Institutional Reforms at Main Canal Level and Their Water Allocation and Yield Impacts : A Case from South Ferghana Canal, Uzbekistan

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Summary

Since independence in 1991 in Uzbekistan, the collective farming system has gradually been broken up into numerous individual small and medium size farms. The existing water management arrangements proved unworkable in this new context, with individuals rapidly coming into conflict over distribution. Reforms in the water sector have lagged those in agriculture, further contributing to disruption in irrigation service to farmers. Therefore, in 2003, the Uzbek government adopted a basin approach to water management, with a major focus on improving water distribution through restructuring management along hydrographic boundaries. Before this, the International Water Management Institute (IWMI) and its partner the Scientific Information Center of Interstate Commission for Water Coordination (SIC ICWC) pilot-tested this approach for three years, in conjunction with strong water user participation in the South Ferghana canal in Ferghana Valley (94,000 ha). This huge main canal previously traversed 11 administrative districts, resulting in a highly fragmented and competitive management structure. The International Water Management Institute (IWMI) and its local partner, the Scientific Information Center (SIC) introduced two institutional innovations at the main canal level throuogh the IWRM FV project[7]. First was the establishment of new hydrographic Canal Management Organizations (CMOs). The second was the establishment of Canal Water Committees (CWCs) for each of the three pilot canals. Although the status and mandate of the CWCs are still under discussion, they provide a higher level of representation and influence than the WUAs at watercourse level.

By introducing these two new approaches, the project claimed that more equitable water distribution in the pilot canals were achieved. This paper presents an assessment of the impacts of these institutional changes on water distribution in one instance – the South Ferghana Canal (SFC), in Uzbekistan. The impact of the changes was measured in terms of the adequacy and

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equity of water delivery to all users. The paper also examines how institutional changes at higher level have affected agricultural productivity.

The water distribution for periods of before and after project interventions were measured through temporal and spatial analysis of delivery performance ratio (DPR). The results suggest that there are real changes that have had a positive impact on uniformity of water distribution, reducing the excessive water delivery, a common practice in the pre-intervention period. The weighted average of DPR for the pre-intervention period was estimated at 1.97, but reduced the intervention period to 1.20, which is classed as moderate water distribution performance . The IWRM Ferghana intervention has also resulted in an unexpected decline in water delivery, increasing the number of cases with extremely low DPRs. This normally happens towards the end of the crop season and could reflect poor planning of actual needs at the start of the season. A spatial improvement in DPRs was observed from values fluctuating from 1.08 to 9.56 pre-project, falling into the range of 1.00 and 1.53, afterwards. Better timeliness was also observed. We conclude that, due to the project interventions, the number of excessive water delivery cases was considerably reduced and moderate water distribution performance achieved over a broader area.

To assess the impacts of IWRM Ferghana project interventions on water users, two surveys were conducted in one of the exemplary WUAs located along the South Ferghana canal. The survey indicated that there are positive changes in timeliness and adequacy of water supply to water users, though problems with stability of water level in some watercourses still persist. The yields for major crops such as cotton and wheat in the SFC command area revealed no overall changes during the intervention period. However, spatial differences in crop yields between canal reaches have greatly decreased. The average depth of water applied in different units of SFC became more uniform in the intervention period. This is a very good indicator of the impact of institutional changes on water distribution.

A major concern though remains about the sustainability of new institutions, especially those representing the water users. The Canal Water Committees (CWCs) can play an important role in scheme management to ensure more equal water distribution. This function has been so far operationalized through regular coordination between the CMO and the CWC on 10-day water distribution schedules. The CWC represents water users (both irrigation and non-irrigation) in all canal management matters through democratically elected representatives. However, due to the large size of SFC's command area, this single umbrella body may struggle to be effective in the future. Therefore, we propose that additional CWC's should be formed at each hydrounit of SFC and then federated at the entire canal level.

The analysis confirms that even partial changes in irrigation water management of the countries in transition, especially in Central Asia can bring positive changes in water distribution . However, these changes have greater weight in voicing water users' needs when making water distribution decisions at the main canal level than in using water more effectively at field level. It is worth noting also that SFC is located in Uzbekistan, a country featuring strong central government control and a quota system in agricultural production. So proper groundwork and consultation in the form of well-planned social mobilization campaigns among major stakeholders can effect changes that really work, even if the overall agro-economic system is distorted.

For the last 10-12 years, Uzbekistan has been trying to create more effective farming system through its land reform and the replacement of former collective farms. However, the water sector has so far been failing to keep pace. This case study provides a concrete and detailed example of a model that has great potential to be applied to the enormous number of main canals servicing the Ferghana Valley, and in other systems where hundreds of main canals like SFC exist in Uzbekistan and elsewhere in Central Asia. The replication of the experience of this study in those canals in Uzbekistan and in Central Asia as a whole will bring long-expected sustainability in irrigation water management. The approach described in this study will help to equalize irrigation water distribution to the large numbers of new, individual new water users, emerging due to agricultural and land reforms. The inclusion of water users will also bring more transparent practices and as result reduce the transaction costs of water management. The implementation of the above approach on a basin scale will require a huge effort to mobilize water users and re-organize the irrigation water management structure. Water allocation approaches should also be revised with more inclusion of water users' voice in the process. This requires good will from state agencies, which has to be managed as a key element in the process.

Introduction

Irrigated agriculture contributes much to food security and improved livelihoods of the rural population around the world (FAO, 2005). Occupying only 17% of the total cropland, irrigated agriculture produces more then 40% of the world's food. However, the number of people dying from hunger and living in extreme poverty is not declining (UN, 2005). At the same time the development of new water resources and land for irrigated agriculture in order to increase food production is increasingly less economically, environmentally and socially viable. Real changes in irrigated water use can be achieved through improving the productivity of existing available water resources. In Central Asia, the contemporary water crises are mainly institutional in nature rather than resource-based (Dukhovniy and Sokolov.2005). Therefore, institutional interventions to improve irrigation water management are a pre-requisite for increasing the productivity of limited water resources and feeding millions in the region.

Irrigated agriculture is one of the cornerstones of the Uzbek economy, contributing 30-35% to its national gross domestic product. 60% of the region's population rely on agriculture, with few alternatives for off farm employment (UNDP, 2006). Therefore, both the social and economic health of the country is very much dependent on the sustainable development of irrigated agriculture at least for the next 10-15 years.

However, 90% of the water consumed in irrigation in Uzbekistan comes from transboundary rivers, such as Syr Darya and Amu Darya. Only a fraction of the water resources used in the country (< 10%) is sourced within its territory. A complex and rigidly controlled irrigation network was constructed and upgraded during Soviet times, but after its collapse, emergent national agencies took over the management and exploitation of previously shared natural resources. The extent and trajectory of irrigation water sector developments in Uzbekistan could have far-reaching consequences for interstate water resources availability and management.

Objectives and Scope

The principles of IWRM and River basin management include seeking coordinated development and management of land and water resources (GWP-TAC, 2000, Mostert et al. 2000). They can readily be extended to management of other resources in a basin (Svendsen et al. 2005). Water management is a socio-technical process, arising from the interactions between water users, technology and water availability (Mollinga. 1998). Water management reforms to address emerging water crises started in the mid 20th century in different countries around the world (Brewer et al. 1999; Vermillion and Sagardoy 1999; AHT and WAPDA 2001; Bandaragoda and Memon 1997; Starkloff and Zaman 1999).

