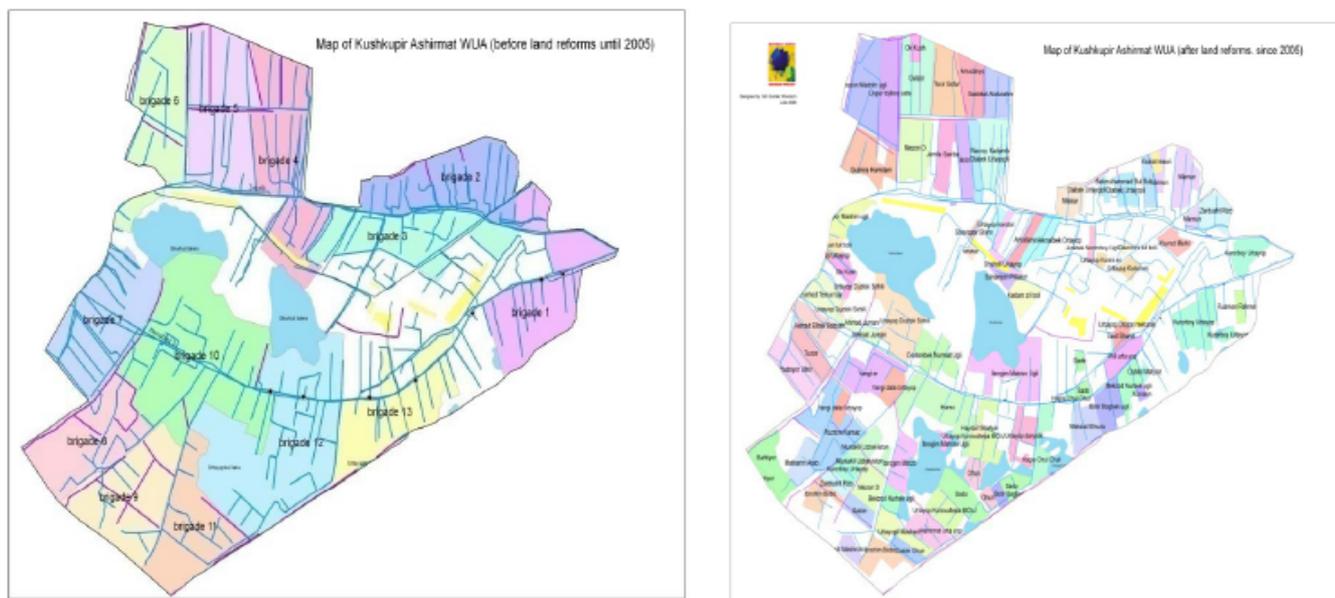
3.1. Socio- technical analysis of water management

The WUA Koshkopir Ashirmat is located almost 100km from Amu Darya River, the main water source of the Khorezm region. In the 2008 irrigation season, the WUA received only 70% of its water share. The local population is mainly busy with agriculture, while alternative sources for income generation are limited to migration to Russia and Kazakhstan or other parts of Uzbekistan. The living standard of the rural population is very low, even according to Khorezm standards, which itself is one of the lowest in Uzbekistan. The WUA was established in 2005 and covers 2116ha of irrigated land. The WUA Koshkopir Ashirmat was established in place of 14 brigades of two former collective farms (Figure 3). The map shows that before de-collectivization (2005) there were 14 brigades, which were growing mostly cotton and rice. In 2005, in place of the former 14 brigades, more than 70 individual

⁷ For a detailed report on the FTI for WUA components of the project, see [12].

farms were established by the commission in charge of land reform. The individual farmers were assigned to grow cotton, wheat (50% of individual farmers), vegetables, and livestock. The irrigation and drainage network, formerly managed by the collective farm, was assigned partly to WUAs (former on-farm canals and pumps) and individual farmers (tertiary and below-level irrigation canals).

Figure 3. Pre- and post-reform maps of the Koshkopir Ashirmat Water Users' Association (WUA).



Note: In the left-hand figure, different colors indicate the 14 brigades, while in the right-hand figure, different colors indicate the newly established individual farms.

The irrigated areas receive water from the Zeu Yop canal, which is fed by the Polvon main canal – one of the largest irrigation networks in the Khorezm region. The man-made water scarcity situation, due to competition for water resources at the head of the Zeu Yop canal, has resulted in the abandonment of considerable parts of the irrigated agricultural fields in the WUA area – 150 to 200 hectares were not cultivated in 2008 – and are now regarded as unsuitable for cultivation by the local government at district level (hakimyat). The hakimyat makes almost every important decision regarding agriculture.

