Improved Water Management through Effective Water Users Associations in Central Asia: Case of Kyrgyzstan

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Abstract

Continuous institutional changes in the rural sector in Central Asia have negatively affected the reforms and the development of other related sectors, e.g. the irrigation sector. Therefore, reforms in the irrigation sector have been carried out in an ever changing and uncertain environment. Institutional changes have so far been aimed the farm level that was formerly managed by collective and state farms. Replacement of relatively few collective farms by thousands of individual farming units has resulted in chaos and anarchy in water management at on farm level. Water Users Associations (WUAs) were introduced in Kyrgyzstan to better organize farm level water management.

The key questions concerning WUAs in Kyrgyzstan at present are: Do they provide better service for farmers in delivering water? Do irrigation services result in good crop yields? Are they financially viable? In order to answer these questions, the irrigation performance of four WUAs located within one main canal area in Osh province of Kyrgyzstan were assessed for the period 2003-2005. The analysis indicates that in spite of intense international support, WUAs in the study area were performing relatively poorly on irrigation service provision. However, there are signs of improvement, such as increasing water productivity, reduced water use and improved financial sustainability. The Kyrgyz experience on transformation of on-farm level water management from collective farms to WUAs can provide good examples for neighboring countries, e.g. Tajikistan, Uzbekistan, where agricultural restructuring has only started recently.

Key words: water management, irrigation, canal water management organizations, union of canal water users, water distribution, water user association, productivity.

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Introduction

Central Asia, once the backyard of the Soviet Union, is again becoming a playground for the great powers in controlling its natural resources. The region, with 60 million people, is rich in natural resources, i.e. natural gas and oil. In 1991, the Central Asian states became independent from Russia, which was followed by almost ten years of turbulent transition from the centrally ruled Soviet empire to independent nation states. The Central Asian economic transition experiences are well documented and studied (Anderson.1999, Blanchard at al.1997). However, in-depth studies of institutional changes and transition are yet to be documented. De-collectivization of agricultural production is the common feature of agricultural transition in the Central Asian countries (Spoor. 2003, Lerman.2003). Pioneer of agricultural transition in Central Asia, Kyrgyzstan already declared the private ownership of land in the mid 1990's (Bichsel.2005, Bloch et al.1998). Drastic institutional changes in Kyrgyz rural sector have resulted in stagnation of the development of other sectors, including agricultural water management. Changes in the rural sector continue and so reform in the water sector has to be carried out within dynamic environment (DFID. 2003).

Institutional changes in agricultural water management, so far, were aimed to reform the on-farm level that was formerly managed by collective and state farms. Replacement of few collective farms by thousands of individual farming units resulted in chaos and anarchy in water management on farm level (Abdullaev et al.2006, Ul Hassan et al. 2004). Water User Associations (WUAs) are the major organizational innovation in most of the Central Asian countries. Kyrgyzstan is pioneering the agricultural reforms, taking into account the broader changes in water management in Central Asia (Lerman.2003, Herrfahrdt et al.2006, Ul Hassan et al.2004) and hundreds of WUAs were formed within short time. Institutional analysis of WUAs in Central Asia is well presented (Herrfahrdt et al.2006, DFID.2003). By contrast, water management aspects (performance) of WUA activity are still to be studied. The goal of this analysis is to present water management performance of WUAs in Kyrgyzstan, assess the impact of evolution of WUAs on water service performance (adequacy, and equity) at the on-farm level.

Kyrgyz experience on the transformation of farm level water management from collective farms to WUAs can provide a good example and instrument for neighboring countries, such as. Tajikistan, Uzbekistan, where agricultural restructuring have been started recently.

Methodology

Research Framework

Kyrgyz agricultural reforms were similar to all those in other formerly Soviet states. The main approach was a "market panacea", when transition strategies faced a major issue – the absence of markets and institutions (Spoor.2003). Land distribution in Kyrgyzstan had a more social purpose than in neighboring territories and each citizen and member of former collective farms (*kolkhozes*[5] and *sovkhozes*[6]) was issued a piece of land. The plots allocated were very small and fragmented mostly for subsistence and involving mixed cropping. The resulting issues for on-farm water management observed in Kyrgyzstan are (i) provision of irrigation water to numerous newly emerged water users, (ii) sustaining crop yields and productivity of irrigation with subsistence farming, (iii) the ability of small farmers to support WUAs through irrigation service fees and (iv) institutional sustainability of WUAs. These issues were analyzed through on-site research and data collection on water allocation and distribution; analysis of budget and expenditures of WUAs; and statistical analysis of primary and secondary data. The study was conducted within the scope of the Integrated Water Resources Management in Ferghana Valley (IWRM FV) Project[7].

Provision of irrigation water to multiple water users

Provision of irrigation water in Soviet times was the responsibility of water specialists (*hydro technicians*) working in *kolkhozes* and *sovkhozes* and district water management organizations. Internal organization of water distribution within the *kolkhoz* and *sovkhoz* was based on system of informal requests from large irrigation units (called *brigades*). When the lands of the *brigade* were ready for irrigation, *brigade* manager (*brigadier*) used to request water from *hydro technician.* Within one *brigade*, mostly one crop was sown (cotton, wheat, rice etc.). Land was owned by the collective farm and outputs were sold to the state. Strict agronomic control by the state resulted in almost uniform crop development within the *brigades* and irrigation occurred at the same time within the entire brigade area. There was competition over irrigation timing between *brigades* and collective farms. In most cases, water was delivered on time and in requested amounts. Following the land reforms, hundreds of individual farms, which acquired lands of the former *brigades,* started growing different crops using different agronomic methods. Competition over irrigation water has grown fiercely since the beginning of land reforms. Outdated irrigation infrastructure combined with the institutional vacuum created after the abolition of *kolkhozes* and *sovkhozes* have further worsened water management.
In Kyrgyzstan, the state has tested several options to improve on-farm water management. For example, it created the branches of water management organizations instead of collective farms, organized hydroservice groups (private operators) and tried to delegate water distribution to the rural self-governing communities - *ayil okmotus*. By the mid 1990's, WUAs became the

[5] *Kolkhoz* (Russian): A collectively owned farm (semi state and self sufficient) comprising elected by farmers head, several agricultural experts and farm laborers responsible for the collective management of the production system and delivery of targeted outputs (quotas) to the state.
[6] *Sovkhoz* (Russian) is a Soviet state owned farm, including state appointed head, agricultural experts, farmers, which had a same organizational structure as kolkhoz but financed from the state budget directly.
7 The second phase of the project Integrated Water Resources Management in the Ferghana Valley (IWRM Ferghana) started in May 2002 and finished on April 30, 2005. The Project aimed to improve the effectiveness of water resources management in the Ferghana Valley through the introduction of IWRM principles and water user participation. Project was funded by SDC and implemented jointly by IWMI and SIC ICWC. Currently, the project is in its third phase.

main organizations to manage water at on farm level. WUAs were promoted by the Kyrgyz government and received a substantial financial and technical support form international donors (Herrfahrdt et al.2006). The questions asked by authors were: “Does this support mean that WUAs perform their functions better?” and, if yes, then “How well are they doing? To answer these queries, four WUAs located along the Aravan Akbura Canal command area (Osh province of Kyrgyzstan) were assessed through application of widely accepted set of performance indicators (Wolters 1992, Murray – Rust and Snellen. 1993, Bos *et.al*., 1994). The major focus of performance analysis was to find out how adequately water is being delivered in comparison with planned amounts. The adequacy of water delivery was measured as temporal variability of the ratios of actual and planned deliveries to each WUA (formula 1, 2). Equity was calculated as the spatial change of the adequacy by secondary outlet over the period between 2003 and 2005.

$$DPR_{plan} = \frac{W_{actual}}{W_{plan}} \tag{1}$$

where:

DPR_{plan} – delivery performance ratio- adequacy of planning;

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

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

Sustaining crop yields and productivity of irrigation

Crop yields are important indicators, which can indicate whether WUAs were able to sustain irrigated agriculture through effective water provision. However, crop yields and agricultural production affected too many other factors, e.g. agronomic practices, inputs etc. Therefore multi-year crop yield analysis may help to identify role of irrigation water provision.

Water productivity analysis combines physical accounting of water with yield or economic output to give an indication of how much value is being obtained from the use of water (Molden et al, 1997). For this analysis, physical water productivity was calculated by:

$$WP = Output / Q \tag{2}$$

where: *WP* is the productivity of water in kg/m^3, *Output* is the mass of crop in kilograms and Q is water resources supplied, used or depleted (m^3). In this study, only physical productivities of the supplied and depleted water are analyzed.