However, the water reforms and implementation of IWRM principles in the post Soviet transition economies have not been well studied. The project "Integrated Water Resources Management in Ferghana Valley" is the first attempt to introduce water sector reforms in Central Asia, with a specific focus on the irrigation sector.

In 2003 Uzbekistan began a programme of water sector reform, introducing a hydrographic approach where water resources are to be managed at basin level and not by the provinces (Decree #320 by the Cabinet of Ministers of the Republic of Uzbekistan, issued in 2003). Prior to the Uzbek water reforms, in 2002 International Water Management Institute (IWMI) with its local partners began the Integrated Water Resources Management in Ferghana Valley project (IWRM FV). The Project was implemented in three pilot areas: the South Ferghana Canal in Uzbekistan, the Khojabaqirgon Canal in Tajikistan, and the Aravan-Akbura Canal in Kyrgyzstan. Along each of these primary canals, one Water Users Association (WUA) and several field plots were selected to test interventions and monitor resulting changes. The Project set out to improve the effectiveness of water resources management in the Ferghana Valley with the objectives of the project defined as follows:

- To introduce and pilot test Integrated Water Resources Management (IWRM) approaches and water user participation in the Ferghana Valley; and
- To demonstrate options to increase water productivity at all levels of the production system.

Institutionally, the project brought two innovations at the main canal level. First was the establishment of new hydrographic Canal Management Organizations (CMOs). The second was the establishment of Canal Water Committees (CWCs) for each of the three pilot canals. Although the status and mandate of the CWCs are still under discussion, they provide a higher level of representation and influence than the more common WUAs at watercourse level.

By introducing these two new approaches, the project achieved more equitable water distribution in the pilot canals. This paper presents an assessment of the impacts these institutional changes had on water distribution in one instance – the South Ferghana Canal (SFC), in Uzbekistan. The impact of the changes was measured in terms of the adequacy and equity of water delivery to all users. The paper also examines how institutional changes at higher level have affected agricultural productivity.

This paper tries to evaluate the impact of institutional changes brought by Uzbek government decree on introduction of hydrographic water management in 2003 and IWRM FV[8] project interventions in terms of water allocation and crop yield levels (especially in the tail-end areas) at the selected pilot South Ferghana canal , in Uzbekistan.

The water distribution performance and crop yields analyses for the South Ferghana canal command area was undertaken for two different periods: (i) before the interventions (2000-2001) when water allocation was managed administratively and (ii) after the institutional changes (2002-2005) when the hydrographic principles and user participation in water management were introduced.

Analysis of institutional changes are problematic, after all, this is no laboratory experiment and institutions are humanly devised and individually perceived. Authors recognizes limitations of such analysis where “harware” indicators , such as water delivery, allocation are very much shaped and influenced by social interactions of different groups. The data collected for very narrow period, only five years may also be not enough to produce convincing recommendations. However, approach and method used in this paper could be very good methodology on assessing institutional interventions.

Project Area: Ferghana Valley and South Ferghana Canal

The Ferghana Valley is located in the southeast of the Central Asian region and the eastern part of the Aral Sea Basin. It is almost entirely surrounded by mountains (the Ala-Tau Range in the North, the Tian Shan Mountains in the East and the Alai Mountains in the South), with the exception of the narrow western opening through which the Syr Darya River drains into the lower basin of the Aral Sea. The larger central part of the valley falls within the Republic of

[8] International Water Management Institute (IWMI) and its partner the Scientific Information Center of Interstate Commission for Water Coordination (SIC ICWC) pilot-tested Integrated Water Resources Management in Ferghana Valley within scope of project funded by Swiss Development Cooperation (SDC)

Uzbekistan, while the northern and eastern fringes are located in the Kyrgyz Republic and a small area in the valley's west and southwest belongs to the Republic of Tajikistan.

***Insert:* Figure 1. Map of the Ferghana Valley**

The Ferghana Valley forms the upper to mid-reach of the Syr Darya River Basin, which flows from the confluence of the Naryn and Kara Darya rivers.

The average temperature in the valley is 13.1°C, ranging from -8°C to 3°C in January and 17°C to 36°C in July. Annual precipitation ranges from 109 mm to 502 mm whereas evaporation ranges from 1133 mm to 1294 mm throughout the Ferghana valley. The long–term (1970-2000) average annual precipitation for the SFC command area is 175 mm. During the study period (1999-2004), precipitation rates were mostly higher than the long-term average, having the highest value of 330 mm in 2003 and the lowest of 150 mm in 2000. The effective precipitation rates are equal of only 15-20% of total values. The main reason for low effective precipitation rates is that they occur in winter. The potential evopotranspiration for the study zone is 1800-1850 mm (Mukhamedjanov et al.2004) and thus effective precipitation contributes very little to total water supply (only 2-3%). Therefore, the authors have ignored the role of precipitation in water supply for the study years.

South Ferghana canal is located in the south part of the valley (figure 1) and was built in 1936 and then reconstructed and extended In 1940. The SFC is135 km long, with 60 km located in Andijan Province of Uzbekistan and 85 km is in Ferghana Province. It is lined from head to tail and receives water from Andijan reservoir. The inflow to the canal is 100 m^3/s. Total irrigated area under the SFC command is 83,884 ha of which 26,983 ha are located in Andijan Province and 53,155 ha are in Ferghana Province and some 3,746 ha fall in Kyrgyzstan . The Karkidon Off-Channel Reservoir is used during the irrigation season as an additional source of supply to SFC. The major crops grown in the SFC command area are cotton and wheat, which occupy 28% of total irrigated area, compared to orchards – 26% and kitchen gardens – 19% (table 1)

***Insert:* Table 1. Land distribution and cropping patterns by hydrounits of SFC (Syrdarya-Sokh BISMO, 2004)**

Background information on irrigation and water management in Uzbekistan and need for institutional reforms

Uzbekistan has a very long agricultural history which, according to Russian sources, which goes back to 2000 BC. The first irrigation infrastructure discovered by historians and archeologists indicates that people who lived in what is now Uzbekistan used small water reservoirs and a complicated network of irrigation canals as early as 1000 BC (Bartold, 1970; Mukhamedjanov,1976). However, until the mid 20th century, irrigated agriculture was mainly for subsistence needs of the local population. Lack of budget and the absence of engineering capacity were limiting factors to the development of large scale irrigation in Central Asia.

In the 1960's, the Soviet government started its "virgin land development" program, which included construction of the reservoirs and canal networks and the development of millions of hectares of desert and virgin lands. In the old irrigated systems, such as the Ferghana Valley, some new main canals were constructed to improve water availability for irrigated agriculture. The principal performance indicator of irrigated agriculture was the amount of cotton produced per unit area and the efficient use of resources was never an issue.

During the soviet time the infrastructure was operated and maintained by centralized, hierarchical organizations, branches of the Ministry of Reclamation Amelioration and Water Management. Water management was under political-administrative control and inter-district (hydrographic) canal management organizations were created in only a few cases (Academy of Science of Uzbekistan. 1970). The sole aim of the administration was timely delivery of water to satisfy the demands of cotton growing state farms. Because water management organizations were organized territorially, it was rare to have equitable water distribution in practice.

Under Soviet water management, conflicts were handled by administrative procedures such as giving priority to units with the best performing agricultural production quotas.

