



INTEGRATED WATER RESOURCES MANAGEMENT IN FERGHANA VALLEY

HANDBOOK on Implementing a Time-Based Water Distribution

(for WUA hydro-technicians in Central Asia with examples from the Sokolok Distributory off the Aravan-Akbura Main Canal in Osh Province, Kyrgyzstan)

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C O N T E N T

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FOREWORD

Independent states in Central Asia following the collapse of the Soviet Union have been continuously undergoing major economic reforms including those in agriculture and land distribution. This has led to the emergence of numerous smallholder farmers, thus, putting water allocation and distribution at the on-farm level under an immense stress due to poor equity, adequacy, reliability and timeliness in water supply. With water distribution practices for the previously on-farm canals lacking due clarity and systematic approach, conflicts among water users over discharges, timing and stability have become common.

With transition from administrative boundaries-based towards integrated water resources management (IWRM) gaining more momentum in Central Asian states, irrigation management at the secondary and tertiary levels is being or will be handed over to immediate water user communities through setting up their own water user associations (WUAs), which are widely recognized as an effective solution to water allocation and distribution at the on-farm level. However, it is not only the WUA establishment that makes things different but rather building the capacities of such WUAs and water user groups at large to tackle the problems faced on their own through truly user-driven collective action and adoption of simple and effective practices in managing their water. So it is very important to equip WUAs and water users at large with right and simple tools and methodologies that would enable them to considerably improve the situation and overcome the unclearness and chaos in their current sporadic practices.

With all this mind this handbook provides step-by-step guidelines for adopting one of such simple methods to efficiently mitigate those tensions and stresses through organizing and implementing a rotational water distribution system among farmers and watercourses based on time allocations and is meant for using by WUAs, farmer communities, village neighborhoods, other informal water user groups at large, water management trainers, volunteers etc.

WHY A TIME-BASED WATER DISTRIBUTION?

Implementation of water use plans at the on-farm level based on water demands (crop water requirements) and the proportionate allotment of actual water available requires precise water measurements at each farm gate. But given huge numbers of farmers and their field turnouts within one watercourse this becomes an incredibly hard task. On average every such watercourse may consist of 10 to 100 turnouts, so measuring water at each one of them would require quite a number of workforce and water measuring devices to employ. In some places people lacking good water allocation principles do try to find some home-made solutions, but all such efforts lack clarity, elaboration and systematic approach.

In overall the history of private farming in the post-Soviet Central Asia is still fairly young with the first such farms having emerged only in the 1990’s. Given the long years of farming under collective system when all inputs including water were provided centrally, local water users have hardly grown into position to find out any elaborate and systematic ways for equitable water allocation themselves. Nevertheless, some places have seen water users to have started introducing water turns among themselves. But even so, the time for each outlet would be then determined rather by sheer guesstimate with water rotation schedules being time and again violated and the farmers wasting most of their time for disputing about water.

WHAT IS A TIME-BASED WATER DISTRIBUTION?

A time-based water allocation is, basically, a method for water rotation that sticks to and builds up on the conventional wisdom of water users to fairly distribute water among the entire community. Similar principles can be found in many countries of the world including those in Central Asia. Methods such as *avron, navbat, shel-ji, and warabandi* to name a few have been widely in use in the region since long time with all of them meaning literally the same - "*setting turns*". Thus building up on the very same principles the proposed method provides an elaborate and systemized way to ensure equitable distribution of available irrigation water by fixing turns among farmers in a time roster which specifies the day, time and period of irrigation for each and every irrigator in a given hydraulic unit. It provides a system for continuous rotation of water where one complete cycle normally lasts 7 to 10 days (in fact, it can be designed and adjusted to any number of days as the case may be). The duration of water supply is proportionate to the size of a farmer's landholding within the watercourse command area. Besides, water users can also be allocated some extra time to compensate for conveyance time losses. However, no allowances are normally made for seepage losses, if any, along the watercourse in order to encourage farmers to properly maintain their watercourses and thus minimize the losses.

The time-based rotational water distribution is designed with a particular cropping pattern and cropping intensity in mind. However, during water distribution it doesn't really matter what the actual cropping pattern is for a given season. So it is up to the farmer to decide which crop and what area to plant, and how to irrigate each time the turn comes. In fact, when water supply is reliable a farmer will irrigate as maximum area as practically possible to maximize the returns to land and water. On the other hand, if water is unreliable the farmer will try to maximize his/her per area unit yields by concentrating available water to a smaller area. To match water supply to the demand under time-based water rotation, it is the period of instant irrigation that matters and is changed in proportion to the irrigated area size.

The proposed method can be applied to both, water-stressed and water-abundant canal command areas. It is basically meant to ensure and keep the protocol of water distribution as simple as possible, which would be understood and accepted both by water users and WUA staff.