Ability of small farmers to support WUAs through irrigation service fees

There are number of reasons why governments transfer water management responsibilities to WUAs. One of them is the high cost of previous agencies (WMOs) in managing irrigation systems, accumulated debts and the inability of governments to repay the costs. What is often neglected is whether WUAs are able to raise enough resources for necessary operation and maintenance (O&M) (Ruth Meinzen-Dick et al, 1994).

In the Kyrgyz Republic, the on-farm O&M costs are fully covered by the water users. Water users also pay for the irrigation water, delivered by the main canal. There is no state control on level of charges that WUAs set for their members. However, government indirectly supports O&M through subsidized electricity costs and concessionary land tax, especially in the poorest parts of the country. In addition, major repairs and rehabilitation are also carried out by the state, often in conjunction with donor-supported projects (Mott MacDonald 2003).

Water Users Associations depend financially on irrigation service fees (ISF) collected from water users. Financial viability of the WUAs is critical to the sustainability of irrigation infrastructure (Ruth Meinzen-Dick et al, 1994). To date, WUAs have often had no financial support following their initial establishment. It should be no surprise that many WUAs subsequently fail to become sustainable. Therefore, in this paper attempts to analyze financial performances of WUAs, especially with regard to:

1) Financial Self Sufficiency (FSS) is the annual revenue from water user fees and other local income (not including subsidies), divided by total annual expenditures.

$$FSS = \frac{I_F}{E_T} \qquad (3)$$

I_F - income from water users (ISF) and other local sources (not including subsidies), in Kyrgyz soms[8].

E_T - total annual expenditure of the WUA, in Kyrgyz soms

For financial self-sufficiency, this indicator, i.e. ratio should be near or equal 1 (David E. Nelson 2002).

FSS is a measure of the present state of financial self-sufficiency of WUA. A value less than one indicate that at present, a WUA is financially not self-sufficient. However, if WUAs are taking advantage of subsidy opportunities the value could be still low then one and WUAs may still be financially self-sufficient. If FSS is equal to 1 it means that WUA fully cover its annual expenditures from income from its clients.

2) Fee Collection Performance (FCP) - also known as Fee Recovery Ratio (FRR) – is the annual irrigation fee collected, divided by the total annual fees levied (Bos, 1997).

$$FCP = \frac{F_C}{F_A} \qquad (4)$$

F_C - the annual amount of irrigation service fee (ISF) collected, in Kyrgyz soms;

F_A - the annual amount of irrigation service fee (ISF) levied, in Kyrgyz soms.

[8] Kyrgyz som is the local currency (the rate is 40 Kyrgyz soms per $1).

The ratio should also be close to one. It indicates the effectiveness of WUA fee collection program but it can be affected by the general economic condition of the water users and the degree to which the water users feel the system is worth supporting. A low value can indicate financial problems within WUAs, a lack of support from water users, or a poor collection program. If FCP is greater than 1, it indicates that WUAs have collected water users' outstanding ISF debts from the previous years.

Institutional sustainability of WUAs

Water users associations (WUAs) in Kyrgyzstan are facing several well-known problems on irrigation management transfer: (i) administrative boundaries (Coward 1977, 1980), (ii) few incentives for collective action by water users (Olson 1965, Hardin 1968) and (iii) weak management and governance structure. The major internal constraints, which hinder the effective WUA development in Central Asia, are the following:

- Lack of funds for operation (financial);
- Absence of qualified staff (capacity) to manage WUAs;
- Irrigation systems designed to serve big farms (technical) instead of small (DFID.2003).

In this paper, authors have studied each of these problems and tried to understand local solutions for WUAs in Kyrgyzstan.

Analysis of institutional changes is problematic, after all, this is no laboratory experiment and institutions are humanly devised and individually perceived. Authors recognize limitations of such analysis where “hardware” 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 DESCRIPTION

The Fergana Valley is located in southwestern part of the Tian Shan mountain system, where glaciers and snow feed the Naryn and Karadarya Rivers. Both rivers join and source the Syrdarya River, one of the two main rivers of Central Asia. The Ferghana Valley is bounded by the mountain ranges of Ala-Tau and Alai. Fergana Valley is an ancient oasis, a favorable place for farming, with a flourishing ancient culture of local tribes. Irrigation culture and civilization in Ferghana Valley date back thousands of years. During Soviet times, large irrigation systems were constructed in the valley along the Syrdarya tributaries, developing large areas of virgin and fertile lands. Canals such as Savay, Big Fergana, South Fergana, North Fergana, Akhunbabayev, Big Andijan and Big Namangan were all built manually by collective labour. By the 1980s, the most of the land of the Fergana Valley was used for irrigated agriculture, so that the valley became the most densely populated region in Central Asia. It occupies 49,000 km^2

and has more than 200 people/km^2 compared to an average of 14 people/km^2 in Central Asia. High population density causes stress on the natural resources base, so that irrigated agriculture became the main source of livelihood, and competition for irrigation water increased (SIC, 2003).

Kyrgyzstan occupies almost 200,000 square km (20 millionha), of which 40% is situated in the Ferghana Valley, which is home to 51% of the total population of the country. More than 30% of the GDP comes from irrigated agriculture. 10.8 million.ha of the land (54%) is used for agriculture. mainly pastures, which covers 9.2 million.ha (46%). Cultivated land accounts for only 7% (1.4 mln.ha), including irrigated lands 5.3% (1.07 mln.ha) (Kyrgyz Ministry Report 2005).

The climate is continental and summer is hot and dry. The winter temperatures range between 20-30 ^oC. In July, average temperature ranges from +25 to +37 ^oC. The major portion of precipitation falls in western part of the Ferghana ridge ~ 1090 mm, but only minor amounts are observed in Osh Province ~ 147 mm. The evaporation rates are three times higher than rainfall; this clearly indicates the aridity of the climate and explains the need for irrigation (figure 1).

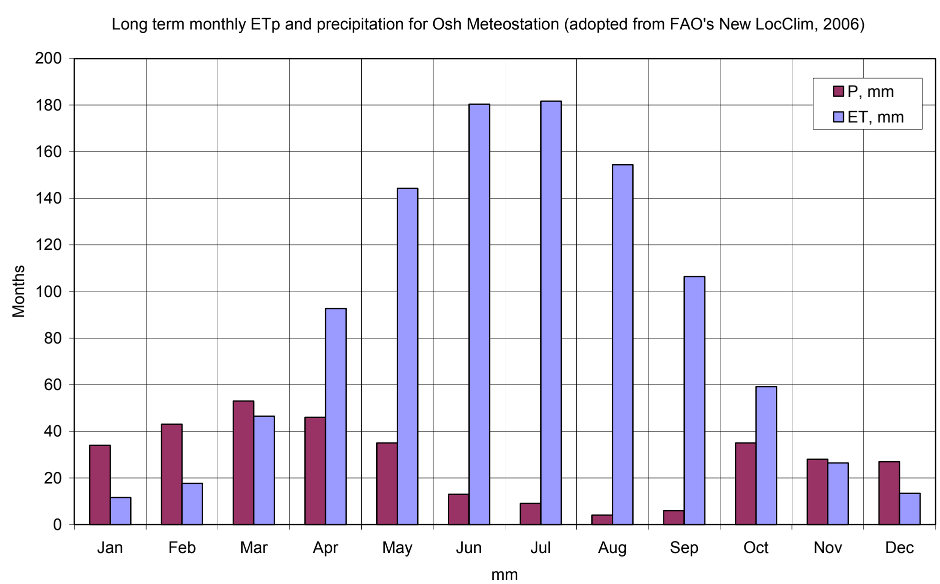

Figure 1. Long-term monthly potential evapotranspiration and precipitation (mm) for Osh Meteorological station (adopted from FAO, 2006)

85% of the territory of Kyrgyzstan is occupied by high mountain ranges, where the most of the Central Asian water supply is sourced. The total water resources of Kyrgyzstan amount to 50 km^3 of surface runoff (table 1), 13 km^3 of groundwater, 1,745 km^3 of lake water, 650 km^3 of glaciers. Kyrgyzstan uses only 12-17% of total water resources that are created in its territory, of which 96% are used for irrigated agriculture, 3% for drinking water and 2% for industry. In 2004, Kyrgyzstan captured 9.03 km^3 (including 1.2 km^2 of groundwater) of water and actually used only 5.7 km^3 of it.

Table 1. Annual Availability of Surface Water Resources in Kyrgyzstan (km^3 per year)

River Basin	Provinces	Probability of Exceedance		
		50%	75%	95%
Chu	Chu	3.73	3.4	2.99
Talas	Talas	1.35	1.18	1
Assy	Issyk Kul	0.19	0.17	0.14
Syr Darya	Osh, Jalalabad, Naryn	27.42	22.82	18.45
Amu Darya	Osh	1.25	1.1	0.93
Issyk Kul	Issyk Kul	3.33	3	2.62
Ili	Issyk Kul	0.36	0.31	0.24
Tarim	Issyk Kul	6.5	4.87	3.56
Total	**All**	**44.46**	**37.53**	**30.62**

(Source: Ministry of Agriculture, Water Resources and Industrial Processing of the Kyrgyz Republic, 2005)

62% of the Kyrgyz population lives in rural areas and in one way or another contribute to the agricultural production process. The major crops grown in Kyrgyzstan are given in Table 2.