Water is delivered to the WUA Koshkopir Ashirmat through the territory of three other WUAs located upstream of the study area, which creates an insufficient and unreliable water supply. Although the irrigated area within the command system of the Zeu Yop canal has not been increased since the 1980s, water supplies to the WUAs have become hotly contested both among WUAs and individual water users. Hence, the main attribute of water management in the study area is “constructed water scarcity” [16]. Water distribution among neighboring WUAs and water users within the geographical area of the study WUA is skewed and unequal in physical terms, while within the WUA territory, it is a reflection of the internal social dynamics that have been shaped by a few important elements of everyday water management. These aspects relate to the ownership of irrigation drainage infrastructure, formal and informal institutions, dominant actors, resources, and emerging collective action.

3.2. Contested nature of water infrastructure and its impact on water control strategies

The transformation of the water system from collective farms to WUAs has brought changes in water and drainage infrastructure ownership. The major water control strategies applied by different groups are shaped by the following aspects of infrastructure possession [12]:

1. The existing inter-farm irrigation and drainage network has stayed under control of state run water management organizations (WMOs). The reduced workforce and declining budgets since the 1990s, due to the overall economic decline after the collapse of the Soviet Union, have left this level virtually unattended by WMO staff. As a result, water users, mostly large farmers, have installed different types of pumps along the canal system, practicing technical water control and reducing the water shares of the WUAs located in the tail of the area.
2. The ownership of the collective farm irrigation network has been distributed among the WUA and individual farmers – field and tertiary canals have been assigned to the farmers and secondary canals to the WUA. Originally, numerous pumps from the former collective farms were assigned, but to WUAs in the first instance. However, a few years of operation created problems in payment for electricity, diesel for pumps and for maintenance. Therefore, almost all WUAs in the study region (Khorezm) reassigned pumps to individual farmers. The property regime created by the transformation of pumps to individual farmers has legitimized the wider use of pumps.
3. The drainage network utilized by the former collective farms has not been specifically assigned to WMOs, WUAs or farmers, which has resulted in a plurality in responsibility for its operation and maintenance. The maintenance of the drainage system at the former collective level has been left to the farmers, who, in quite a few cases, have cleaned “their part” of the drainage system, giving them the claim to the ownership of water in the drainage ditches – a case of hydraulic property creation. Furthermore, the farmers have claimed the right to block the drainage system and pump water for their needs whenever the canal water becomes scarce.

3.3. Institutions

Our research has identified the institutions with direct influence on water management that are shaping the water control strategies of the actors involved in the process. These institutions are both formally and informally embedded in society. The formal institutions are part of the current state policies, while informal institutions are made up of rules, regulations and relationships crafted and established by local people [17]. The informal institutions in the study area are also shaping the behavior of the formal institutions.

3.3.1. State quota

The state quota for cotton and wheat has the following important implications for water management. First, water is seen as one of the inputs into the cotton-wheat quota production [11]. The water management institutions (organizations, water rights and legal documents) are subordinate to agricultural planning, and water contracts are prepared only for cotton-wheat farmers. The WMO and WUA are made responsible during the irrigation season for treating cotton-wheat farmers as a major priority. Second, the state quota system makes possible administrative interference into everyday water

management, allowing space and support for farmers who cultivate state quotas to apply socio-economic and political water control strategies. They can complain to the local governor (hakim) about the water “scarcity”, they can apply pressure on WMO and WUA managers if water is not delivered to their fields on the agreed schedule, they can request pumps to be installed into the drainage system, *etc.*