The time-based water distribution method does not mean at all that once adopted water will not be measured and registered. Moreover, once installed under the new system the piped outlet structures having fixed diameter make the whole water accounting procedure even easier. If following a water delivery schedule, canal water is to be delivered at the same time to several off-takes, then the outlet structures can be properly calibrated and simple graphs relating different water levels in the piped outlet (Z, in *mm*) to corresponding outlet discharges (Q, *l/sec*) plotted for each such off-take (Figure 1). Such Z-Q graphs then can be used for registering water discharges by measuring water depths inside the piped outlet structure.

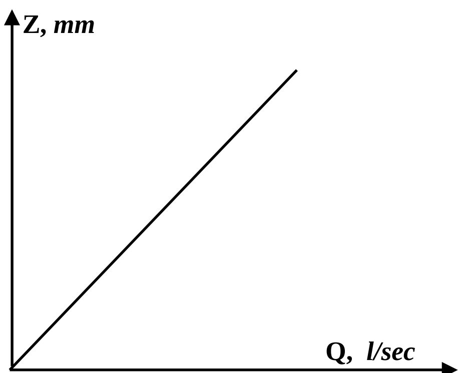


Figure 1. Z-Q relationship curve to determine watercourse discharges

However, under the time-based system it is normally only one canal off-take at a time that receives water for a specified duration, which makes water registration a very easy exercise. In this case the head discharge of the canal goes entirely to one outlet. By knowing the delivery efficiency of the canal one can easily calculate the outlet discharge.

The time-based water distribution method is applicable in different topographies. It is equally effective in both undulated and highly sloppy areas as well as plains. Just few extra water regulation structures (gates) might be helpful to ensure stable water discharges in the head of canals wherever there is a problem.

The proposed method can well be also integrated with advanced irrigation technologies in use such as drip irrigation, sprinklers, LEPA, etc.

In the irrigated areas, where return flows (drainage, waste water etc.) are widely used, the application of time-based water distribution will require that such waters are taken into account on a regular basis when scheduling water deliveries.

PRE-REQUISITES FOR A TIME-BASED WATER ROTATION

Application of time-based water rotation requires some pre-requisites put in place. Among major ones is availability of proper fixed turnout structures and stable water discharge in the canal, constant water level in the watercourse and reduced seepage losses.

When planning the time-based water distribution and the duration of water turns some important features of irrigation in Central Asia should be taken into account, particularly crop water requirements which serve the basis for planning water allocation in the region. It is worth also noting that tertiary canals in Central Asia have fairly unstable flow rates over time, which, being very difficult to manage, is seen as a major obstacle to apply the new method. Among the remedies to mitigate the impact of discharge fluctuations on water distribution schedules can be building simple water regulation structures and/or a small pond in the head of a tertiary canal. The pond can be as small as 3 m x 2 m x 1.5 m preferably located lower than the irrigated fields. It will serve to reduce fluctuations in the water level of canals during irrigation rather than to ensure there are sufficient water supplies kept in reserve.

CASE BOX 1: Sokolok Canal, Kyrgyz WUA 'Japalak'

Study area and water distribution before testing

The study tertiary canal "Sokolok" was selected within WUA "Japalak" in the Aravan-Akbura main canal (AAC) command area. AAC is one of the three pilot canals under the IWRM-Fergana project.

The climate of the area is continental with hot summers of up to 40-45^{o}C and cold winters of up to -15-20^{o}C. The annual precipitation averaging to 350-400 mm mainly occurs in winter season (December-March). Canal *Sokolok* is fed by the main Aravan-Akbura canal and located in the central part of Water User Association "Japalak". The canal command area is 290 ha with the length of the canal being around 6 km. The capacity at the head is 250 l/sec. However, in the year 2003 the maximum allowance for Sokolok canal was 126 l/sec or 50% of the canal's full capacity. The total number of registered farmer water users within the command area was 131, including small backyard gardens served by 14 watercourses

According to the WUA documents, since 1996 the irrigation water had been distributed based on water use plans. However, there had been no measuring devices or regulation structures whatsoever which would enable proper water distribution as per the water use plans. No measuring devices were available at the watercourse level and the actual water distribution along the canal was not recorded on a daily basis. The water use plans used to be prepared for the tertiary canals only with no any such plans made for the watercourse level, so water among watercourses was distributed against users' requests. Each user would submit a verbal request 3 days prior to irrigation to the Mirab (canal master), who would register all the requests and then start releasing water. However, due to a large number of such requests at any particular time, and duration, the Mirab was not able to set up the right order. As a result, almost all turnouts were open with water constantly flowing onto the fields. Small fields would be filled quickly with the extra water disposed of down the drain, whereas bigger plots would never be filled in full during irrigation.