Table 2. The main crops grown in Kyrgyzstan

Crops	Area harvested, *000 ha	%	Yields, t/ha
Cereals	614.3	43.4	2.82
Wheat	410	29.0	2.43
Barley	102.4	7.2	2.28
Maize	73.1	5.2	6.04
Oil-bearing crops	86.6	6.1	1.06
Potatoes	85.2	6.0	15.84
Vegetables	38.8	2.7	18.15
Melons and gourds	4.6	0.3	19.34
Total	**1415**	**100**	

(Source: Kyrgyzstan State Statistical Committee, 2004)

Other agricultural crops grown are sugar beet, tobacco, fruits, and vegetables. The major rangeland animals are sheep, goats and cattle. Spillover production of livestock includes mutton, beef, eggs, milk, wool, and thoroughbred horses. Thus, the livestock production accounts to 60% of the total production of agricultural goods.

Water User Associations

Four Water Users Associations have been studied in this research - Japalak, Jani-Arik, Murza-Aji and Isan of Aravan Akbura main canal in Osh province (figure 2).

- WUA Japalak was formed in 1998 as an Association of Legal Entities (private farms). In 2002, it has been re-registered as WUA according to the new law on WUAs. The irrigated area under the Japalak is 2012 ha, including 470 ha of home gardens and yards. WUA Japalak is a pilot WUA, supported by the IWRM Ferghana project, which has: tried to build capacity through a series of water management trainings; carried intense social mobilization activities; strengthened WUA's governing and management bodies; introduced innovative water distribution methods; and increased user participation through establishment of effective Water User Groups. Each WUA has about 5000 members, with an average of 0.4 ha land plot per farmer.

- WUA Isan was established in 2003 and covers 3050 ha in total, including 2070 ha of irrigated area. The irrigated area is shared by 985 smallholder owner cultivators (farmers) and 6 rural counties populated by a total of 5,585 people from 1,010 households.
- WUA Murza-Aji is established in 2003 and irrigates 1406 ha of land, which is cultivated by 211 peasant farms. The WUA represents a total of 1390 water users.
- WUA Jani-Arik established in 2003, has 1,037 ha of irrigated land. There are 2 cooperatives and 258 peasant farms working on the land. The WUA provides service for 1,944 individual water users.

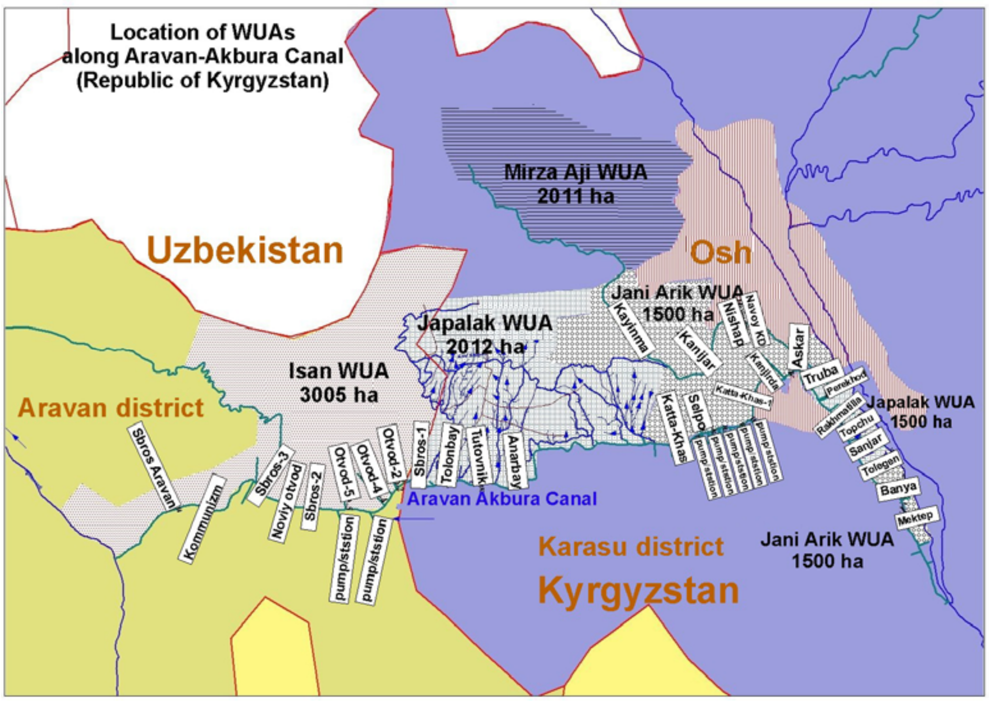

Figure 2. Location of WUAs along the Aravan Akbura Canal, Osh Province, Kyrgyzstan (Source: Mirzaev SIC, 2006)

Results

Irrigation Water Delivery Performance

Adequacy of planned and delivered water – temporal analysis of DPRs

The delivery performance ratio (DPR) is the operational performance indicator for assessment of the irrigation services (Clemmens and Dedrick, 1984; Clemmens and Bos, 1990; Molden and Gates, 1990; Bos et al., 1991). As discussed in the methodology section, DPR is the comparison of the actual[9] value of the volumes of water received by each WUA and planned volumes indicated in the Water Use Plans. In some other literature, it is stated as the adequacy of irrigation service. DPRs in 4 WUAs (Japalak, Murza-Aji, Jani-Arik and Isan) have been calculated by decades (10-day periods) for the growing seasons (April-September) of 2003-2005.

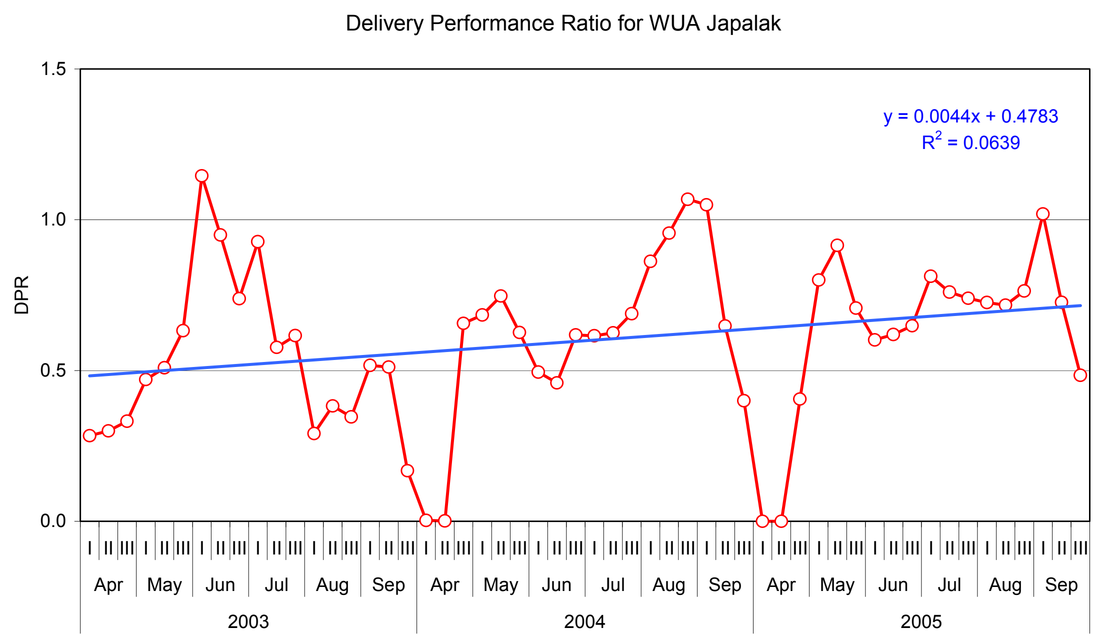

Figure 3. Adequacy of irrigation service provision in WUA Japalak (2003-2005)

The DPR in WUA Japalak fluctuates, which indicates that overall water supply was rather non-uniform. The weighted average DPR increased steadily from 0.44 in 2003 to 0.53 in 2005 (figure 3). In terms of delivery performance, this is reasonable improvement. The lowest DPRs in Japalak during the study were in April and September, at the beginning and the end of the growing season. The highest DPR in 2003 was in June, in 2004 in August and in 2005 in early

[9] In our case 'actual' is referred to the volumes of water provided by the Canal Management Organization and received by the WUA (e.g. director and hydrotechnician) and reflected in the Journal of the Water Receipt and Acts of Receipts and Transfers signed by both sides (WUA and Main Canal).