At the same time, the state quota system gives opportunities for the hakim and state organizations to interfere into WMO and WUA matters. In the study WUA, the Chairman was replaced two times, once by the provincial hakim and the second time by the district hakim. The state quota system also allows local water users to source investments for their irrigation networks. During the 2008 season, WMOs cleaned two main WUA canals a number of times and two pumps were installed in the interstate (Uzbekistan-Turkmenistan) drainage canal to pump water for irrigating tail-end cotton fields. This shows that the state quota system, while seemingly a top-down, directive system, is actually the institution that links the demands of the state with the needs of state quota farms [11]. State planned intervention (state quota), though, is not accepted or implemented by local actors at face value, as the implementation of state quotas is shaped by the social interests of the different groups. For instance, according to state quotas, the irrigated lands of the farmers who grow cotton and wheat must be irrigated first. However, when the water arrives, it is actually first given to the smallholder plots where food crops are grown for mostly consumption purposes (wheat, vegetables and fruit trees). This rule is accepted even by state quota farmers. The interviews with selected quota farmers reflected that they were made aware by local leadership during wedding parties and funerals (social gatherings) of the fact that most of the local population agrees that smallholder plots should be given water first. The pumps installed by state WMOs to serve cotton-wheat areas are also used to irrigate non-quota farms and smallholder land.

3.3.2. *Asvak*: water turns

The water turn, or *asvak* in local language, is an institution that existed even before the Russians came to the region. *Asvak* means that each water user group (WUA, village, sub-canal) and individual water user (farmer, dehkan, household) has a turn in receiving water during the irrigation season, during April- September as part of an irrigation schedule. The *asvak* is applied only if the amount of water available is not enough to supply water simultaneously to everyone. The *asvak* has several levels. There is water turn (*asvak*) among main canals, *asvak* among districts, *asvak* among WUAs and *asvak* within a WUA (among secondary and tertiary canals, among farmers located at the same canal, and among farmers and smallholders (*dekhans*) located at the same field channel (*arik* in the local language). Although *asvak* is generally regarded as a very effective tool for water allocation during water shortages, it does not work every time and everywhere. According to the water users (owners of individual farmers surveyed during the research), the *asvak* institution has become less effective in recent years because it is planned by the local hakimyat jointly with the WMO, with no communication with the water users, villages or WUAs. As a result, the *asvak* is contested constantly by a large group of water users. However, there are some “redesigned”, adapted, informal *asvak* versions in place in every WUA, village and location. Our research shows that even in the driest water shortage periods and locations, local people apply some sort of water turns among different groups.

For instance, in spring, the study village received water after a long period, and the water was given to the family plots first (*yu tomarka*). However, in the summer, the cotton was given the highest priority over other uses. It seems that the informal *asvak* has a very well structured system. Local power structures such as *mahalla* (village or neighborhood) leadership, former Chairmen of collective farms and WUA staff support this informal unstructured/localized *asvak*. The *asvak* is a water control strategy for different groups, e.g., *hakims* organize it in order to fulfil their role as government representatives in the area; WMOs become involved because of their role as the water management organization of the state, etc. However, *asvaks* are frequently interrupted by the same *hakim* or WMOs because of their own interests (to deliver water to their own clients) or due to reduced water levels in the canal. Furthermore, WUAs, villages and individual water users frequently use technical water control means (e.g., permanent or mobile pumps) to disturb the official *asvak*.

3.3.3. Mahalla-neighborhood-village

The *mahalla*, or neighborhood (sometimes also used in connection with a village), is a very old institution in Uzbek society. Although for the last decade the role and function of *mahallas* have been shaped greatly by the state building process, they are still very much alive and fulfil functions related to the daily life of the local people. A *mahalla* is a collection of different clans and individuals with few formal and more local rules in place to offer a more organized system for people's everyday lives. Since ancient times, the *mahalla* has dealt with marriage and divorce issues, feeding people and families in need, and settling conflicts and issues among families and individuals. For the last decade, *mahallas* have also been given the role of distributing social welfare among the most needy. In the water control context, a *mahalla* applies its role as a branch of the state at the village level. According to the Uzbek government system, heads of *mahallas* and the council of *mahalla* leaders represent the state in the neighborhoods. Therefore, leaders of the *mahalla* practice political water control strategies in order to promote the interests of both their neighborhoods and themselves. The *mahalla*, as a part of the state apparatus at the local level, is seen by local people as a legitimate institution to complain to on water related problems. The leader of the *mahalla* is also urged by the local *hakimyat* to take a bold role in everyday water management at the former collective farm level. Due to the weak position of the WUA, the position of *mahalla* leaders has become stronger in water management.