The main canals ("*magistralniy*" in Russian) in Uzbekistan are mostly lined or compacted very well to minimise seepage losses. The majority of main canals receive water from reservoirs or weirs and are operated under an arranged demand schedule. Every major water distribution point on the main canal is equipped with regulating gates (manual or electric), discharges are measured regularly. The canal gate openings are based on water demands collated from users. The requests are collected every 3 days and canal manager prepares schedule of gate openings. However, operators can make immediate changes to schedules, if requested by higher level managers or in case of accidents. In lift irrigation, the reliability of the water supply depends on the availability of electricity. Managers of the main canal and its service areas ("*gidrouchastka*" in Russian) communicate with each other by radios which are now outdated. Managers of the main canal and its service areas ("*gidrouchastka*" in Russian) communicate

with each other by radios which are now outdated, information on water flow and changes in gate openings are communicated with delays. Therefore, the canal masters (head of "*gidrouchastka*") in every reach have relative independence to make decisions on water distribution and fluctuations due to the ad-hoc changes made in the different reaches of the main canal result in unreliable and unequal water distribution.

Post independence: impacts of agricultural reforms on irrigation sector

After independence, almost all states of Central Asia, including Uzbekistan, retained the soviet model for water management. At the same time, some economic changes occurred, such as charging water users a part of the O&M cost, through creation of water users associations. State support was uneven and differed from country to country and it also declined with time.

Until the mid-1990's, a secondary canal typically supplied water to one large collective farm. The agricultural reforms begun in early the 1990 has greatly increased the numbers of water users at on-farm level. Irrigation water management arrangements for collective farming system were incapable of responding to requests for water from so many individual users. Water users started to compete for water and water use plans designed for a collective system were abolished, further increasing widespread water theft and erratic supply.

Major changes started to take place in the agricultural sector when large collective farms were broken up into small farms (Ul Hassan et al. 2005). The formation of the numerous smaller farm units, sharing the inherited on-farm infrastructure led to further deterioration of the water distribution discipline and equity (Abdullaev, 2006). The reaction of the Central Asian states, including Uzbekistan, was to launch a WUA programme based on hydraulic boundaries of the former on-farm irrigation system. However, the main irrigation systems in Uzbekistan were still managed territorially by the state.

After the disintegration of collective farms into numerous individual farming units, the workload of the WMOs increased tremendously. Water management at the farm level, previously handled by collectives has been abandoned. Since the financial and human resources of WMOs have not been increased after agricultural reforms, they could not sign individual water contracts with the greatly increased nymbers of water users at tertiary level, resulting in a loss of discipline and neglect of roles by both parties.

State funding for on-farm water infrastructure of collective farms rapidly declined after de-collectivization of agricultural production, leading to rapid degradation (Abdullaev et al. 2006),.

Until 2003, the management of major irrigation canals and water reservoirs was solely under state control. All irrigation infrastructure at the main system level was managed territorially, through provincial and district level water management organizations. Each of territorial unit (district, province) had state production quotas for cotton and wheat. As water was such a crucial factor, each governor tried to appropriate more water for his or her district. The resulting territorial fragmentation of water resources management led to inequitable water distribution and head-tail water disputes (IWMI 2002, SIC 2003).

On July 21, 2003, the Cabinet of Ministers of the Republic of Uzbekistan issued a decree (#320) to reform the water management system by transferring water management from an administrative-territorial system to a basin approach. The main goal of this reform was to consolidate water management through the establishment Water Users Associations (WUAs) and Canal Management Organizations (CMO's), operating within single hydraulic units, in order to ensure equal access to water for different users and improve water use efficiency.

Institutional Reforms/ project interventions

Prior to the project, SFC was managed by the WMOs of two provinces, Andijan and Ferghana. Each WMO developed separate water use plans, which were submitted to the Andijan Water Reservoir Management, which is under direct management of the Ministry of Agriculture and Water Management. The water use plans of the SFC then were adjusted by Andijan Water reservoir authority in consultation with Andijan and Ferghana WMO has to match the water availability in the reservoir. The adjustments are made based on water availability in the reservoir. The water availabilities of different basins and water systems (canals, reservoirs) are forecast by the Ministry of Agriculture and Water Resources based on information from the central office of hydrometeorology services of Uzbekistan. The hydrometeorology service releases the probability of precipitation for the different zones of the country every 6 months. The WMO's in each province had full control over all water management in their jurisdiction. During the cropping season (April- September) and winter (October- March), water was released based on these plans. However, frequent disturbances due to technical problems (damage to reservoir gates or pumps) and external administrative influence made implementation ineffective in practice. The local administrations in charge of the agricultural production frequently requested WMOs to release more water to the units under their control. Due to the administrative hierarchy, the WMOs were forced to obey the local administration, resulting in considerable deviations from the stated plan. In order to adjust the water allocation to the realities of the administrative system, the managers of both parts of the SFC developed an arranged demand process of water ordering and delivery. The primary water users submitted their water requirements every 3 days to the nearby canal hydrounit. The heads of the hydrounits prepared the consolidated requests and submitted them to the dispatch centers of the Andijan and Ferghana part of the SFC. The dispatch centers of the SFC then would send the requests for the water to the Andijan reservoir management.

In the absence of good governance structures and the exclusion of water users from water management, invariably resulted in mistrust between the two territories of the SFC. The water managers in Ferghana province suspected that Andijan (upper reach) withdrew more water than planned or requested. In turn, the Andijan reach accused Ferghana of excessive water use due to the availability of water from internal Karkidon reservoir (200 MCM) (personal communication, Poziljon).

Figure 2[9] presents the SFC water management structure prior to project intervention . The regulator at the head of the SFC (40 km) belonged to Andijan WMO and the boundary with Ferghana lay at the regulator at 60 km RD (till Palvantash hydrounit).

Insert Figure 2.

The allocation of water shares (quotas) was set by MAWR and communicated to the provincial departments. The provincial departments then forwarded the water allocation agreement to the district departments of MAWR. All the district departments of MAWR had to sign seasonal water delivery agreements with the primary water users (collective farms and cooperatives). At the same time Andijan Reservoir was managed by MAWR and received regular requests from SFC managers to release water during the season. Water had to be released from the reservoir to the Andijan Provincial Department of MAWR, including the share for Ferghana Province. The Andijan provincial department then had the responsibility to deliver this to Ferghana province. SFC management in Ferghana had to sign an agreement on water delivery with the Ferghana Provincial Department of MAWR. District departments of MAWR had to sign agreements with hydrounits of the SFC, and water users signed the agreement with district departments of MAWR. The canal managers developed the schedule of water release for Karkidon Reservoir based on need and availability during the irrigation season. The given schedule had to be agreed with Ferghana Provincial Department of MAWR and submitted to MAWR for final approval. At the same time replenishment and water releases were carried out entirely by the central dispatch center of MAWR. Thus, the organizational management structure was based completely on a command-administrative (top-down) approach, which was complicated by

[9] The green box highlights the administrative mode of water management in the SFC. The yellow box with blue text characterizes the “distance” between SFC management and water users. Below, the reader may notice how the “distance” decreases, e.g. in other words the link between CMO and water users improves in tandem with government reforms and IWRM interventions).

administrative-territorial competition over the water. The rigid and awkward procedures neglected local realities and resulted in inefficient water management (SIC.2002).