Another frequent problem with local tertiary canals that may severely hinder proper water distribution between the farmers of one tertiary canal is high seepage losses. Such losses can be for several reasons including: a) type of soil (e.g. the watercourse channel flows through highly permeable sandy soils), b) the bed level of a canal being higher than the soil surface level, c) improper O&M of the canal. So it is very important to tackle this problem before going to the proposed method. One of the possible and cheapest ways to tackle this problem can be lining the watercourse bed with locally made polyethylene film. Experience suggests that such film when applied will serve 3 to 6 months and cost less than US$ 0.01 per meter of the canal length, while effectively reducing water losses by up to 70%!

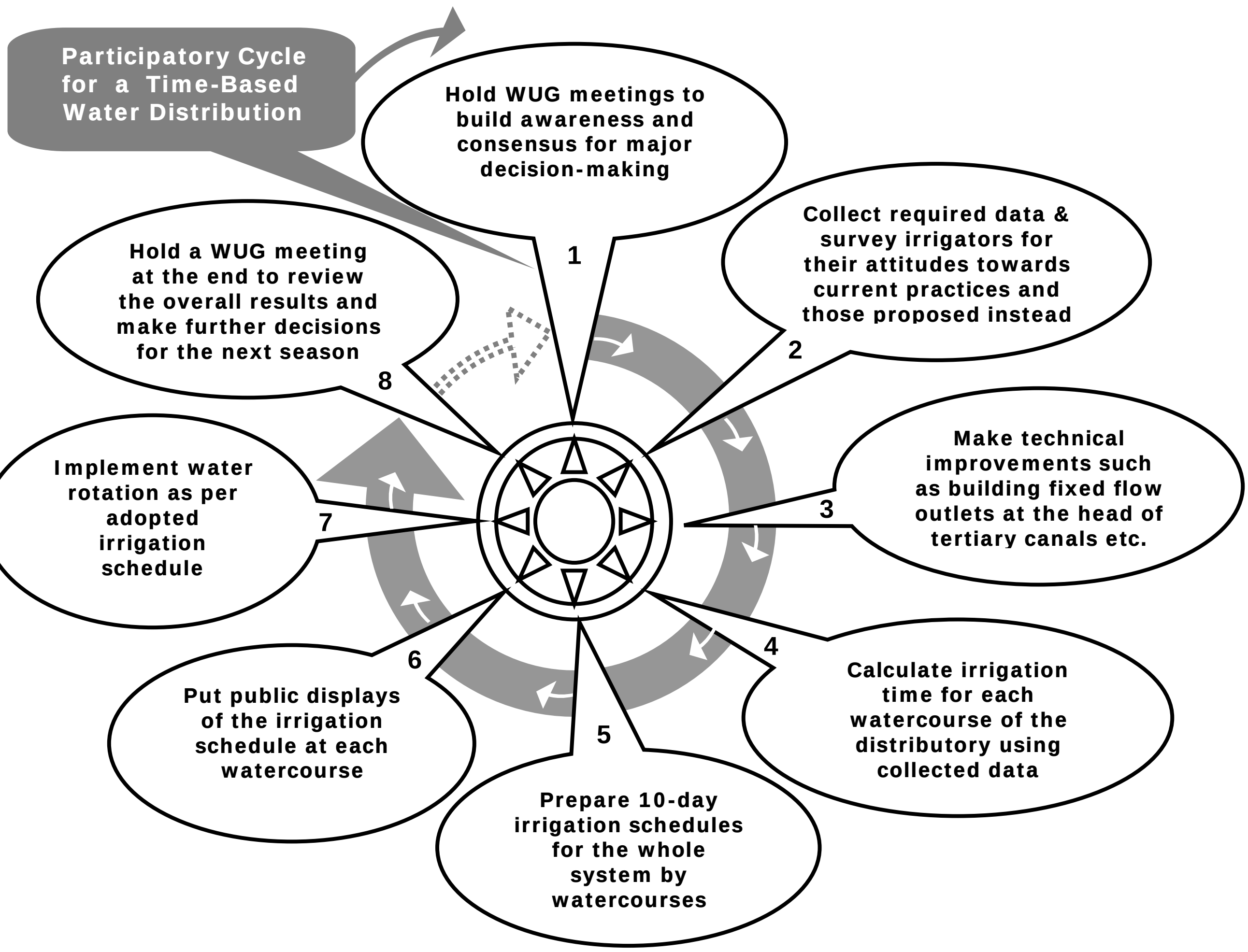
Therefore, to be properly applied at the tertiary level the new method requires the following major organizational and technical arrangements put in place:

- Close consultation with and agreement of water users and their full involvement in all stages of irrigation water planning, management and distribution. When preparing or changing irrigation schedules water users should be regularly informed and consulted with through regular meetings, announcement boards etc.
- Technical conditions of tertiary canals in Central Asia such as high fluctuations in water discharges within the day, seepage losses or improper turnout structures must be fixed before going to time-based water rotation.