September. The DPR in WUA Japalak shows that irrigation supply was less than demand. However, a survey of water users indicates that water was sufficient for irrigating of their crops in all study years (Yakubov et al.2006) and therefore the reason for the low DPRs may be due to overestimation of water use plan, especially at the beginning and ends o of the seasons. Due to the uncertainty in water availability in main canals, most of WUAs in Central Asia request more water than they actually need. WUA Japalak might have done the same. The analysis indicates the improvement of adequacy since 2003, e.g. the weighed average values of DPRs for 2003, 2004 and 2005 were 0.44, 0.62 and 0.53 respectively. In 2005, DPR was uniform in 12 decades out of 18 (67% cases). It could be explained by increased number of staff and organizational capacity, improved infrastructure and inclusion of water users into WUA affairs through creation of grass root water users groups (WUGs). The detailed description of changes implemented within the scope of IWRM FV project is given in the Institutional Sustainability of WUAs section of this paper.

For comparison purposes, DPR values of WUA Japalak (2003-2005) were used as a benchmark and compared with the DPRs of other 3 WUAs – Jani-Arik, Isan and Murza-Aji for the same period of time. A two-dimensional scatter plot was used to visualize relations between two variables, e.g. values of a dependent variable, such as DPR in Japalak against the values of an independent variable, e.g. DPRs of 3 above mentioned WUAs (figure 4). This approach proved to be powerful exploratory and analytical technique for investigating relationships between irrigation service performances of benchmarked pilot WUA and other ones along AAC.

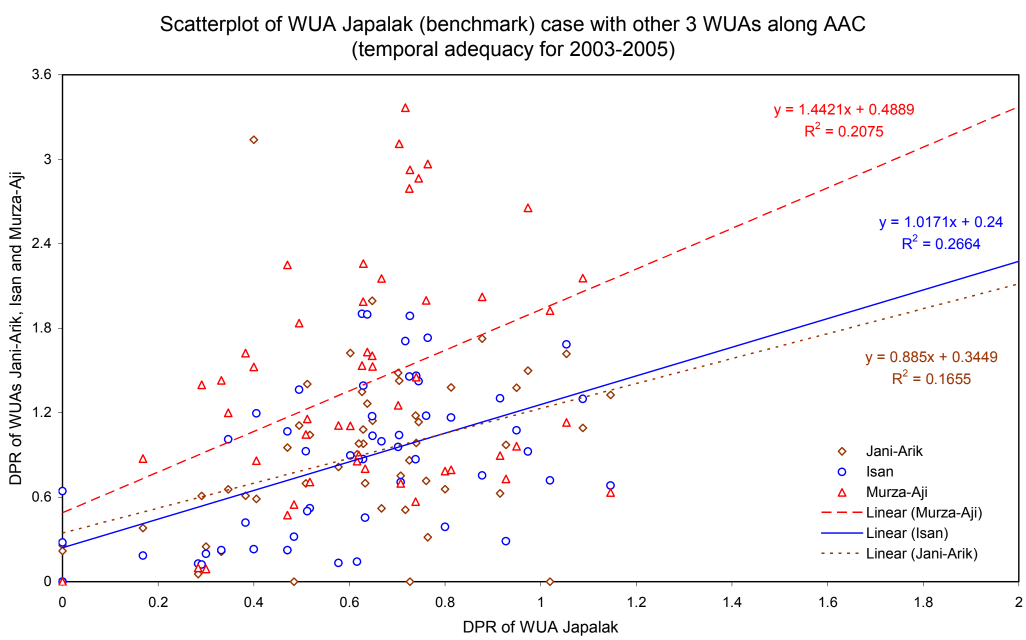

Figure 4. Adequacy comparison of benchmark WUA (Japalak) with other 3 WUAs (Jani-Arik, Isan, Murza-Aji)

Benchmark comparison assessment is suggested by Bos *et.al*. 2005, states "… benchmark level is set by comparison with best practices of comparable processes" (page 29, table 3.2). In this paper only scatter plot analysis, e.g. regression analysis has been used for analysis. The relationship between WUA Japalak DPR and DPRs of other three WUAs is linear. The trend lines around dots represent the general tendency and regression equations of the correlation. The regression equations were produced for each WUA compared with WUA Japalak (table 3).

Table 3. Regression equations of DPRs ($y= ax +b$)
(DPR of WUA Japalak is as benchmark)

WUA's	y	A	b	r^2
Jani-Arik	$y=0.885x+0.3449$	0.885	0.3449	0.1655
Isan	$y=1.017x+0.24$	1.017	0.24	0.2664
Murza-Aji	$y=1.4421x+0.4889$	1.4421	0.4889	0.2075

The regression equations of WUA Isan has the most adjacent values of *a* and *b* which are equal to 1.017 and 0.24 respectively. This equation is the best fit for benchmark linear regression model. The next best fitting equation is of WUA Jani-Arik, having a=0.885 and b=0.3449. The equation for WUA Murza-Aji has the biggest deviation from the benchmark DPR. The correlation coefficients (r^2) for all 3 WUAs have very low values, indicating weak relationships between the DPR of WUA Japalak and others.

WUA Japalak has the best DPR at the moment, partly because of intensive project interventions, the others are not performing well, rather outrageous over supply in Murza Aji, pretty good in Janiarik and somewhere in between in Isan.

The analysis where water delivery performances of the three WUAs were compared with the best performing WUA (Japalak) shows that WUA Isan and Jani-Arik have the relatively better water management performance compared to the WUA Murza-Aji. The problems associated in the WUA Murza-Aji are lack of leadership, poor staff situation, which negatively affected the operation and maintenance, and weak water planning skills.

Knowing that WUA Japalak (as a pilot WUA) is one of the best water users associations in the Osh province, one would expect that in other three WUAs water delivery performance may be even worse. Thus to test our conclusions derived from above analysis, authors have compared the mean, standard deviation and 95% confidence intervals of temporal adequacies of DPRs (figure 5).

The temporal distribution of DPRs of four WUAs was compared (figure 5). Statistical performance of DPR of WUA Japalak is relatively steady, mean of which is lower than 1.0 and standard deviation (SD) is 0.27. WUA Isan has the ideal distribution of mean values of DPR (0.85), but having high standard deviation coefficient of 0.54. WUA Jani-Arik has very similar mean and SD as Isan, 0.87 and 0.59 correspondingly. The DPR of WUA Murza-Aji has high value of mean (1.35) and SD (0.87) among other WUAs.

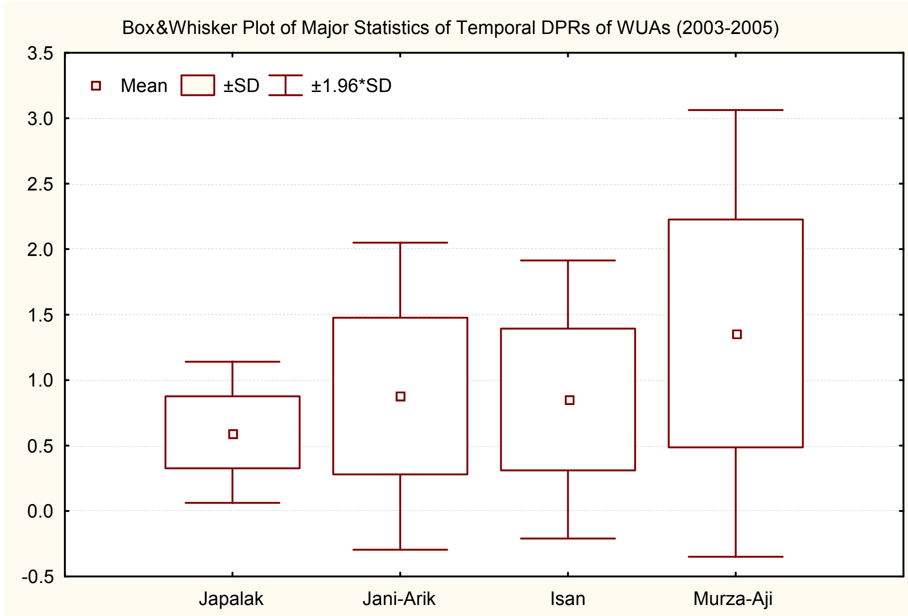

Figure 5. Comparison of mean, standard deviation and 95% confidence intervals of adequacies of 4 WUAs along AAC

Although DPR in WUA Japalak has been made uniform over the study period, it had a very fluctuating nature. However, fluctuations are systematic and mainly at the beginning and at the end of the season. Therefore water users are adapted their cropping and agronomy for the fluctuations. This is the indication of uncertainty of irrigation water provision. As it was indicated above this may be due to overestimated water planning. The temporal analysis of DPRs (adequacy) indicated great variation between the studied WUAs. The comparative analysis of DPRs of other three WUAs with WUA Japalak indicated that there is very loose statistical relationship. This means that each WUA has different temporal characteristics of DPR.

