Planning Water Use at the Level of WUAs - the Plan of Daily Water Use based on the Irrigation Schedule

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Hundreds and even thousands of private farms with an irrigated area ranging from 0.3 to 20 ha have replaced former collective farms and state farms under reforming the agricultural sector in Central Asian countries. In former large farms, irrigation water was delivered with constant flow rate since the beginning until the end of the growing season to the brigades having an area of 150 ha and more. During the irrigation season, an area serviced by one brigade was being subdivided into several irrigated units (irrigation maps). A foreman, after receiving water for irrigation, was distributing this water with constant flow rate to each irrigation map by turn.

At present, a lot of small farms that replaced former brigades in collective farms and state farms create considerable difficulties for organizing water distribution among new water users.

If a water use plan for continuous water delivery with an estimated flow rate to each water user having small irrigated plot will be developed then unproductive irrigation water losses and duration of water applications will be considerably increased due to small flow rates. But if a water use plan aimed at irrigation of former brigade's area will be developed then it will be complicated to specify to whom among numerous water users, when during the ten-day period and with what flow rate irrigation water should be delivered.

On the other hand, independently from sizes of their irrigated area, all water users hold an interest in receiving required irrigation water for each water application during a short time period (1 to 5 days). The existing irrigation network was however designed based on a specific water duty specified by the crop pattern (as a rule, for the rotation of cotton and alfalfa and irrigation intervals of 10 to 25 days).

Keeping in mind above-listed circumstances, it was proposed to use the daily planning of water distribution (within a ten-day periods during the growing season) to ensure uniform and equitable water distribution among water users within WUAs. This approach allows to reduce organizational irrigation water losses and to enhance the discipline of water use. Under shifting towards the daily planning of water distribution it is necessary:

- to specify who among water users will receive irrigation water by a continuous flow and who by a discontinuous flow based on the technical characteristics of the irrigation network within a WUA;
- to follow strictly the established irrigation schedule based on the crop water requirement zoning for a given irrigated area under planning terms and rates of irrigation water supply to water users;

A daily water use, as a rule, is planned for one large canal with a command area of 200 to 800 hectares within a WUA or for a few small canals with the total command area more than 200 hectares.

Procedure for arranging daily water use within a WUA: It is proposed to plan daily water use within a WUA in four successive steps.

Step 1: Gathering the information on crop patterns in the command areas of irrigation canals within a WUA

In the end of February, water users receiving irrigation water directly from irrigation canals within a WUA or leaders of water users groups *(see Step 3)* have to submit their data on crop pattern planned for the forthcoming growing season to the WUA's irrigation engineer.

Step 2: Specifying the type of water delivery to WUA's irrigation canals and off-takes of water users

According to carrying capacity of laterals and off-takes, water users can be referred to two types:

- water users receiving irrigation water by continuous flow; and
- water users receiving irrigation water in specified periods by discontinuous flow i.e. according to the water rotation schedule.

Sometimes water users associations do not possess any information on a maximum carrying capacity of their irrigation canals and water users' off-takes. Therefore, during the process of planning daily water delivery into water users' laterals (with continuous or discontinuous flow) it is advisable to specify the irrigated areas serviced by these laterals. In case of a relatively small irrigated area (1 to 50 hectares), concentrated discontinuous water delivery into water users' off-takes is advisable. But when an irrigated area exceeds 50 ha[1], water delivery should be provided with continuous flow.

In the future when WUAs will have the actual information on a carrying capacity of their irrigation canals and water users' off-takes it will be necessary:

- to specify the method of irrigation water delivery into canals and water users' off-takes (by continuous flow or by concentrated discontinuous flow); and
- to develop additional measures to enlarge the carrying capacity of laterals and water users' off-takes.

Step 3: Establishing WUGs on tertiary canals and their laterals

Following the previous provisions, it is practical to unite water users having an irrigated area less than 50 hectares into water users groups (WUGs) and to deliver irrigation water to their off-takes by concentrated discontinuous flow under organizing the water rotation among water users-members of these groups.

[1] 60 and more hectares can be accepted in newly constructed irrigated schemes

Step 4: Planning daily water use in the command area of WUA's irrigation canal

Under specifying daily irrigation water demand of water users, all calculations are based on the irrigation schedule. Water management organizations (BISA and Rayselvodhoz[2]) have the information on water users' irrigated farmlands belonging to specific crop water requirement zones and the recommended irrigation schedule as well.