Water Management in South Ferghana Canal after project intervention

In 2003, the Cabinet of Ministries of Uzbekistan issued a Decree (July 21, 2003, №320) on transforming the water management from territorial to hydrographic principles. This was marked as a start of gradual water management reform in Uzbekistan. As a first step toward the implementation of this decree, the Ferghana Central Dispatch Center for the Main Canal Management Organizations was established in the Ferghana Valley (Figure 3). As a replacement for the former provincial water management organizations (Ferghana, Andijan), two irrigation system management organizations (BISMO) the Syrdarya-Sokh (Ferghana Province) and the Naryn-Karadarya (Andijan Province) were created.

Insert Figure 3

The two BISMO's were responsible for irrigation water management. The SFC management was merged for both parts of the canal and a new Canal Management Organization (CMO) was created. The new CMO took over the management of the whole canal command area, excepting the feeder canal from Andijan reservoir and a portion of the end of the SFC (15 km or 8000 ha). The CMO of the SFC was located in the middle of the canal. Therefore, the SFC became a bulk water supplier to the BISMOs, which were responsible for distribution to primary water users. Even after the reforms, water management remained semi-administrative, as water users still had to sign agreements on water delivery with district branches of the BISMO, which continued to sign an agreement on water delivery with SFC. SFC had to develop a schedule for water use from Karkidon Reservoir but had to agree with the Central Dispatcher Center and BISMOs and have approval of the central office of MAWR. After long negotiation Uzbek authorities in 2006 have transferred the whole canal (including the feeder part and the tail) to the CMO of SFC. However, the data considered here do not extend to 2006.

Water Management in South Ferghana Canal after project intervention

This project brought two major changes to the water management of the SFC: (i) full introduction of the hydrographic principle through merging of two separate canal management units into one and (ii) formation of the Canal Water Committee (later named as Water Users

Union) for the involvement of the water users in the governance of water management at the main canal level (Figure 4).

The introduction of hydrographic water management at SFC went smoothly; the Ministry of Agriculture and Water Management of Uzbekistan, the project's major partner, issued a decree for a unified SFC Canal management unit (CMO). The new unified organization took over from the two separate units before the end of 2002. Organizationally, the CMO has four major departments: (i) the dispatch group, (ii) the O&M group, (iii) the construction group and (iv) the finance and the administrative group. It has re-deployed the former staff of the two separate WMOs and has been allocated the same budget as the two units had before. All the capital equipment (tractors, cars and excavators etc.) were transferred to the new CMO. The second project intervention was more social in nature and almost revolutionary by the paternalistic standards of Central Asian water management Inclusion of water user's into the governance of the system was very new and challenging.

Insert Figure 4

The institutional changes can be considered over three short periods: (1) 2002 was a preparatory year, when stakeholders were informed about upcoming institutional changes. In this period the CMO was created; (ii) in 2003, new canal management was strengthened, and staffed with former workers of the two WMOs and also received adequate funding for O&M. The CMO started to take control over water distribution in all hydrounits of the canal. At this stage, a new body, which represented water users – a CWC - was launched. The CWC Council started to participate regularly at the CMO meetings as an advisory body; (iii) in 2004, several training sessions were conducted for the CWC Council and the CMO. The Council of CWC became stronger and started to share their concerns over water distribution. The process of institutional change was relatively rapid. Within one year, SFC management was fully transformed from territorial to hydrographic principles.

Methods and Materials

Concept of institutional changes/reforms

Irrigation water management, which is focus of this paper, goes beyond technological process, successful irrigation management deals with not only water infrastructure but also water user and organizational interactions (Coward.1980). Already for few decades many countries in Asia with generous assistance from international donors trying to improve their irrigation management institutions. However, due to limitations of state mode of irrigation management progress in institutional reforms are limited (Shivakoti et.al. 2005). Uniqueness of water reforms in Central Asian countries predetermined by their common soviet history and quite striking differences at post indpedence path.

Conventional view on institutional changes describes its occurrence due to two reasons: (i) increase efficiencies or (ii) improve equity (North and Thomas.1970, Binswanger and Ruttan.1978). Bromley (1989) argues that institutional changes are also motivated by (i) reallocation of economic opportunity and (ii) distribution of economic gains. The institutional changes can be classified from supply-demand perspective (Feeny.1993). Demand for institutional changes in irrigation sector presents water users needs for improved and sustainable services. The supply perspective presents states role on institutional changes where it plays major role. The active role of state in institutional changes decreases transaction costs (North.1986). Therefore, it is important to describe and analyze the results of Uzbek water reforms that present supply perspective on institutional changes. In other hand international donors, funding agencies could promote suppliers of institutional change through identification, pilot testing and disseminating of “best” practices of institutions (North.1990). Interventions made by IWRM FV project is good illustration of suppliers for institutional changes.

The institutional changes in the irrigation sector can be attributed to legal, policy and organizational interventions (Saleth et al. 2005). Uzbek government reforms and IWRM FV project interventions both contributed to to organisational change, e.g. the of hydrographic water management units, governance bodies that represent water users, transforming on-farm water management to WUAs. The conecept of organizational changes are very well studied for context of developing countries (Saleth.2004, Giordano et al.2007). However, results of organizational changes are country specific and require country based studies.

Assessment of Water supply performance of SFC

Performance assessment in irrigation and drainage can be defined as the systematic observation, documentation and interpretation of activities related to irrigated agriculture with the objective of continuous improvement (Bos et al. 2005). Small and Svendsen (1992) identify four different types of performance assessment: (i) operations, (ii) accountability, (iii) interventions and (iv) sustainability. A considerable amount of work has been undertaken in the past 10 years to develop a framework for irrigation performance assessment. Irrigation performance indicators cover the traditional aspects related to adequacy, equity and reliability of the water service (Wolters 1992, Murray – Rust and Snellen, 1993, Bos et.al.1994). The evaluation of irrigation water use has undergone major changes in the last 20-25 years. It started as an assessment of classical irrigation efficiencies (Bos and Nugteren. 1974,) and developed to define performance indicators (Bos et al.1994) and a framework of water accounting at the regional scale . Bos et al. (1994, 2005), after thorough research, suggested a package of indicators which are related to the performance of (i) the water delivery system, (ii) the environment and (iii) the irrigated agricultural economic system. For the last decade more advanced systems like benchmarking, designed to compare performance across systems, within defined contexts have emerged as new approaches (IPTRID/WB/IWMI).

The main performance indicator used in this study is the delivery performance ratio (DPR), which quantifies satisfaction of demand (Bos et al. 2005). DPR is calculated as the ratio of actual delivered volume of water to that planned (equation 1). Uniformity was determined as the temporal change of DPR and equity was measured as spatial change of DPR.

$$DPR= W_{actual}/W_{planned} \tag{1}$$

Where: *DPR* – *delivery performance ratio*

W_{actual} – actual water delivery in the diversion point in a given decade (cubic meters)

$W_{planned}$ – planned water delivery in a given decade (in cubic meters)

FAO (1986) distinguishes three levels of performance in irrigation water delivery: (1) deficient water supply (when DPR< 0.8), (2) moderate performance (0.8<DPR<1.2) and (3) excessive supply (DPR>1.2). A system with perfect water management should have spatially and temporally similar water distribution coefficients. South Ferghana canal receives water from Andijan Reservoir and has a very secure water supply. Therefore, one would expect that good management should provide temporally and spatially uniform *DPR*. A frequency distribution was calculated and DPRs for the study period (2000-2005) were arranged into three groups corresponding with deficient, moderate and excessive performance (Figure 9).