Equity of water delivery- spatial variation of DPRs by WUAs' outlets

The equity of irrigation water delivery is indicates whether water users of different reaches have been treated equally by WUA when irrigation infrastructure is in relatively good shape. The equity of water distribution has been determined through analysis of spatial variation of delivery performance ratios for study period in four WUAs. The spatial variation of DPRs for WUA's major outlets, which receives water from Aravan Akbura canal (AAC) and delivers it to the tertiary canals, has been defined as equity indicator.

WUA Japalak

19 outlets were assessed for equity in WUA Japalak, in 2003 almost all canals had DPR<1, indicating under supply of irrigation water, except one canal *Abay (Orke)* which had a maximum

DPR of 1.1 The minimum DPR of 0.17 has been recorded for canal *Askar* (figure 6). The factor of difference between maximum and minimum DPR was 6.5. However, there was no clear head-tail discrimination on irrigation water provision in WUA Japalak. Both head and tail outlets have been experiencing the same problem- undersupply of irrigation water, especially *Askar, Satar* and *Tutovnik* canals that received only 10% of the planned water.

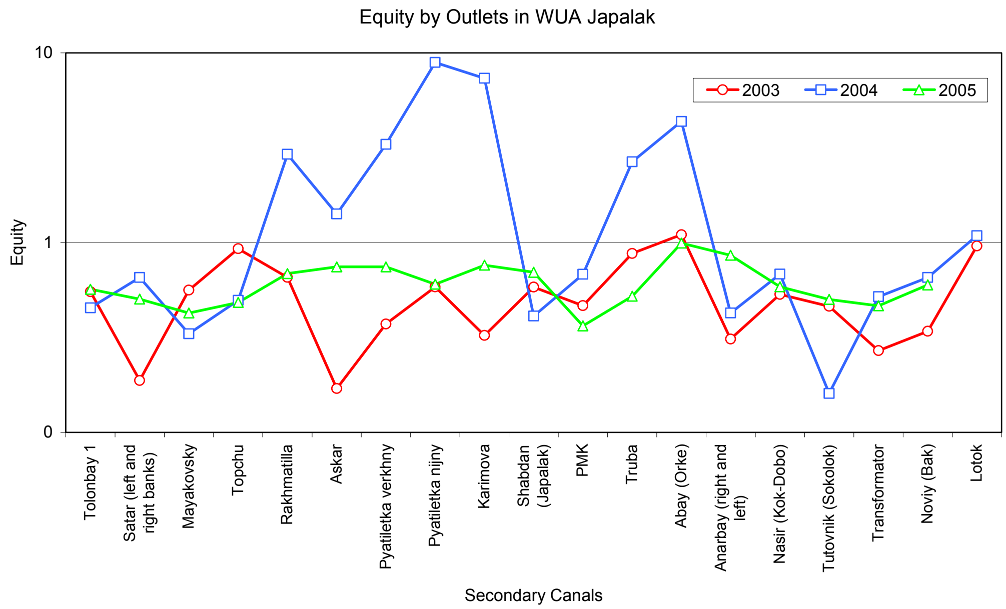

Figure 6. Equity by secondary outlets in WUA Japalak (2003-2005)[10]

In 2004 equity of irrigation water delivery worsened further, having maximum of DPR= 8.89 for canal *Pyatiletka nijny* at the mid and minimum of 0.18 for *Tutovnik* canal at the end tail. This is equivalent to a 49 factor of difference between maximum and minimum DPR. The clear discrimination towards tail canals can be seen in 2004, when 5/6 tail canals had DPR< 1, whilst 5 /10 head tail canals had DPR>1.

In 2005 the equity of water distribution improved, the maximum DPR of 0.99 was recorded for Askar (Orke) canal and minimum of 0.36 for PMK canal. The difference between maximum and minimum DPRs was equal to 2.75. The slight discrimination between head and tail reaches was monitored. In 2005, the spatial distribution of DPRs by outlets was relatively homogenous with weighted average value of equity 0.61 and ranged from 0.36 to 0.99, while end tail outlets received water at least 50% of planned values.

Overall, in three years WUA Japalak had problems of providing equal irrigation service to its canals. Water users are receive water from the tertiary not from secondary canals. However, one would expect that unequal water distribution at the secondary canals would in turn be reflected in water distribution at the tertiary canal and among water users.

[10] Left to right the outlets those take water from the AAC and located from head to tail.

Figure 6 clearly show some learning by the WUA – from undersupply in 2003 (are there other reasons, like low main canal supply) to oversupply and somewhat erratic distribution in 2004, to a generally equitable and improved supply in 2005, always slightly under, but no oversupply

WUA Jani-Arik

13 canals were selected for equity analysis in WUA Jani-Arik. In 2003, mean DPRs of 7/13 canals was less 1 (figure 7). The maximum DPR of 2.30 was recorded in *head KD* canal and minimum of 0.10 in *Shamsi* canal, equivalent to a 23 times difference between the two extremes. A clear discrimination between tail end and head end service was monitored in WUA Jani-Arik in 2003, and 5/7 tail end canals has received almost 10-15% more water than the head end canals. The DPRs of head end canals ranged from 0.10 to 0.29 and DPRs of tail located canals varied between 0.78 and 2.39. This was a poor condition of the head tail parts of the canals in 2003, which later were included into the rehabilitation project. Most of the time head located outlets were closed for rehabilitation (lining and equipping with water regulation gates, etc.) therefore, they had no means to withdraw water into their fields for few month (WB. 2005).

In 2004 equity worsened also in WUA Jani-Arik, but only 4/13 canals received less water than planned and the rest of the canals received much more than their entitlement. This indicates that, in 2004, water was abundant for the most canals of WUA Jani-Arik. The water was under delivered only for mid-reach canals of Tolonbay 2, Katta-Khas 1, and Katta Khas 2. The maximum of DPR was recorded in 2004 at *Kanjirga* canal (3.69) and minimum of 0.38 for *Katta Khas* 1 canal, resulting 9.7 times difference between maximal and minimal means.

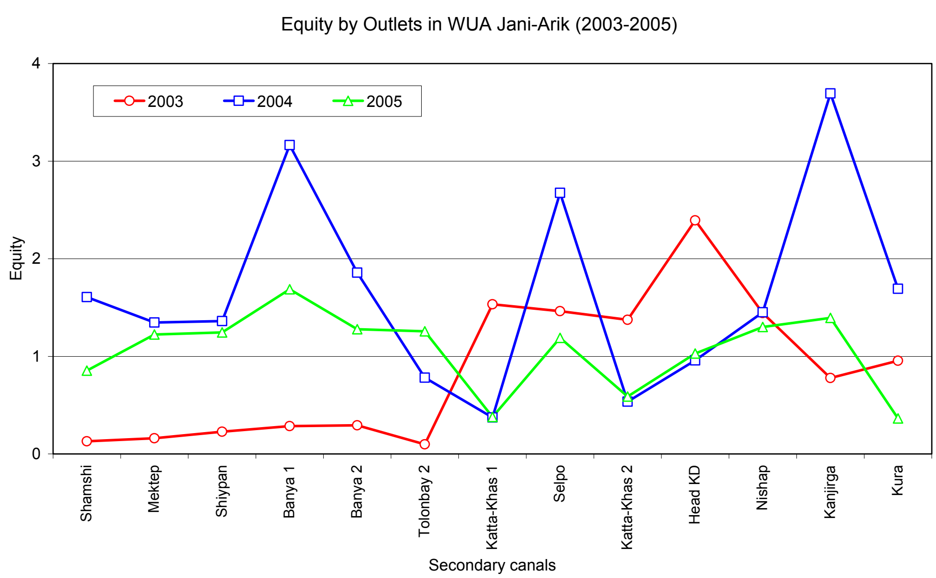

Figure 7. Equity by secondary outlets in WUA Jani-Arik (2003-2005)

In 2005, DPRs of secondary canals in WUA Jani-Arik were slightly more even, with 4/13 canals having a DPR less 1. The maximum DPR of 1.8 was recorded *for Banya* 1 canal and minimum

of 0.38 *for Katta Khas 1*, the difference between maximum and minimum DPR was equal to 4.7. The middle located canals had the lowest DPRs in 2005.
Overall, in 3 years equity of water delivery among canals of Jani-Arik WUA was not uniform. Unlike WUA Japalak in Jani-Arik over supply of irrigation, water was practiced for the most of the canals.