STEPS FOR IMPLEMENTING A TIME-BASED WATER DISTRIBUTION

Before launched the time-based water distribution needs to be properly planned and prepared. Usually it will require from a WUA or WUG, first, to hire, allocate, select or volunteer somebody, normally *mirabs* (water masters) to do the job, who in addition to their conventional water distribution experiences would have the required skills and good understanding of the newly proposed methodology, for it is them who will start taking all the required steps such as building required public awareness and consensus among all farmers, mobilizing their support, collecting baseline information, providing guidance and facilitation for any technical improvements needed in the watercourse and finally implementing water rotation in a most participatory way. Therefore, once identified those water masters should further proceed through the full cycle of events as follows:

Figure 2. Participatory cycle of adopting and implementing a time-based water distribution



STEP 1: Analyze problems, build awareness and consensus, mobilize support and resources

Normally it will take one or two initial problem analysis and consensus meetings with water users to be held by *mirabs* (water masters) by each watercourse/WUG concerned in order to identify and analyze existing water distribution problems, build required awareness and consensus among farmers about the new method proposed, secure their understanding, support and consent. The latter is especially important because to be implemented the new method quite often will require from water users some certain commitments on additional labor and cash contributions. For instance, if all farmers have agreed to adopt the new method, they might be required to more thoroughly clean their canals to improve the capacity and reduce the filling time. So to win farmers support and understanding it would be helpful during these consensus meetings to find out, first, all weaknesses with current practices, how the proposed new method can help to solve them as well as explain the need for collective action in order to succeed and any additional costs involved. For example, the new method in question might also require for fixed outlet structures to be built in the head of watercourses. For it is commonplace to dig off-take structures manually for each irrigation thus resulting in destroyed canal banks, sediment-stricken outlets, unreliable and immeasurable water distribution. There might be many different options of such fixed outlets. So it is the ultimate water users who will need to be consulted on the design and the cost. Possible options for such fixed outlets range from expensive ones such as gate structures with flexible discharge rates (0 to maximum) available at about $180 each or outlets as applied in Pakistan at about $130 per each to much cheaper options such as a pipe structure with an open-closed sealing lid (as designed and constructed by the Karasu-Ayil-Qurilish Construction Company from Osh, Kyrgyzstan, Figure 6). The sealing iron lid of the outlet is insulated with rubber to eliminate and minimize leakages. Such an outlet will full open when it is somebody's turn or, otherwise, be full closed according to the water rotation schedule. In order to avoid unauthorized water withdrawals it will be better if such an outlet structure be cast into concrete frame to make the manual digging of a new outlet completely impossible.

The diameter for such an outlet if chosen could be determined using the following formula:

$$D_i = f\,(Q_{max},\ T_{min})$$

Where: D_i - diameter of the fixed outlet, in *mm*
Q_{max} - maximum discharge for the watercourse "*i*" as per water use plan, in *l/sec*
T_{min} - minimum time allocated for watercourse "*i*" as per water rotation schedule, *sec*

The $D_i = f\ (Q_{max},\ T_{min})$ function can be plotted based on field trials. The maximum discharges for particular canal off-takes can be taken either from a water use plan for this canal or as equal to the maximum discharge in the head of the canal (tertiary). Using Figure 1, water depth (Z) is selected to match maximum discharges (Q) which then can be translated into D_i (diameter of pipe) as the Z versus D_i relationship. The Z-D_i relationship graph can be also plotted through field trials. As for the piped outlet structures of less than 75 mm in the diameter, D_i can be determined by formula $D_i = Lp/50$, where L*p* is the length of the pipe.

As for the costs, to produce one such outlet with sealing lid (without pipe structure) will cost about $25, while a concrete pipe for it - $2 per 1 meter. So in total the complete outlet with 5-meter concrete pipe, manufactured locally will cost to water users in the vicinity of $35-40 each. Given that all water users will share in the costs it should not be too much of a burden on the farmers.

It is strongly advised for mirabs during the initial meeting to find out and analyze farmers' attitudes, perceptions and the pertinent reasons with regard to existing and proposed water distribution methods. This will help identify and properly address, while planning, major concerns expressed by water users

So once the WUG meeting decides to go for the new method any additional costs in labor and cash to be shared by all water users concerned should be calculated. Then it will take only to collect the required funds to additionally order whatever is missing in materials, structures and any services, decide who will do installation, and/or plan and organize labor contributions for cleaning canals as the case may be.

CASE BOX 2: Sokolok Canal, Kyrgyz WUA 'Japalak'

Selecting the outlet diameter

Watercourse No		Diameter, mm
1, 3, 12	-	200
2, 5-11, 14	-	300
4, 13	-	400

The biggest diameter of the pipe outlet was 400 mm installed at two watercourses, while the smallest one of 200 mm was installed at another 2 watercourses with all the rest outlets being 300 mm in the diameter.