Actual water deliveries (W_{actual}) used in DPR calculations were measured 3 times a day within the service area of each secondary canal and daily averages determined. The established seasonal planning system in Central Asia operates on a 10-day period (a ‘decade’), so that each month is divided into 3 decades. Planned water deliveries ($W_{planned}$) were taken from water use plans prepared for each season for every hydrounit of the canal.

The main goal of this study is to assess impacts of institutional changes on water distribution performance and crop yields in the South Ferghana Canal command area of Uzbekistan, Central Asia. This was undertaken for two different periods: (i) before the interventions (2000-

2001) when water allocation was managed administratively and (ii) after the institutional changes (2002-2005) when the hydrographic principles and user participation in water managenet were introduced.

Water User surveys

Measurements of canal discharges provide information on how an irrigation system (network) performs, but tell us little about the performance of an irrigation and drainage scheme as a whole (Bos et al. 2005). Questionnaire surveys play an important role in diagnostic assessment of irrigation. From questionnaires, important information on service levels, social organization and conflicts can be obtained. A well–designed survey based on statistical methods can provide a strong quantitative base for analysis.

The WUA surveyed - WUA "Akbarabad" - is located in the command area of South Ferghana Canal. The findings of 2 sequential surveys (Yakubov and Matyakubov, 2004; Yakubov, 2004) conducted in 2003 and 2004 have been used to analyze and understand water users' perceptions and attitudes towards the changes that occurred in water management before and after project interventions. Both surveys were designed and conducted at farm household level as structured interviews to collect a set of data on farmers' initial attitudes and perceptions with regard to a range of water management and water use issues and track any changes and dynamics throughout the project. One key issue analyzed in the surveys was the perceived change in the quality of irrigation services in terms of adequacy, timeliness and stability of water supply.

The *population* for both surveys in WUA "Akbarabad" included all households living and working their main land parcels and/or backyard gardens within the WUA service area. The service area of this Uzbek WUA, when first established in March, 2003 was 2820 ha, including 33 proprietary farms of about 13 ha, 3 huge cooperative farms (locally called *shirkats*[10]) and 5 villages. A stratified random sample of *60 local agricultural water users* were interviewed. The sampling was limited to household heads stratified by the location of their main land holdings along watercourse and distributary canals (head, middle or tail). Additionally local farmers were stratified by farm type: *shirkats*, medium- to small-size commercial farms and tiny subsistence backyard enterprises.

When conducting the second survey, every effort was made to include all farmers from the first sample, with 55 farmers out of the baseline 60 being re-interviewed.

[10] Large cooperative farms in Uzbekistan - *Shirkat Farms* (*shirkat kho'jaligi,* in Uzbek) - are still quasi-governmental in nature though formally collectively owned by their members; the term 'Proprietary Farm' has also different renditions in Uzbekistan (*fermer kho'jaligi,* in Uzbek*, i.e. Sole Proprietary Farm*).

Water Supply to WUAs, Water Productivity and Crop yields

In order to assess the impacts of the project interventions at lower levels (WUAs and individual water users) the DPR at the head for the WUA service area was assessed for the pre-intervention (2001-2002) and project periods (2003-2005). WUA Akbarabad was formed in 2003 therefore data on DPR for pre-intervention periods are given as an average of the 4 secondary canals, which were under Kuva WMO management in 2001-2002. The command areas of secondary canals and number of outlets closely match those of WUA Akbarabad.The only thing changed were the number of water users after abolishment of collective farms. Therefore comparison of pre- intervention and intervention periods is based on data collected from secondary canals.

Data on major crop yields (cotton and wheat) and actual water supply depth for canal command area were collected also for the study periods in order to assess the impacts of the IWRM Ferghana project.

Analysis of institutional changes is problematic, after all, this is no laboratory experiment and institutions are devised through insight and experience and are individually perceived. The authors recognize the limitations of such analysis where “hard” indicators, such as water delivery and allocation are very much shaped and influenced by social interactions of different groups. The data was collected for a relatively short period, only five years, and so may also be insufficient to make convincing recommendations. However, assessment of the performance of water reforms and the associated participatory management of irrigation remains rare, and this paper adresses this gap..

Results and discussion

Impact of project interventions on annual water distribution along the canal

The SFC has 8 large hydrounits, from which the water is delivered to the primary water users (WUAs, collective farms). A temporal analysis of DPR was carried out for all 8 hydrounits of the SFC. The period for the analysis was 2000-2005, the years 2000-2001 represent a baseline. The changes on SFC water management occurred after 2003. The DPR’s of these two periods are compared in Figure 5.

Insert: **Figure 5. Temporal variations of average DPRs before and after water reforms and institutional changes**

Although the period of comprasion is short the temporal analysis of the DPR (uniformity) of SFC indicated that there is a clear difference between the period of pre and after the project interventions . The blue band in figure 5 is when the planned and actual water distribution match (0.8<DPR<1.2). The pre intervention (2000-2002) period is characterized by over supply of water. Surprisingly, excessive water distribution occurred even during the year 2000, which was a year of water shortage in Central Asia. The weighted average of DPR for the pre intervention period is 1.97 with three peaks of DPR : 7.95 (April 2000), 6.21 (April 2001), 2.75 (September 2001). Excessive water delivery against the planned allocation may be due to inappropriate water planning and implementation given the complexity of institutional arrangements.

The period after the project intervention (post 2002) is characterized by a weighted average of DPR of 1.20, or moderate performance over the period 2003-2005. During the intervention period there were a few cases of extremely low DPR – 0.21 (September 2004) and 0.16 (September 2005). However, these occurred at the end of the crop season therefore, should not seriously harm the irrigation water users but might have had negative impact on other water users. At present water use plans for canals are prepared for field irrigation only. Therefore needs of other sectors (gardens, drinking water, small industry) are not presented in water plans and not taken into account in water distribution process. This is a major issue for users, who derive much of their real and disposable income from gardens.

The overall water distribution performance during the intervention period can be measured as moderate and in 2005 was mostly optimal. Overall assessment of the uniformity of the water distribution in SFC for the pre- intervention and intervention periods shows that project interventions had an overall positive impact on water distribution uniformity. However , authors recognize that differences between pre- intervention and intervention period comprasions are based on only two year and three year data sets respectively.

The temporal analysis of DPR (reliability) indicates the adequacy of the overall water distribution in the SFC pre and during the project intervention periods. In order to assess the equity of the water distribution for those periods, a spatial analysis of DPR was conducted for the pre intervention period (administrative districts) and for the project period (hydrounits). The analysis of spatial DPR (equity) shows significant statistical differences. The weighted averages of the water distribution coefficients for two periods are 1.97 and 1.2, respectively. This clearly corresponds to the weighted averages of the temporal analysis of water distribution coefficients (table 2).