WUA Isan
In 2003, WUA Isan had relatively smooth distribution of irrigation water among canals. One out of 13 canals of WUA had DPR >1, the rest of canals received much less irrigation water than they were entitled to. The highest DPR of 1.7 was registered for canal *Otvod Kirpich* and the lowest of 0.10 for *Sbros 1* canal. There was a 17 times difference (figure 8) between maximum and minimum DPRs. In 2003, there were no huge differences between DPRs of head and tail end canals.
In 2004, water distribution equity among canals of WUA dramatically deteriorated. The maximum DPR of 2.6 was monitored for *Duker* canal and minimum of 0.04 was recorded for *Sbros 1* canal, indicating 65 times difference. Only three out of 13 canals had DPR of less 1. In 2004, WUA Isan started to over supply irrigation water to its canals. The head end and tail end differences were elevated through increased water delivery to the canals located at the head. In year, 2004 most of WUAs and canals practiced over supply of irrigation water due to surplus water in Papan water reservoir, which feeds Aravan- Akbura main canal. The water resources availability in 2004 was equal to 140% of long-term average for 10 years.
This is due to the two main reasons: first, it is change of the WUA management, in the middle of the irrigation season in 2004 and second is the issue with the under estimated water allocation plans, which had supplied more water than it was planned.
In 2005, the equity of water distribution in WUA Isan declined again, the gap between maximum (3.8) and minimum means (0.02) of DPR has widened up to 190 times. 5/13 canals had DPR< 1, indicating that irrigation water was under supplied. The head canals had very high DPRs, 3 out 5 had DPR>2. Middle and tail end canals had DPR< 1 in 4 cases out 6, indicating discrimination in water supply. This was one of worst performance among WUAs for whole period of study.
In the three study years, the equity of water supply to the canals in WUA Isan was uneven. In 2004, WUA Isan started to over supply irrigation water to the head end canals; the overall results of which were higher DPRs. However, overall water equity in WUA was substantially lower normal; in all of the years, at least 4-5 canals received much less water they were entitled for. At the same time, a few of head tail canals received 2-3 times more water.

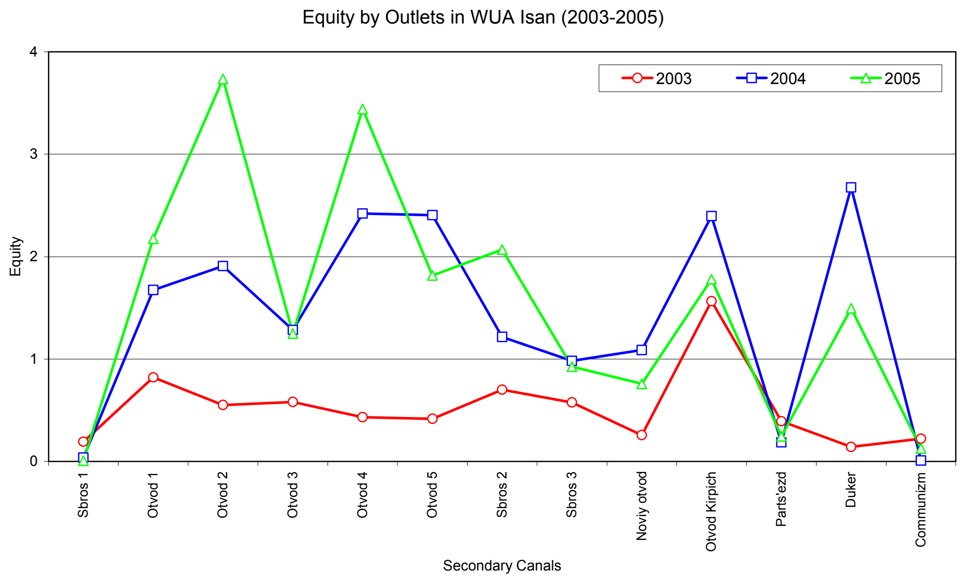

Figure 8. Equity by secondary outlets in WUA Isan (2003-2005)

WUA Murza-Aji

WUA Murza-Aji has only two secondary canals, which serve around 3000 ha of irrigated area. In 2003, canal *Kayirma* had DPR of 0.49 and canal *KD* had DPR of 0.91, close to a factor of difference of two. However, *Kayirma* and *KD* irrigate different units and their water intakes are located quite far from each other, Kayirma canal has even extra water intake from Akbura river. WUA submits water orders to AAC, but if water users of Kayirma canal feel that water is not sufficient then canal master can open water from Akbura river. Therefore, it is difficult for the WUA to adjust water deliveries to these canals.

However, it is quite striking those 2 years out of 3 of the study period that Kayirma had lower DPRs than the KD (figure 9).

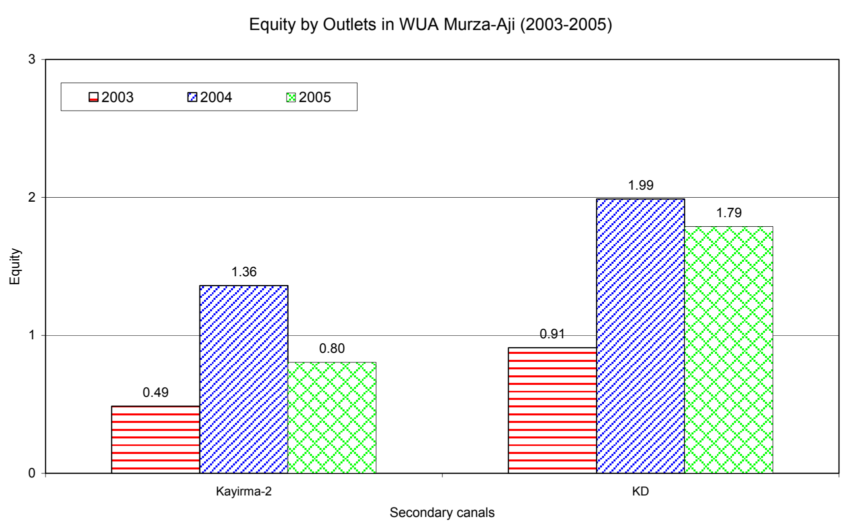

Figure 9. Equity by secondary outlets in WUA Murza-Aji (2003-2005)

The maximum DPR of 1.99 was registered for KD canal in 2004; Kayirma also had DPR of 1.36 at that year. The gap between DPRs in 2003 was 1.9, in 2004 was 1.5 and in 2005 was 2.2 times. Due to the limited number of canals under WUA management, the gaps in DPR between canals are smaller than in the other 3 WUAs. Therefore, one would expect that water users in WUA Murza-Aji have rather better conditions than water users of other WUAs. However, due to non-payment of fees by some farmers in the WUA and a struggle over more equitable water distribution in 2005 WUA Murza-Aji, split into two WUAs.

In spite of extensive institutional (SDC.2004) and technical support (WB.2003) overall water delivery performance of 4 WUAs along Aravan Akbura main canal of Kyrgyzstan for the study period were non- uniform. The improvements on irrigation water delivery for some canals under study are attributed to an over-supply of irrigation water. However, this did not improve equity of irrigation water distribution. The tendency of over supply of irrigation water was crosschecked with water withdrawals from main canal - AAC (SIC.2006). The institutional environment in Kyrgyzstan is much friendlier to water reforms than those of other Central Asian countries (Gunchinmaa et al. forthcoming). However, this research showed that WUAs along AAC of Kyrgyzstan have to improve their services on irrigation water delivery substantially in order to become sustainable water management units.

Sustaining Crop Yields and Water Productivity

The main indicator which could describe how well farmers are doing is the yield of the main crops and the productivity of irrigation water (kg/m^3 or $/ m^3). In this research, we conducted a comparative analysis of crop yields and water productivities of four WUAs along the AAC. The major crop grown in all four WUAs along AAC is wheat. It is used both for local consumption and sales in the local market. The productivity of water also requires detailed water supply records. In each, study WUA one tertiary canal, which feeds farmers, fields were selected and water supply data were recorded on daily basis (table 4). Within the scope of IWRM FV project, water users groups (WUGs) were formed: these are informal groups of water users to improve water distribution along the tertiary canals. Consequently, recording of crop and water data became easier and the quality of collected data improved. Tertiary canals were selected with equal number of water users and similar infrastructure qualities in order to make comparative analysis more valid.

The specific water supply has been declining in all four tertiary canals since 2003, e.g. in Soklok-1 canal (WUA Japalak) average water supply fell from 5,035 m^3/ha in 2003 to 4,188 m^3/ha in 2005 (table 4), about 17%. The same situation applies for all canals, except for Altin-Kazik canal in WUA Isan, where water supply increased from 8,614 /ha in 2003 to 10,714 m^3/ha in 2005 or by 24%.