3.3.4. Clans and their impact on water management

During the Soviet era, the central state power in Moscow attempted to modernize Central Asian republics by eliminating the clan system. However, at present there are still many elements of clan networks in all five states of the region. The clan system in the study area re-emerged due to the fact that members of a few families were very successful in the state system. This successful uplift into the highest political levels of the country has nurtured a clan system around the nucleus of the families of those successful politicians. Now, members of the clan are claiming their right to gain access to the different resources and for special treatment, because of their status within the state apparatus. Members of the strongest clan in the study area also keep a few important positions within the local set up. Research into this field of study has revealed that the clans apply socio-political water control, *i.e.*,

the leaders of the clans apply pressure on the *hakimyat*, the WMO, the WUA and electricity companies to get water to their location and the fields of their clients/members.

3.4. Actors and their resources

In the study area three actors had a particularly active role in everyday water management. They did not act alone, but rather each had their own circle and social position within the village, as described in Table 2. Table 2 also shows that, although officially the WUA is the organization that performs water management functions, no WUA staff member is a central actor in the water management process.

Table 2. Actors and their position within the community.

	<i>Central actor/actor group</i>	<i>Position</i>
1	Chairman of the rural council (<i>mahalla</i>) + his circle (relatives, classmates, former collective farm managers)	<ul style="list-style-type: none"> • Official status as rural council head • Relative of high-level state official • Farmer himself
2	Former manager of collective farm + his allies (relatives, classmates, people whom he worked with on the collective farm)	<ul style="list-style-type: none"> • Son of long-serving collective farm chairman (<i>son of Rais</i>) • He was chairman (<i>Rais</i>) for years
3	Chairman of the local tractor workshop and his group	<ul style="list-style-type: none"> • Head of a crucial network of wealthy rural businessmen and managers, relative of high-level academician

The three central actors use the WUA as a platform through which they act, for instance to promote their candidates for the position of WUA Council Chairman. There were a few clashes of interest among different actors, for example on the appointment of the aforementioned appointment; however, the three actors came to an agreement in the end, realizing that open disagreement would undermine their power within the community.

These central actors commonly apply the following types of resources: (i) regulatory resources – access to decision-making on water allocation, (ii) information resources – access to information regarding water allocation and distribution, (iii) professional resources – links with water management organizations (or individual bureaucrats in the water sector), (iv) administrative resources – access to local government offices (*hakimyat*), and (v) technological resources – access to technologies and infrastructure pertinent to the water network. The application of the different resources depends on the position and agenda of the actor (Table 3).

Table 3. Actors and resources.

<i>Actors</i>	<i>Resources</i>
Rural Council (<i>mahalla</i>) chairman	<ul style="list-style-type: none"> • Access to, and distribution of, the state social security package (payments for poor families, money to support children) • Access to resources and funds for social activities • Influence on land distribution decisions • Most important say in internal water distribution decisions
Former collective farm chairman	<ul style="list-style-type: none"> • Links with former friends • Kinship with most villages' "respected people"
Local tractor workshop chairman	<ul style="list-style-type: none"> • Access to crucial information from state organizations • Ability to influence state quota resources distribution • Access to funds and mechanical hardware • Access to water distribution decisions

3.5. Collective action

The physical attributes and features of the irrigation system (extensive network, large canal size, no regulation gates, *etc.*) make collective action a prerequisite for everyday water management. Any group or individual water user alone is not capable of managing the irrigation system, which was originally designed and built to supply water to large collective farms. WUA Ashirmat's main irrigation canals do not have a single water regulation structure because, during collective farm days, water was taken to the irrigated field by 12 large pump units, which required both a workforce and financial input for operation. Only if the farmers worked together could they afford the pump costs. After de-collectivization, the pumps were transferred to the WUA. At the end of the irrigation season, the WUA evenly distributed the pump costs among its members – large farmers. Smallholders did not pay for the cost of pumping, but large farmers charged their share of the costs of pumping against state credits that paid for the cotton or wheat. However, in most cases the payments were delayed and the WUA was fined for non-payment of electricity costs. In 2007, the WUA assigned the operation and maintenance of ten pumps to cotton-wheat farmers who had access to state credits and subsidies, which helped the management of the WUA by reducing their debt to the electricity company, and led to the formation of water users' groups around these newly "privatized" pumps.