***Insert:* Table 2. Descriptive statistics of spatial variations of DPR by districts (before IWRM interventions and water reforms 2000-2001) and hydrounits (after project interventions)**

Table 2 is divided into two groups: i) administrative districts in head to tail order; ii) hydrounits, also given in head to tail order. The mean DPRs for the pre-intervention period are relatively homogeneous as far as Kuvasay district WMO (ranging 1.08-1.46), which is located at the middle of the SFC. However, the DPR at the Kuvasay is 2.52 and significant fluctuations occur below the Kuvasay. Thus average DPR reduces to 0.97 at Okunbabaev and then reaches it is highest values in Oltiarik, Fargona and Yozyovon districts - 2.23, 4.28, and 3.07 respectively. This analysis indicates that the water distribution among the administrative districts located along the canal was very non-uniform during the pre-intervention period and the contrast between the mean values of upstream and downstream reaches of the canal is clear. The highest standard deviation of the DPR for pre intervention period was observed in the Kuvasay, Fargona and Yozyovon districts of the Ferghana province – 3.71, 9.56 and 2.34 respectively (figure 6). The same trend was retained for the coefficients of variance (13.79, 91.45, 5.50) and the standard error of means of the DPR (0.62, 1.59, 0.39).

The unequal water distribution did not result in impaired water delivery to the tail end districts. Rather, the tail end users received more water than planned . The pre-intervention period can be characterized by very high DPR both spatially and temporally, highlighting significant over supply from the SFC.

Insert: **Figure 6. Spatial variation of statistical indicators (mean, standard deviation and standard error of means) of water distribution coefficients by districts of SFC (2000-2001 before water reforms and institutional changes)**

After 2003, the variations of the mean values of DPR range between 1.00 and 1.53, indicating moderate water delivery performance (figure 7). The highest standard deviations are observed in hydrounits 3 and 8, with values of 0.74 and 1.22 with similar patterns in standard deviation and standard error of the mean. However, the overall water distribution was more equitable, as a result of the unification of the canal under hydrographic unified management and the active role played by water users following their representation in the CWC.

Figure 7.Spatial variation of statistical indicators (mean, standard deviation and standard error of means) of water distribution coefficients by hydrounits of SFC (2002-2005 after water reforms and institutional changes)

The overall uniformity of the water distribution in SFC can be classified as good after project intervention. The frequency distribution of deficient, moderate and excessive classes along the SFC suggests a good result. The percentage of cases with excessive water distribution rose from 43 to 65% in 2000 and 2001, declined to 34% in 2002 and then increased to 56% in 2003 before declining again to 47% (2004) and then to 7.6% in 2005 (figure 8).

Figure 8. Temporal changes of frequency distribution percentage of deficient, moderate and excess cases of water allocation along SFC (2000-2005)

The percentage of observations within the range of moderate DPR continued to increase steadily after the project intervention, from 38% in 2003 to 54% in 2005. This can be assessed as a positive impact. However, at the same time the deficient water supply cases also increased from 11% in 2003 to 37% in 2005. This may be an indication of the increased control (some times excessive) by the water management unit of SFC. It may very well be an attempt by CMO to reduce water use in the canal to raise water distribution performance. On the other hand, formation of water users associations (WUAs) along the canal has also contributed to more controlled water use at the farm level. There is a tendency to over-order in water use plans and this could also explain cases of deficient water supply.

The analysis of the annual temporal and spatial water distribution in the SFC before and after the project indicates that there have been improvements in the water distribution. The pattern of temporal changes (uniformity) of water distribution clearly mirrors the interventions in SFC. In 2000-2002, when the canal was managed territorially with no water user representation, water supply was excessive. We conclude that the introduction of interventions to improve water management at SFC led to a reduction of excessive water delivery and increased prevalence of moderate water distribution performance. However, the frequency of deficient delivery also increased, but occurred at end of the crop season and therefore “only” affected non-agricultural users. The non- agricultural water uses, communal water use, industrial consumption and other users have a tiny demand in comparison to agriculture water use (3% in total water use).

Impact of canal management interventions at lower levels on water users

Linkages between water users and the Canal Water Committee

Establishment of the Canal Water Committee (CWC) is an important water management innovation introduced in the region by the IWRM Ferghana project (SDC 2005).

The CWC in SFC was started with rapport building between the project and two major stakeholders: the state water management organization (CMO of SFC) and water users (WUAs and shirkats). The rapport building was conducted through regular meetings, at first, separately with each stakeholder group and later in joint meetings. The second step involved social mobilization among water users. A group of local people with appropriate technical and social backgrounds, were selected and trained by the project staff to become social mobilisers. They visited WUAs, shirkats and private farmers to explain the idea of including water users in the governance of water at the main canal level. In contrast to bringing the separately managed canal parts under single hydrographic management, nurturing the principles for water user representation and participation in the canal governance took much longer. The stage by stage process of mobilizing stakeholders' support from awareness building to consultation meetings through election of group representatives to the establishment of CWC) took almost 8 months.

The third step was election of water users' representatives from each hydrounit to the General Assembly of CWC. The elections were held in each hydrounit of the SFC. Thus, one person from each hydrounit was elected to represent their interests in CWC. In many cases water users elected WUA and shirkat leaders to be their representatives - a clear indication that water users preferred those who are better connected to effectively deal with and voice their problems at the higher hierarchical level of the system. There are undoubtedly other explanations as well.

At the General Assembly of CWC, these representatives then elected a Council of the Canal Water Committee to serve as a permanent body. The council is composed of one person from each hydrounit representing irrigation water users and one delegate from each non-irrigation user such as power generation, or drinking water utility. The canal manager (head of CMO) was also elected as a member of the CWC Council.

In the first meeting of the Council, the chairman and secretary were elected through open voting. The official documents of the CWC were sent to the Ministry of Justice for the registration as the representative (governing) body of the water users. At present, the CWC is an advisory unit with no power of approval/disapproval, therefore its role and influence over water management issues is still limited. However, the appearance of water users' representatives at every meeting of CMO has had an impact on the water management decisions taken to date. The manager of the CMO has started to present water use and implementation plans to the Council. The CWC Council members mainly were concerned about equal and reliable water distribution in the SFC and how water use plans are specified for their respective hydrounits.

The cost of the CWC operation, such as regular meetings, travel cost of the Council Chairman, and salary of the secretary, were covered by the CMO budget. However, in order to provide more independence, the General Assembly of CWC announced the introduction of a fee which will be collected from all primary water users (WUAs and shirkats). A major problem facing the CWC is the difficulty of representing numerous water users along such a large canal. At present, there are around 26 WUAs within the SFC command area. However, soon their numbers may be doubled or tripled. In this situation, CWC may become another centralized and hierarchical body and may be ineffective in representing water users' needs. Therefore, the next step taken in 2006 was the establishment of CWC branches in each hydrounit of SFC. This allows to link numerous WUAs along canal with CWC. This will require huge social moilizaton among WUAs, canal staff and other water users.

The major challenge in the immediate future concerns the status and mandate of the CWCs in combination with the establishment of CMO on the principles of hydrographic unity. The CWCs can play an important role in canal management as has been demonstrated by the project in terms of achieving a more equitable distribution of water. However, as the representative organ of the users and stakeholders in the command area of the canal, the CWC could play a much more distinct role in IWRM, such as: water allocation, drainage management, water quality, etc. Ultimately, the mandate of the CWC will very much depend on how all water related activities in the command area are financed. It could range from a pure consultative role to one where the CWC would have full control of the management of all the assets under its jurisdiction (SDC. 2005).