Sealing iron lids of the outlets were insulated with rubber to eliminate and minimize the leakages. The tests showed no leakages in 11 outlets out of 14 and minimum leakages in the remaining 3 outlets.

The new outlets installed would get full open or full closed in line with an irrigation time schedule. To avoid unauthorized water withdrawals the outlet structures were cast into concrete frames, which made the digging of new off-takes impossible.

In order to reduce the costs of up-scaling the method locally the Karasu-Ail-Qurilish Construction Company manufactured the outlet moulds of 4 different sizes. Owing to this the making of an additional new outlet with sealing lid (except pipe) cost only $25. As for concrete pipes they also could be produced locally at $2 per meter. Thus the total cost that water users paid to produce one such complete outlet structure with 5-meter concrete pipe amounted to about $35

STEP 2: Collecting canal-specific data and surveying water users

After everybody in the water user group is aware and convinced in the benefits of the new method and by a consensus makes decision to go for it, the mirab(-s) selected and/or authorized by the group should collect required technical data on the distributary and watercourse canals scheduled for water rotation to start the planning process. This can be normally done during the same meeting once consensus is reached or later if so decided by a majority of the water users. The information required will include the following data:

1. Technical information on each watercourse (command area, length, technical conditions, any hydraulic and flow control structures, number of water users);
2. Cropping pattern for a particular vegetative or non-vegetative season;
3. Water use plan for a particular vegetative or non-vegetative season;
4. Long-term averages for water discharges and volumes (for not less than 3 years)
5. Technical characteristics of distributary canal system (length, technical conditions, any hydraulic and flow control structures)

Some of the above information the mirab can obtain from the water use plan for impending season while some will require asking water users directly.

STEP 3: Making technical improvements

Following the decisions made at the consensus meeting about additional construction, cash or labor requirements if any, after the agreed funds collected or obtained and required construction materials and structures purchased they have to be properly installed either by themselves or a contractor. So earlier agreed labor contributions should be mobilized or a third party contracted to do this. Also if any commitments were made as to cleaning the canals, the water users should deliver such cleaning as was agreed.

CASE BOX 3: Sokolok Canal, WUA 'Japalak'

Technical Improvements: Fixing the Outlets

The fixing of regulated outlets was step to improve water distribution in the "Sokolok" canal. Previously, there were no permanent outlet structures previously, so the water users had to manually make the outlets for each irrigation. This normally resulted in destroyed canal banks, sediment build-up in the outlets, unreliable and immeasurable water distribution. Thus, to start distributing water based on time allocations required that the fixed outlet structures be put in place.

During consultations water users were presented 3 options of the outlet structures: gate-like structures with flexible discharge rates (0 to maximum), warabandi-type outlet structures as applied in Pakistan and, finally, pipe outlet structures, with sealing lid (open-closed). The 1st option was rejected by the water users for two reasons: high cost ($175/each) and possible leakages under the gate. The second option was perceived as very complicated. Thus a majority of water users voted for the third option ($129/each). Potential manufacturers were invited for bidding. The winner design for the pipe outlet was the one made by "Karasu-Ail-Qurilish" Construction Company from Osh, Kyrgyzstan .

STEP 4: Calculating irrigation time: transformation of water amounts

There are several methods allowing the transformation of water amounts to be delivered to an off-take with each of them representing an option for calculating the irrigation time:

1. *Calculation of irrigation time, based on the size of the command area of an off-take*. Under this approach the irrigation time for each off-take is calculated using this formula:

$$T_{irr\,(i,\,j)} = K_{outlet} * 240 \text{ hours} \quad (1a)$$

where: $T_{irr\,(i)}$ – irrigation time period for the watercourse "*i*" in the *j-th* decade, in *hours;*
K_{outlet} - coefficient of land size (command area of the canal)
240 hours- total hours within a 10-day period

The land size coefficient can be calculated using the following formula:

$$K_{outlet} = w_{outlet\,I} / w_{canal} \quad (2a)$$

where: $w_{outlet\,I}$ – command area of the outlet "I" , in *ha*
w_{canal} - total command area of the canal , in *ha*

2. *Calculation of irrigation time based on water use plans (cropping pattern, size of command area).* The irrigation time period for each watercourse canal using this method is calculated based on water use plan data and other canal-specific technical information collected, using the following formula:

$$T_{irr\,(i,\,j)} = V_{irdecade\,(i,\,j)} / Q_i * 3.6 \quad (1b)$$

where: $T_{irr\,(i)}$ – irrigation time period for the outlet (watercourse) "*i*" in the *j-th* decade, in *hours;*
$V_{irdecade\,(i)}$ – water volume required for the outlet "*i*" in the *j-th* decade, in m^3
Q_j – *planned head* discharge for the tertiary canal in the "j" *decade*, in *l/sec*
3.6 - coefficient to convert *l/sec* into m^3/h

CASE BOX 4: Sokolok Canal, WUA 'Japalak' **Water distribution principle: demand-based vs. time-based**

Since mid-1960's water distribution in Central Asia was based on water use plans prepared with regard to specific applicable norms and standards. Water requirements for each specific crop once tested and approved were issued and used as a normative when preparing irrigation service plans. Since at that time there were mainly huge collective farms in agriculture predominantly specializing in monoculture farming this approach was justified. With water requirements for the most farms relating to one crop grown (predominantly cotton), such normative irrigation could well replace any alternative water distribution approaches such as a time-based water distribution.