An additional reason for collective action related to pumps is that the water discharges of the big and old pumps are much higher than the irrigation needs of even the largest farms (e.g., 100 ha). The pumps were designed for the irrigation of a brigade (>200 ha). Therefore, in one run, pumps are able to deliver water to two or three farmers or dozens of smallholders. Therefore, irrigation was organized by groups of smallholders from the same neighborhood (*mahalla*), and farmers operating around a single

tertiary canal often worked together to irrigate their crops. Other collective action was taken on the maintenance of the irrigation and drainage network. Due to the huge size of the canals and the drainage network, large machinery and a large workforce was required. Again, this could not be provided by a single water user, so, in most cases, the farmers and smallholders brought their resources together to tackle the issue. Collective action is promoted by the organisations and networks listed above, and an active role is taken by *mahallas* and clans.

Water users also act as a group (collective action) when appealing to the *hakim* and other state organizations to release water for their area (exerting social pressure). In 2008, a group of people from WUA Koshkopir Ashirmat visited at least twice both the provincial and district *hakim* to appeal for water for their fields. This indicates that water users frequently apply socio-political pressure as a group. Nevertheless, water users from different levels of the WUA presently only form collective action groups for short periods, until they receive water into their areas. Carefully planned social mobilization activities by WUA management may help to turn this temporary collective action into a more systematized water users' group.

4. Discussion

The process of social differentiation is in its early phases, and is still to express itself fully due to the strict state control of agriculture and social life in general. However, different groups have started to apply physical and socio-economic water control strategies for gaining access to water through the means of social control. For example, farmers with larger extents of irrigated land and higher incomes can afford to buy diesel or electric pumps to assist in the irrigation of their fields. They usually allow neighboring farmers and smallholders to use water, but only if they pay for the cost of the operation of the pump. Smaller land owners and weaker groups are not represented in WUA structures at present. Standard WUA bylaws establish membership on the basis of land ownership, *i.e.*, only the heads of registered farm units can become a member. However, most medium-sized farmers (up to 1ha) and smallholders (less than 0.5 ha) are not registered as farm units, which creates inequality and, hence a lack of representation by WUA for many water users in the area. Therefore, it is extremely important to have a mechanism for the inclusion of small farming units and water users that use water for other purposes. This includes the lakes that are used for fishing and construction (brick making), and the households that depend on the irrigation network for their water for daily use (drinking purposes). WUA Koshkopir Ashirmat has three lakes where people catch fish, while many families use the irrigation network for household water purposes. However, they are not members of the WUA. On paper, the water plan (allocation) provides access to water for these types of water users as well. In practice, though, daily water distribution is a different process inasmuch that it is more decentralized than allocation, because of the huge irrigation network and many actors (stakeholders) involved at each level. The national and regional levels, although playing an important role in water distribution, have no real power to implement local-level water distribution. Water is actually distributed at the canal and WUA levels, where mainly lower level water managers (canal managers and operators) operate the gates and regulation infrastructure. Although the water allocation and distribution process in Uzbekistan is usually presented as a very structured, hierarchical process, water distribution often

becomes a daily struggle for water control [9,1,12], a struggle among different interest groups, notably cotton-wheat farmers vs. other water users.

5. Conclusion

The socio-technical framework has allowed us to show that actual water management in an irrigated region in northwest Uzbekistan is different from the dominant presentation of it as a structured, hierarchical and fully state-controlled process. Socio-political transformation in Uzbekistan since the 1990s, limited as it may be in some respects, has generated the emergence of new, formal and particularly informal arrangements in irrigation water management. The main drivers of this change have been the individualization of farming, the ‘lack of fit’ of the existing physical infrastructure with the newly emerging situation, and the paucity of funds and other resources in the state water bureaucracy. It is also plausible that in other regions of Uzbekistan and Central Asian states such processes of change in centralized water governance and management are taking place.

An important finding of the research is that the emerging water management situation has implications for rural livelihoods. New arrangements for water management may lead to unequal water distribution among wealthy and poor, large farmers and smallholders, and irrigation vs. non-irrigation water uses. Water management may, consequently, develop as a vehicle for the intensification of socio-economic differentiation in rural Uzbekistan.

This research has found that the ‘normal’ things that occur in large-scale canal irrigation, as documented in the international literature [9], have also started to occur in the Uzbekistan context – of course, with a specific, locational twist. This indicates the emergence of a new set of water management issues in the rural areas of Uzbekistan, and in the irrigated landscapes throughout the whole of Central Asia, where equally more or less (semi-) authoritarian policy frameworks apply to agriculture and water management. A research agenda responding to this situation will have to unravel the dynamic relationships among (differentiating) rural livelihoods, the socio-technical complexity of water control systems, and bureaucratic and political reform.

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