Water supply to Water Users Associations

WUA "Akbarabad" when established in 2003 had 33 indvidual farms of 13 ha on average, 3 huge quasi-state cooperative farms (locally called *shirkats*) and 5 villages populated by about 16,000 people making up a total of 3609 households, with each one having a separate backyard garden. In the following year (2004), the number of individual farms increased to 45 as a result of continuing land reforms (with farmland of big shirkat farms being gradually parceled out to such new farms). The local WUA manages 4 secondary canals with a total of 105 off-takes. Major local farm types include *shirkat* farms that cover thousands of hectares in the crop area and are shared by hundreds to thousands of farm workers; individual farms normally owned by one household with the farmland on long-term lease (up to 50 years) and ranging from 1 to 50 ha; as well as tiny household-based backyard gardens (locally called *dehqan* farms, ranging from 0.10 to 0.15 ha on average). The basic crops grown are cotton and winter wheat on most commercial big- to medium-size farms, fruit orchards on medium- to small-size proprietary farms and vegetables in household kitchen gardens.

WUA Akbarabad receives water from hydrounit #5. Before the WUA and CMO were formed, the water users received water through the Kuva district WMO in Ferghana province. The number of water users, command area and state of the irrigation and drainage network makes Akbarabad a typical WUA in the SFC command area The assessment of the water delivery performance in WUA Akbarabad is a good illustration of the project's impact at on-farm level. DPRs for pre-intervention periods are given as an average of all 4 secondary canals, which in 2001-2002 were under Kuva WMO management. The DPRs over the pre-intervention period (2001-2002) were equal, that is the area received exactly the planned amount of water during the crop season. In 2003, at the start of the IWRM interventions, the DPR declined to 0.91. In 2004, it increased to 0.98 and then again declined to 0.93 in 2005 (figure 10). This indicates that the water delivery performance has deteriorated after IWRM interventionsThe project team conducted a water user's survey for the project intervention period in order to have a better understanding of what changes had occurred in water services. The next section of the paper reflects those responses.

Figure 9. Adequacy of annual water supply in the WUA Akbarabad (2001-2005)

Responses of water users on Irrigation Service

A set of questions in a baseline and follow-up surveys was specifically designed to verify the quality of irrigation service and find out any relationships between the baseline year (2002) and subsequent years. The answers to these questions allow some judgment on the quality of irrigation service in terms of its adequacy and timeliness. In particular, the following three measures were used: (1) the number of irrigations requested; (2) those actually received; and(3) those received on time. Thus, the ratio of (2) to (1) would define water adequacy while that of (3) to (2) timeliness of water delivery.

Adequacy of Water Deliveries

Comparison of the 2-years' findings reveals that water deliveries to the water users remained quite adequate in both years - before and after the project (Table 3). Although there was little space for further improvement there was a slight increase in water adequacy following the first year of project interventions.

Insert: **Table 3. Water Adequacy during the cropping season in WUA Akbarabad**

Timeliness of Water Deliveries

Good water supply alone, while satisfactorily meeting water demands in volumetric terms, is not sufficient to guarantee farmers a good irrigation service. The right timing of water supply also matters. Survey results show that the number of those who enjoyed timely service in WUA "Akbarabad" in 2003 considerably improved from the preceding year, from 40% to 71% (Table 4).

Insert: **Table 4 Timeliness of Water Delivery during the cropping season in WUA Akbarabad**

Stability of Water Level in a Watercourse

There was a considerable increase in the number of respondents who reported that water level in their watercourses was always stable and constant in 2003, compared to the year before (Table 5). On the other hand there was also an increase in the number of those who experienced constant problems with the water level. Among the main reasons for lack of stability in water level, respondents noted that there are many water users and lack of discipline and order among tiny kitchen garden owners when distributing water. This might have been due to the WUA's initial preoccupation with meeting mostly the bigger farms' needs without much regard to the needs of smaller water users such as family plots and kitchen gardens resulting in tampering with WUA delivery schedules to make sure they have enough water.

Insert: **Table 5. Stability of Water Level in the Watercourse during the Cropping Season in WUA Akbarabad**

Overall, though the outcomes of the 2 WUA surveys discussed above, being short-term, reveal no major breakthroughs in the quality of irrigation services by the newly established WUAs. However, institutional interventions coupled with social mobilization among water users somewhat improved the head-tail inequities in water distribution. (Yakubov, 2004, 2005).

Crop yields, specific water supply and water productivity by canal units

The impact of the IWRM project interventions on agricultural production is an important indicator of its acceptability by water users and producers of the crops. The two major crops grown in SFC command area are cotton and wheat, both under a state quota system. In 2001, which was used as baseline year (pre-intervention), the average cotton yield was 3.2 ton/ha and wheat yield was 5.8 ton/ha. The yields for both cotton and wheat were higher in the upstream areas of the canal and lower in the downstream (table 6).

The highest cotton yield in 2001 (3.8 ton/ha) was recorded in the Bulakbashi district of Andijan province at the head end of the SFC. The lowest yield for cotton at 2.8 ton/ha was registered in Ferghana district of the Ferghana province which is in the tail end of the SFC. Similarly, the wheat yields were highest in the Bulakbashi district (7.4 ton/ha) and lowest in the Ferghana district (4.8 ton/ha). Overall, before the project the head-located districts obtained higher yields for both cotton and wheat.

***Insert:* Table 6. Cotton and Wheat Yields in the SFC command area in 2001 (baseline year), ton/ha**

Crop yields for 2002-2005 were analyzed by canal hydrounits. Average cotton yields declined dramatically in 2003, immediately after the IWRM Ferghana interventions started and then started to recover. In 2002 average cotton yields for SFC were 3.2 ton/ha. In the following year it declined to 2.5 ton/ha with slight increase in 2004 to 2.8 ton/ha. The recovery continued in 2005 with the yields averaging 2.9 ton/ha. In 2005, the highest cotton yield recorded was 3.8 ton/ha at hydrounit 1, while the lowest at hydrounit 7 (2.3 ton/ha), i.e. at the head and tail ends of the SFC, respectively. In 2003, the yield of cotton was at its highest (3.3 ton/ha) again in the head-end hydrounit 2 and at its lowest at 1.3 ton/ha in the tail-located hydrounit 7. The same trend was again observed in 2004 and 2005 with the yields at their highest (3.3 ton/ha) in hydrounit 2 and at their lowest, though slightly improved at 1.9 and 2 ton/ha in hydrounits 7 and 4, respectively (table 6). Thus, the general trend for cotton yields until 2005 shows no change after IWRM Ferghana interventions with the head-located commands featuring higher yields and those in the tail – the lowest . However, in 2005 this trend started changing with the hydrounits in the tail reaches of SFC showing higher yields than those in the middle.

***Insert:* Table 7. Cotton and Wheat Yields in the SFC command area in 2002-2005 (after IWRM Ferghana interventions)**

Average wheat yields declined in all years following the introduction of the new water management mechanisms, from 6.7 ton/ha in 2002 to 5.7 ton/ha in year 2005. During the early stages of the interventions (2002-2003) the highest wheat yields were found at the middle of the SFC and later at the head of the SFC. Over the whole period of study (2002-2005) the lowest wheat yields were recorded at the tail ends of canal command area. The yields of two major crops were disturbed after the IWRM Ferghana interventions. The initial decline of the cotton yields recovered by the following year whereas wheat yields did not.