Research community and water managers in Central Asia are still pretty much in favor of the crop water requirements-based approach in water distribution. There are good reasons for this. The three largest cotton growing countries in Central Asia - Uzbekistan, Tajikistan and Turkmenistan - are still trying to stick to this major cash crop in agriculture relying mostly on large size farming units. Even in the most reformed countries of the region such Kyrgyzstan and Kazakhstan cotton is a prevailing crop. In this situation the crop water requirements-based principle in water distribution is a way to secure high crop yields. In contrast, under a time-based irrigation the farmer receives water not according to crop requirements, but based on a fixed time. Such ignorance of crop water requirements in this case might result in crop productivity losses. However, the crop water requirements-based principle when applied requires some tools to be put in place for controlling the norm compliance. One of the options to control might be introducing a water measuring system (instruments and monitoring) at all levels of water use:

Collect information on cropping pattern 1 → Prepare water use plans 2 → Install water measuring devices 3 → Measure water depth 2-3 times 4 → Translate water depth (cm or m) to water discharge (l/sec or m3/sec) 5 → Compare the measured discharge to water use plan 6

Survey of water users conducted in the Sokolok canal helped to more clearly formulate the principles of water distribution for the tertiary canal level. Such principles should care for the type of crop crown, irrigated area and also be simple (such as based on time). The principle for water distribution in case of the pilot canal in question as suggested was water-right-equals-time-for-irrigation. To address water users' concerns about the type of crops grown, information on cropping patterns and irrigated areas was included for collection at the first stage of planning water distribution with the water use plans prepared at the second stage:

Collect information on cropping patterns and areas 1 → Prepar e water use plans 2 → Translate water volumes into time 3 → Prepare irrigation schedules and monitor the time-compliance of Irrigation turns 4 → Compare estimated and actually measured (observed) time 5

CASE BOX 5: Sokolok Canal, WUA 'Japalak': **Calculating irrigation time for a watercourse of the tertiary canal**

Method #1 (area-based)

What will be the duration of water delivery in the 2nd 10-day period of April for a tertiary canal off-take of 100 ha in the command area, if the total command area of the canal is 560 ha?

$w_{outlet\ I}$ – *command area of the off-take = 100 ha*

w_{canal} - *total command area of the canal =560 ha*

1. Calculation of the land size coefficient: $K_{outlet} = w_{outlet\ I} / w_{canal} = 100\ ha/560\ ha = 0.18$

2. Calculation of the water delivery duration: $T_{irr\ (i,\ j)} = K_{outlet} * 240\ hours = 0.18 * 240\ hours = 43{,}2\ hours$

Answer: For an off-take of 100 ha in the command area , the water delivery duration in the 2nd 10-day period in April will be 43 hours

Method # 2 (cropping-based)

If for the 2nd decade of April a watercourse of a tertiary canal expected 1400 m3 of water then what will be irrigation time period (Twc)? The head discharge of the tertiary canal for the 2nd decade in April was planned at 40 l/sec while the one actually measured on April 9 turned out to be 37 l/sec.

$V_{irdecade\ (i,\ j)} = 1400\ m3$

$Q_j = 40\ l/sec$

$Qfact_j = 37\ l/sec$

1. Calculation of irrigation time period: $T_{irr\ (i,\ j)} = V_{irdecade\ (i,\ j)} / Q_i * 3.6 = 1400/40*3.6 = 9.7\ hours$

2. Calculation of adjustment coefficient: $K_{(i,\ j)} = Q_j / Qfact_j = 37 l/sec/40 l/sec = 0.925$

3. Actual irrigation time for the watercourse for the 2nd decade in April: $T_{wc} = T_{irr\ (i,\ j)} * K = 9.7*0.925 = 8.97\ hours\ or\ 9\ hours$

Answer: For the watercourse in question of the tertiary canal , the irrigation time period for the 2nd decade in April will be 9 hours

The formula (1) above helps calculate the irrigation time period required for each watercourse. However, it is the actual discharge in the canal that will finally determine if there is enough water to deliver to each outlet according to the estimated irrigation time period:

$$K_{(i,\,j)} = Q_{factj} \,/\, Q_j \qquad (2b)$$

Where, K is adjustment coefficient, and

Q_j - planned head discharge for the tertiary canal in "j-th" decade, *l/sec*

$Q_{fact\ j}$ - actual head discharge for the tertiary canal in the "j-th" decade, *l/sec*