The crop (wheat) yields also declined over the study period, e.g., in Sokolok-1 canal of WUA Japalak, wheat yields declined from 3 ton/ha in 2003 to 2.6 ton/ha in 2005, a fall of 13.3%. However, in Rabat canal (WUA Murza-Aji) continuous growth of wheat yields was recorded over the whole study period. The wheat yields in this canal command area have increased from 3.1 ton/ha in 2003 to 3.8 ton/ha in 2005, a 23% increase

Table 4. Water supply, crop yields (wheat) and water productivities of selected tertiary canals of study WUAs, 2003-2005

#	WUA	Tertiary canals (WUG)	Water supply, m3/ha			Wheat yields ton/ha			Water productivity, kg/m^3		
			2003	2004	2005	2003	2004	2005	2003	2004	2005
1	Japalak	Sokolok-1	5,035	4,507	4,188	3.0	3.1	2.6	0.6	0.69	0.62
2	Jani-Arik	Korgon	11,183	8,958	7,083	2.8	3.0	2.7	0.25	0.33	0.37
3	Isan	Altin-Kazik	8,614	11,035	10,714	2.5	3.1	2.5	0.29	0.28	0.23
4	Murza-Aji	Rabat	11,584	10,205	10,281	3.1	3.3	3.8	0.27	0.32	0.37

The water productivity comparisons may give a hint about the quality of irrigation services in study WUAs and its impact on farming practices. The highest water productivity (supplied) of 0.69 kg/m^3 for irrigation water was recorded in Sokolok-1 canal of WUA Japalak in 2004. The lowest of 0.23 kg/m^3 was recorded for Altin- Kazik canal of WUA Isan in 2005. The sharp increase of water productivities were monitored in Korgon canal of WUA Jana- Arik where water productivity has been increased from 0.25 kg/m^3 in 2003 up to 0.37 kg/m^3 in 2005 or 48% increase. The same was monitored for canal Rabat in WUA Murza-Aji. The difference of water productivities of Sokolok-1 canal compared to other canals was strikingly two times higher for all three years of monitoring. It indicates that water productivity in other three WUAs is far lower of WUA Japalak and there is a scope for improvement. More important is that the crop (wheat) yields in all four canals are almost similar with minor differences. The major difference is water supply rates; in Sokolok-1, canal water users are achieving the same yields with much less water supply. This could be explained by the fact that Sokolok canal has shifted to the time based water distribution system in 2003 (Abdullaev et al.2006).

The analysis of water supply, crop yields and water productivities have indicated that overall water supply rates were generally declining in study years. The water productivities of Sokolok-1 canal of WUA Japalak were almost two times higher in other canals, indicating the need for improvement. .

Ability of small farmers to support WUAs through irrigation service fees

Financial self-sufficiency (FSS)

The WUAs are struggling to be financially self-sufficient, carrying the burdens of paying the canal management organization (CMO) for water (bulk supply), sustaining the on-farm infrastructure and paying for its staff (Anarbekov et.al. 2006). The major source of WUA income is irrigation service fees (ISF) collected from water users. Today, WUA income is generated mainly from a combination of cash and in-kind contributions from its water users – farmers, where in-kind payments prevail over the cash ones.

Therefore, financial self-sufficiency is very important indicator, which can suggest and show whether WUAs in Kyrgyzstan can survive in the new economic environment, where state support for on-farm irrigation management has been withdrawn (Herrfahrdt et al.2006, Hassan et al.2004).

Thus, we investigated what percentage of annual total expenditure of WUA is generated from water users (members) in a given year. During the study period, WUA Japalak had the best performance, increasing its FSS level from 0.53 in 2003 up to 0.72 in 2005, indicating that 72 Kyrgyz cents per Kyrgyz som WUA is generated locally from its members in 2005 (figure 10). The second best performer was WUA Jani-Arik, which increased its FSS from 0.61 in 2003 to 0.63 in 2005. However, FSS at WUA Jani-Arik decreased in 2004 (from 0.61 in 2003 to 0.59 in 2004). One of the main reasons for this decrease is that the WUA used more water than planned in 2004. The WUA Isan also had a steady improvement in FSS from 0.38 in 2003 to 0.56 in 2005. Only WUA Murza-Aji experienced a decrease in FSS from 0.66 in 2003 to 0.55 in 2005. WUA Murza-Aji management explained that one of the major reasons for decreased FSS, especially in 2005, was due to flooding that destroyed the on-farm irrigation infrastructure, which had directly affected the yields received by farmers plus caused the overuse of water over the planned amounts.

It must be noted that according to the Kyrgyz legislation[11] water users are not restricted to pay irrigation service fees in the form of in-kind contributions. At present 70-80% of the revenues in the studied WUAs are generated from in-kind payments. The main problem observed in all 4 WUAs along the Aravan Akbura Canal was issue of putting up for sale agricultural crops contributed as in-kind to generate cash flow, which pessimistically affects the financial self-sufficiency of WUAs.

[11] The Law of Kyrgyz Republic “On establishing the tariffs for irrigation water delivery services” by Jokorgu Kenesh (Kyrgyz Parliament) from December 29, 1998

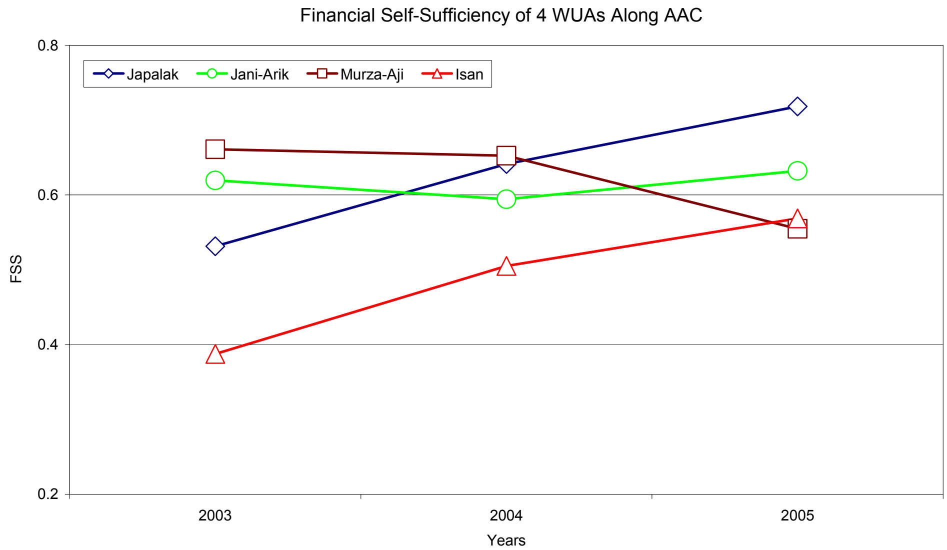

Figure 10. Financial self-sufficiency of four WUAs along AAC.

Irrigation Service Fees

Since 1996, it is mandatory to pay for irrigation water in Kyrgyzstan, and WUAs are subject to two irrigation service fees (ISF), one for the summer crop season ("*vegetatsionniy period*" in Russian) set at $0.73 rate for each 1000 m^3 of water received, and another for the off (winter) crop season ("*mezhvegetatsionniy period*" in Russian) set at $0.24. Additionally, WUAs charge a markup to this amount to cover their own operation and maintenance costs.

The analysis of the ISF collection rates in the study WUAs for the period of 2003 to 2005 indicates that, while some WUAs have increased ISF collection rates, they have not yet reached a financially sustainable level. The lowest FCP is documented in WUA Isan is 0.38 in 2003 and 0.50 in 2004 (figure 11). However, in 2005 the lowest FCP was 0.55 in WUA Murza-Aji. As it was mentioned in the previous section, one of the main reasons of FCP decrease in 2005 was flooding. However, the overall FCP of WUA Murza-Aji declined every year and it indicates that the financial problem of the WUA is either lack of support from water users or a poor fee collection program. The highest FCP of 68% is observed in WUA Japalak in 2005. The FCP of WUA Jani-Arik was 63% in 2005. The relatively better FCP of WUAs Japalak and Jani-Arik compared to other two is partly explained by its qualified management staff, which can deliver irrigation services and are paid for it.

Main canal (AAC) management applied tough measures to improve ISF collection rates. For instance, the gates were shut and no water was released to non-payers, resulting in improvements in ISF collection in WUA Isan in 2004 and 2005. However, the overall situation concerning ISF collection is still not stable. In two WUAs out of four (Isan and Murza-Aji) ISF collection rates were less than 60% in 2005.