Figure 10 presents water delivery information by administrative unit along SFC over the period of 2000-2001, when water management was administrative. Political districts are arranged from the head to tail of SFC. Average water delivery for this period was equal to 1078 mm, with a maximum of 2400 mm for the most downstream district Ezyovon, in Ferghana province and the lowest of 350 mm for the Markhamat district of the Andijan province. Seven districts out of eleven performed very similarly, having 1000-1100 mm average depth supplied. Interestingly, the water distribution pattern at the tail was more favorable, or perhaps excessive, compared to the head reaches. This happened because the CMO organization mainly disciplined (controlled) water users located in head and middle part of the canal,leaving absolutely uncontrolled tail areas. This situation contributed to increased water tables, excessive drainage formation and waterlogging in the tail areas of the canal.

Figure 10. Specific water supply by administrative units before reforms (2000-2001)

Figure 11 depicts the specific water supply after IWRM Ferghana project interventions. The average specific water supply for this period was 1120 mm, which is slightly higher than the pre-intervention average. The uniformity of the water delivery improved noticeably at the end of the monitoring period. The previous variabilty in specific water supply rates between different hydrounits reduced and tail-head differences disappeared. However, there is some undersupply in the mid-stream hydrounits (#4, #5), which could lead to further problems in future.

Figure 11. Specific water supply by administrative units before reforms (2000-2001)

Overall, water deliveries were more uniform after the changes in management introduced by the project. The gap between maximum and minimum water delivery rates declined dramatically, and the tail-head inequalities decreased. However, the middle reaches of SFC received 200-300 mm less water than either the head or tail.

Conclusions/Policy Implications

The current crises in the water sector have revealed the limitations of institutions in dealing effectively with the new set of problems related more to resource allocation and management than to resource development (Saleth and Dinar, 2004). Water management institutions and organizations cannot be seen apart from what people do. They are constantly shaped and reshaped through people's practices (Mehta et al., 1999). The need for water resources management reform in Central Asia was determined by the socio-economic changes that occurred after the collapse of the Soviet Union, particularly by the transition from a collectivized farm system to different type of smaller size farming (Ul Hassan et al. 2005).

Attempts to re-activate water management institutions in the new economic and social setting began in the late 20th century in many parts of the world (Hazi.1998, Rosegrant and Gazmuri.1994, Barraque et al.1998, Correia at al.1998, Adam.1997, World Bank.1994, Yaron.1997, Ke Lidan.1997). In Central Asia, the transformation of the water sector to fit a new agricultural setting lagged behind. Fragmentation of previously large collective farm units was not matched by supporting changes in irrigation water management. The regulated economy in agriculture - state quotas and fixed prices below market levels for cotton and wheat - still remained unchanged. The irrigation water management in the region has always followed in the footsteps of agriculture. Therefore, changes in the agricultural sector happened first. Governments first started disbanding the old farming system rather than filling the subsequent institutional gap in on–farm water management that followed. For quite a long time (5 to 7 years), on-farm water management was neglected, resulting in chaos and many problems.

The Swiss Development Cooperation in Central Asia started funding activities aimed at improving irrigation water management through institutional reform and wider public involvement (SDC. 2004). The IWRM Ferghana project has introduced a new set of irrigation water institutions in post –independent Central Asia. The philosophy of the project was to sustain a scheme of water management through hydrographic management and the inclusion of water users in irrigation management. Before the project, the SFC canal was split in two and managed by two different provincial WMOs, organized along territorial boundaries. Water management decisions were dominated by territorial interest and needs. As a result, conflicts and friction over water were commonplace among the districts.

The changes introduced through the IWRM Ferghana project in 2002 were relatively rapid. Within one year, an independent SFC management organization was established and its water management structure was transformed from territorial to hydrographic jurisdictions and from a paternalistic organization to a more open, user represented' semi-public one. The goal of the interventions was to make water distribution between all water users more equitable. Public participation in water resources management is a completely new concept to both water managers and users who for years lived under top-down and administrative management setting. The project interventions endeavoured to catch up with the continuing agricultural reforms through facilitation and creating right incentives to nurture bottom up approaches and initiative when organizing water users and other stakeholders into groups, associations and water committees or unions at all levels of the water management hierarchy.

The temporal and spatial analysis of delivery performance ratio (DPR) for SFC was used to assess the impact of the institutional changes on water distribution. The results suggest that there are real changes that have had a positive impact on uniformity of water distribution, reducing the excessive water delivery, a common practice in the pre-intervention period. If weighted average of DPR for the pre-intervention period was estimated at 1.97, then throughout the intervention period this indicator came down to 1.20, which is classed as moderate water distribution performance (FAO.) The IWRM Ferghana intervention has also resulted in an unexpected decline in water delivery, increasing the number of cases with extremely low DPRs. This normally happens towards the end of the crop season and could reflect poor planning of actual needs at the start of the season. A spatial improvement in DPRs was observed from values fluctuating from 1.08 to 9.56 pre-project, falling into the range of 1.00 and 1.53, afterwards – suggesting an improvement in performance. Better timeliness was also observed. We conclude that, due to the project interventions, the number of excessive water delivery cases was considerably reduced and moderate water distribution performance achieved over a broader area.

To assess the impacts of IWRM Ferghana project interventions on water users, 2 surveys were conducted in one of the exemplary WUAs located along the South Ferghana canal. The survey indicated that there are positive changes in timeliness and adequacy of water supply to water users, though problems with stability of water level in some watercourses still persist. The yields for major crops such as cotton and wheat in the SFC command area revealed no overall changes during the intervention period. However, spatial differences in crop yields between canal reaches have greatly decreased. The average depth of water applied in different units of SFC became more uniform in the intervention period. This is a very good indicator of the impact of institutional changes on water distribution.

A major concern though remains about the sustainability of new institutions, especially those representing the water users. The Canal Water Committees (CWCs) can play an important role in scheme management to ensure more equal water distribution. This function has been so far operationalized through regular coordination between the CMO and the CWC on 10-day water distribution schedules. The CWC represents water users (both irrigation and non-irrigation) in all canal management matters through democratically elected representatives. However, due to the large size of SFC's command area, this single umbrella body may struggle to be effective in the future. Therefore, we propose that additional CWC's should be formed at each hydrounit of SFC and then federated at the entire canal level.

The analysis confirms that even partial changes in irrigation water management of the countries in transition, especially in Central Asia can bring positive changes in water distribution . However, these changes have greater weigth in voicing water users' needs when making water distribution decisions at the main canal level than in using water more effectively at field level. It is worth noting also that SFC is located in Uzbekistan, a country featuring strong central government control and a quota system in agricultural production. So proper ground work and consultation in the form of well-planned social mobilization campaigns among major stakeholders can effect changes that really work, even if the overall agro-economic system is distorted.

For the last 10-12 years, Uzbekistan has been trying to create more effective farming system through its land reform and the replacement of former collective farms. However, the water sector has been failing so far to keep pace. This case study provides a concrete and detailed example of a model that has great potential to be applied to the enormous number of main canals servicing the Ferghana Valley, and in other systems where hundreds of main canals like SFC exist in Uzebkistan and elsewhere in Central Asia. The replication of the experience of this study in those canals in Uzbekistan and in Central Asia as a whole will bring long-expected sustainability in irrigation water management. The approach described in this study will help to equalize irrigation water distribution to the large numbers of new, individual new water users, emerging due to agricultural and land reforms. The inclusion of water users will also bring more transperant practices and as result reduce the transaction costs of water management. The implementation of the above approach on a basin scale will require a huge efforts to mobilize water users and re-organize the irrigation water management structure. Water allocation approaches should also be revised with more inclusion of water users' voice in the process. This requires good will from state agencies, which has to be managed as a key element in the process.

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