So the actual irrigation time for each watercourse concerned will be adjusted as follows:

$$T_{wc} = T_{irr\,(i,\,j)} * K_{(i,\,j)} \qquad (3b)$$

Where, T_{wc} – adjusted irrigation time period for the watercourse "i", *in hours*

Thus the irrigation time period for each watercourse of the distributary canal is calculated using water use plan data and formulas (1b), (2b) and (3b) as above and once calculated can be set out for all watercourses concerned in the following format.

Table 1. Estimated irrigation time period for individual watercourses of a distributory

№	Watercourse	Irrigated area, Ha	Parameters	April			May			June			July		
				1			2			3			4		
1.	Sokolok	3.32	Discharge, *l/sec*	1.6	1.6	1.3	1.2	2	3	1	2	3	1	2	3
			Volume, m^3 ($V_{irdecade\,(i,\,j)}$)	1.4	1.4	1.1	1.0	1	1.4	1.0	1.0	0.3	0	0	0
			WC irrigation time period, *hrs* (T_{wc})	4	4	3	3	1	1.4	0.9	0.9	0.2	0	0	0

STEP 5: Preparation of 10-day irrigation schedules for entire distributary system and coordination with irrigators

After irrigation time for each watercourse in the distributory has been calculated on a decade-by-decade basis for the entire vegetative season a detailed consolidated irrigation schedule for each decade (10 days) for the whole distributory by individual watercourse canals is made using $T_{irr\,(i,\,j)}$ if based on Method 1 or T_{wc} if based on Method 2 (Table 2).

A survey of water users earlier advised as one of the initial actions to find out farmers satisfaction, attitudes and perceptions with regard to existing and proposed water distribution practices can be a good help in making such a schedule more effective and widely accepted. For example, knowing from where water distribution normally starts along the canal under the existing system can help in making the adoption of the proposed new water distribution principles based on time allocations more consistent and compliant with the previous practices thus reducing pressures on farmers because of new changes. For instance, if before irrigation

CASE BOX 6: Irrigation Schedule for Sokolok Canal in the 1st Decade of April

№	Watercourse Name	1.04	2.04	3.04	4.04	5.04	6.04	7.04	8.04	9.04	10.04
1	Sokolok	00-04									
2	Azamat	04-17									
3	Teke-1	17-20									
4	Teke-2	20-00	00-01								
5	Teke-3		01-00	00-09							
6	Teke-4			09-14							
7	Zelenstroy			14-00	00-00	00-12					
8	Private Farms					12-00					
9	Private farms						00-12				
10	Toloykon						12-00	00-06			
11	Adileit							06-00	00-13		
12	Private farms								13-00	00-07	
13	Private farms									07-10	
14	Backyard plots									10-11	

would normally start from the head of the canal following the same routine under new system will help minimize unwanted complications.

When prepared the irrigation schedule should be discussed at length with water user representatives. For this a consultation meeting is called inviting representatives from all watercourses concerned. During the meeting the proposed irrigation schedule is presented in much detail inviting feedback from all water user representatives. Opinions, interests and concerns of each water user group should be carefully listened to and accommodated as best as possible. The discussions might lead to some changes in the irrigation schedule. For example, water users from small watercourses might be unhappy with shorter duration times allotted to them. To avoid any complications when implementing irrigations it is strongly advised that the schedule be adopted with as much consensus as possible. The approved irrigation schedule will have the following final format:

Table 2. A sample 10-day irrigation schedule by individual watercourses from ___ to ___, 200_

WC No	Time	1-10 April, 2004									
		1	2	3	4	5	6	7	8	9	10
WC #1	Planned	from 00 am	to 09 am								
	Actual	from 09 am	to 09 pm								
WC #2	Planned			from 03 am	to 04 am						
	Actual			from 09 pm	to 10 pm						

STEP 6: Communicating the adopted irrigation schedule to the farmers concerned

After the irrigation schedule is approved and adopted it should be communicated and publicized among all water users in the command area. A good idea would be to place at the head of each watercourse a kind of display with the approved schedule. Such a display can be made locally without much of an expense ($1.5- $2 for must be enough). The displays will be a good reminder for all irrigators about who, when and for how long will receive water at each particular time.

Figure 3. An irrigation schedule display put at the head of watercourses in WUA "Zhapalak"

STEP 7: Implementing water rotation as per adopted irrigation schedule

Once everything is ready as described above the time-based rotational water distribution is ready for practical implementation.