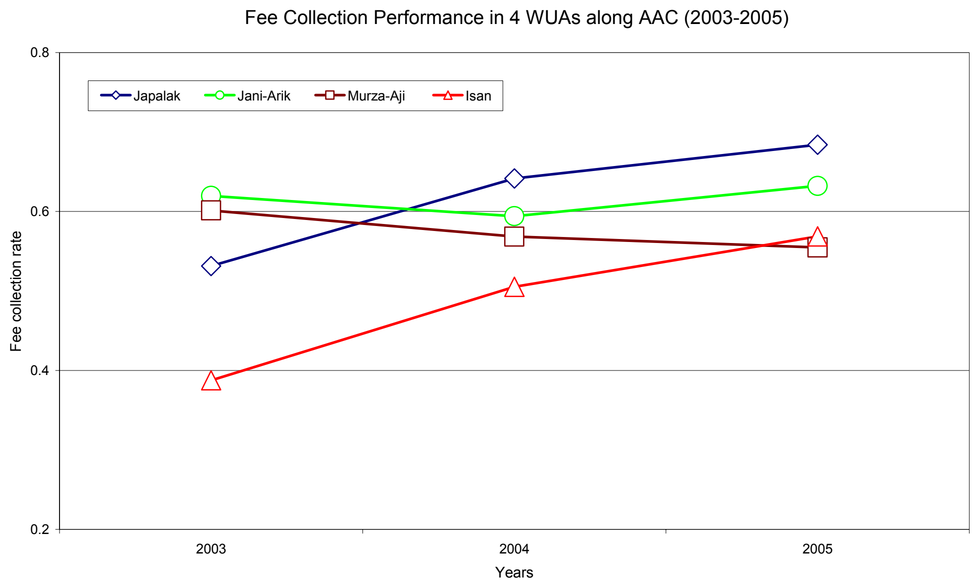

Figure 11. Fee Collection Performance (FCP) or Fees Recovery Ratio (FRR)

The difference between these two indicators, FSS (table 10) and FCP (table 11), is as follows: FSS shows how the WUA is performing in terms of coverage of its expenditures generated from its users, which means how the WUA staff feel about spending of resources compared to revenue from water users, and how the WUA effectively plans the expenditures and wisely uses of the collected fees. Besides, FSS takes into consideration actual annual revenue of WUA that comprises of ISF and other income but FCP only takes into consideration irrigation fee collection (FCP). FCP shows how well the WUA can plan and implement the fee collection program, which implies the trust, participation, user satisfaction and willingness to pay service costs by water users.

A striking finding is that both FSS and FCP trends are similar to the water productivity trends of WUAs. The higher the water productivities in WUA, the better are the rates of FSS and FCP. Therefore, the implication of this for WUAs with financial problems is that they should reduce unnecessary water withdrawals from the canal (AAC), reduce losses on-farm and grow more high value crops.

Institutional sustainability of WUAs- interventions by IWRM FV project

Within the scope of the IWRM FV project, a few interventions were made to improve the situation in the WUAs in the study area. These interventions include activation of WUA Councils, introduction of more transparent water distribution and formation of water users groups at the tertiary canals.

Activation of WUA councils

The WUA management structure consists of two divisions, one is executive (or locally called Directorate) and second is legislative (or council). The directorate, which includes the director of the WUA and its staff, deals with day-to-day operational and water management issues in the area. In all four WUAs, councils were very weak and had no control routine issues. In each studied WUA there was a council consisting of 5-7 people, who were elected by the general assembly (GA). Since 2001, IWRM FV project has formed a purpose-trained group of local specialists – called the social mobilization and institutional development group (SMID). The SMID is made up of local people who closely worked with members of WUA council on their functions. The SMID group has conducted a series of trainings and workshops for WUA Councils, and distributed handouts and reading materials on the subject matter. The SMID group has also extended its support to the organization and documentation of regular council meetings. These all lead to the active participation of councils in WUA matters and understanding and acceptance of the WUA concept among water users.

Transparent Water Distribution

Land and agricultural reforms in Kyrgyzstan, following the collapse of the former Soviet Union, have led to a big increase in the number of individual farm units along secondary and tertiary canals. Given the new setting, the methods for water distribution applied under the former large-scale collective farming system became irrelevant, leading to a chaos, inequity and unreliability in water supply to farmers. Thus, many farmers and water managers have had to move (with varying success) to some alternative water distribution methods to meet these new challenges. Nevertheless, transparency and equity in local water use still remains an issue. Since 2002, within scope of IWRM FV project, a time-based water distribution has been tested and then implemented in all four study Water Users Associations (WUAs) along the AAC. The time-based water distribution method was developed in a truly participatory manner and allowed each farmer involved to be always aware of their specific time schedules including when to irrigate their fields and for how long. This alone led to huge timesavings for farmers when waiting for their turn and a more equitable water distribution between different canals reaches

Formation of Water Users Groups

The numerous individual water users along tertiary canals were organized into water user groups (WUG). The WUGs are informal units within WUA along every tertiary canal (Kazbekov et.al. 2006). The idea to set up WUGs arose out of a SWOT analysis of the study WUAs. The SWOT analysis showed that existing WUA structure does not allow water users to actively engage in water management processes. The hierarchical WUA structure offered no place for water users' concerns over water management practices. This has led to frequent conflicts between water users and WUA staff (canal riders, mirabs, and director). The water users therefore perceived the WUA as an alien organization meant only for ISF collection (Yakubov.2004).. Each WUG unit has a leader elected by the water users themselves to represent all water users of tertiary canal on water management issues. An average WUG has around 40-60 ha of irrigated land and up to 100 water users. The WUG leader has given authority to sign water agreements with the WUA Directorate and receive water from secondary canal, distribute it amongst irrigators. The IWRM FV is promoting the idea of including water user group leaders into the WUA Council, which would link WUG, and WUA.

Discussions and conclusions

WUAs play an important role as change catalysts in irrigation water management process. However, until now they have been mainly created for the state purposes and economic reasons, for applying foreign credits and support (Herrfahrdt et al.2006). Therefore, many of WUAs in Kyrgyzstan became non-operational and inefficient. Rooted deeply in the legacy of Soviet times, top-down water management is still an overwhelming fact in most of the countries of the FSU. The weakest element of irrigation management is the participation of water users in WUA affairs (Ul Hassan et al.2004). The main objective of this study was to determine how existing WUAs in Kyrgyzstan fulfill their major function of providing irrigation services. The quality of irrigation services of four WUAs located along Aravan Akbura canal command area of Osh province were studied for the period of 2002 - 2005. IWRM FV project and World Bank have supported all 4 WUAs for rehabilitation of irrigation infrastructure, and in their institutional reforms.

In spite of institutional (IWMI.2005) and technical assistance (WB.2003), the overall water delivery performance of 4 WUAs along Aravan Akbura main canal of Kyrgyzstan for the study period was heterogeneous. Most improvements on irrigation water delivery in the study WUAs is attributed to an over-supply of irrigation water. The tendency of over supply of irrigation water was crosschecked by records of main canal - AAC (SIC.2006). However, this has not improved equity of irrigation water supply. The institutional environment in Kyrgyzstan is much friendlier to water reforms than those in other Central Asian countries (Gunchinmaa et al. forthcoming). However, this research showed that WUAs along AAC of Kyrgyzstan have to improve their irrigation services in order to become sustainable water management units.

While WUAs are given, sole control on irrigation water at the on-farm level one of the limiting issues of effective irrigation services is outdated irrigation infrastructure (DFID.2003). After the agricultural reforms (i.e. land re-distribution), the irrigation infrastructure did not match requirements of the new farming set up. It was built in Soviet times to serve large collective farms with only a few outlets and tertiary canals.

The analysis of water supply, crop yields and water productivities indicate that, overall, water supply rates have generally declined over the study years. In study WUAs, there is a huge potential to improve water productivities, at least up to the levels of canal Sokolok. The major reason of high water productivities in Sokolok-1 canal is more organized and time based water distribution.

A striking finding is that the higher the water productivities in WUA the better are the rates of FSS and ISF. Therefore, the implication of this to WUAs with financial problems is that they should reduce unnecessary water withdrawals from canal (AAC), reduce their losses within on-farm level and grow higher value crops, or produce more. However, water charges do not need to be the only source of finance. WUAs could develop other sources of revenue such as renting out mechanics, levying fishing charges or the providing other agricultural services (Mott MacDonald 2003).

The improvement of irrigation service performance and water productivity within the study WUAs could be largely due to the interventions of international agencies. The World Bank has financed rehabilitation of irrigation infrastructure in two WUAs along AAC. IWRM FV project have initiated some good steps on improving irrigation services, such as activation of WUA councils, introduction of time based water distribution and formation of water users groups. These attempts and coordinated state efforts on WUA support through creating supportive legal and institutional environment may result in improvement of irrigation services in Kyrgyzstan soon.

Most of the Central Asian countries started irrigation sector reforms in the late 1990 has and still have to reach their goal – to improve irrigation water provision to the farming units organized instead of large collective farms. Therefore, the Kyrgyz experience on WUA development could be very good example.

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