While preparing and implementing the water rotation schedule the following issues should be taken care of:

- Whether water users, especially those growing water sensitive crops will be able to receive their water turns;
- Farmers must have all their land preparation and other related agronomic operations completed before their scheduled irrigation turns not to disrupt the water schedule;
- For the crops with short inter-irrigation period (highly sensitive to water stress) the water delivery schedules should take care of the required frequency of irrigations. The calculated irrigation time (T_{irr}) for such crops must be split into 3 equal parts and scheduled accordingly, so that the off-takes where such crops are prevailingly grown could be delivered water 3 times during a particular 10-day period. As another alternative to such an approach, the off-takes where high water stress sensitive crops (such as vegetables).are grown can be provided with continuous water flow (by keeping the outlet gates always open);
- The irrigation schedule of every next 10-day period should be based on the outcomes of the previous 10 days. If an off-take has not completed its irrigation turn in the last 10-day period it should continue receiving water also in the subsequent 10 days.
- Given different sizes of the command areas of the canal off-takes and the head discharge of the canal being more than 100 l/sec, two off-takes can be delivered water simultaneously.

STEP 8: Holding a review meeting in the end of vegetative season

A good idea for completing the whole implementation cycle and refining it for the next season will be finally holding a WUG meeting to review the overall results at the end of the season and see to which extent the method met the expectations and whether it is worth continuing further the practice.

CONCLUSIONS AND RECOMMENDATIONS

The time-based water distribution as pilot-tested at the tertiary canal "Sokolok" has provided a reliable solution as to how water can be distributed in a more transparent and equitable manner in order to fill the current institutional vacuum at the on-farm system level. The new method has clearly indicated the following benefits to the water users:

(a) The time spent by water users for getting their turns and irrigating decreases several times resulting in considerable time savings;

(b) Actual per-unit-of-area water supply by watercourses becomes more balanced and uniform showing more equity among watercourses, especially for those in the tail reaches;

(c) Water fee collection improves due to a greater satisfaction by water users, especially those in the middle and tail;

(d) Crop yields increase in most watercourses, especially those in the middle and tail reaches;

(e) Net incomes of the tail-enders increase; and

(f) The overall number of disputes about irrigation turns declines, though those about water volumes increase due to less privileges in water supply enjoyed by the upstream water users.

Despite having clear advantages over the past practices of opaqueness, unclarity and chaos, the time-based water distribution requires certain preconditions to be put in place, including:

- ✓ a strong will and felt need for collective action at the grass-roots level;
- ✓ low-cost, small-scale and user-friendly technical improvements in the infrastructure, e.g. installation of water measuring devices and flow regulation structures; and
- ✓ availability of technical guidance, support, and facilitation from an external or internal agent of change.

Thus, this method can be most beneficial for the areas where water user associations or groups have been formed, formally or informally, and are active. It can be also implemented in the areas where there is an extreme shortage of water, such as in the delta of the Aral Sea in Karakalpakstan, Khorazm or any other irrigated areas, where too many water users present make the on-farm water distribution an extremely difficult task.

CASE BOX 7: Sokolok Canal, Kyrgyz WUA 'Japalak'

Impact from changes in water distribution

5 major criteria were used to assess the impacts of the new water distribution method. The 1st criterion was time spent by water users to receive their irrigation turn. This criterion shows how much time is saved for water users due to better water distribution. This was analyzed by surveying 131 water users before and after the new method was implemented.

The second criterion was change in per-hectare water amounts supplied by watercourses. The amount of water supplied is a very good indication for equity of water distributed. This was calculated based on data collected by WUA mirabs for the 2002 and 2003 vegetative seasons.

The third criterion was changes in crop yields and incomes by watercourses. The main crop analyzed for the purpose was wheat. In Central Asia wheat normally needs 2 irrigations before harvested. These 2 irrigations are very crucial in achieving the high yields.

The fourth criterion was water fee collection by different watercourses of the canal in 2002 and 2003. The willingness of water users to pay for services greatly depends on the reliability of water supply. Since no extra measures were taken by the WUA management to improve water fee collection, most changes were expected to take place from any changes in water distribution efficiency.

Application of a time-based rotational water distribution in the "Sokolok" Distributory has revealed the following changes occurred in water use, agricultural practices and water users:

- The time spent by water users for catching their turn and irrigating decreased several times resulting in considerable time savings;
- Actual per-hectare rates for water supplied by watercourses became more balanced showing more equity among watercourses, especially for those in the tail reaches;
- Wheat yields in 2003 increased for those in the middle and tail-end watercourses due to better water supply and good climatic conditions
- With net incomes for those in the tail-end watercourses (except for watercourse 13) having improved, the average incomes in overall declined due to low prices in 2003 for wheat and corn at the domestic market
- Water fee collection dramatically improved for the watercourses 7 through 14 due to more reliable and fair water distribution
- The overall number of water disputes declined, though those about water volumes increased due to reduced water supply to the upstream watercourses.