Daily water use in the command area of WUAs irrigation canal is being planned in the following sequence:

1. At the beginning, daily irrigation water demand of water users receiving irrigation water by continuous flow[3] is being computed;

2. Daily irrigation water demand of water users receiving irrigation water by concentrated discontinuous flow is being computed;

3. In view of the fact that during the growing season, each water user grows two or three crops the irrigation schedules of which differ from each other not only by the number and rates of water applications but also irrigation intervals, daily irrigation water demand of water users should be computed for each crop. Therefore, groups of farmers who grow similar crops are formed within WUAs and WUGs.

4. Further, a period, during which irrigation water demand of water user can be met, is being computed under assuming that irrigation water by concentrated flow is delivered i.e. all water flow necessary for irrigating the first group of crops is directed into his off-take, and the sequence of irrigation water supplies to each farmer who irrigates a given crop is specified;

5. Then, estimated daily irrigation water demand of water users receiving irrigation water by continuous flow and concentrated discontinuous flow is consolidated into the summary table. Required daily flow rates in canals that deliver irrigated water to WUAs are calculated taking into consideration water delivery losses (a canal efficiency factor).

Seasonal and operational adjusting of the plan of daily water use

Seasonal adjusting of the plan of daily water use

A preliminary plan of daily water use in the command area of a WUA's canal for the forthcoming growing season is drafted in the end of February or in the beginning of March based on mean annual weather data. Seasonal adjusting of the plan of water use is made in March-April each year. A water management organization establishes the irrigation water use limits of WUAs for the growing season in accordance with water availability in the current year.

[2] District subdivision of the Ministry of Agriculture and Water Resources
[3] Irrigation water by continuous flow is delivered to off-takes of homestead plots or to water users having large irrigated plots

A WUA, being informed about irrigation water use limits, specifies a water availability factor using the following formula:

$$K_{\text{water availability}} = \frac{\textbf{Irrigation water limit for a WUA (000' m}^3\textbf{)}}{\textbf{Crop water requirement (000' m}^3\textbf{)}}$$

Updating of volumes and flow rates of daily irrigation water delivery to WUAs and water users established in the preliminary plan of daily water use and delivery is being fulfilled based on a water availability factor.

Operational adjusting of the plan of daily water use and providing the procedures for coordination of water resources management between a WUA and farmers as well as between a WUA and the SFC Administration

Actual terms of irrigation water delivery to water users can be changed depending on:

- Current water availability in a irrigation water source;
- Current meteorological parameters;
- Planting date;
- Crop growth at a given period of the growing season; and
- Progress in implementing land treatment etc.

Above-mentioned factors sometimes are the reason for adjusting the plan of daily water use. In addition, organizing the actual water distribution among water users should be implemented in accordance with their applications for irrigation water. At the same time, organizing of the first water application[4] or the first cycle of irrigation water delivery to water users in line with the water rotation schedule is especially important under distributing irrigation water among water users according to their applications.

Submitting an application for water by a farmer is evidence of his readiness to irrigate crops i.e. the following operations were executed prior to irrigation water delivery:

- His irrigation network was cleaned from weeds and sediments;
- Irrigation furrows were already made;
- An appropriate amount of necessary fertilizers is applied; and
- A sufficient number of irrigators are available.

[4] It can be implemented by supplying water to one farmer 3-4 days before a planned date of the first water application and on 3-4 days later to another farmer because such deviations insignificantly affect the crop growth, but further irrigations should more strictly meet the recommended irrigation schedule.

Operational adjusting of the plan of daily water use and providing the procedures for coordination of water resources management between a WUA and farmers as well as between a WUA and the WMO consist of three mandatory stages:

Stage 1: Collecting, registration and systematization of farmers' applications for irrigation water and scheduling daily water delivery into WUA's canals;

Stage 2: Submitting the WUA's summary application for irrigation water to the Irrigation System Administration (ISA) and receiving the ISA's notification about a possible water delivery according to a WUA's application for a forthcoming ten-day period taking into account forecasted water availability; and

Stage 3: Operational adjusting the schedule of daily water delivery into WUA's canals in accordance with the ISA's notification about a possible water delivery in a forthcoming ten-day period, and implementing the measures for using internal reserves with the purpose to improve water availability in a WUA.

Procedures for collecting, registration and systematization of farmers' applications for irrigation water and drafting and adjusting the schedules of daily water delivery into WUA's canals

A WUA's irrigation specialist takes applications filled by water users according to the special format. The following data are filled in the first part of application:

- A name of a private farm;
- An irrigated area;
- Crops to be irrigated; and
- An irrigated area under each crop.

The following data that should be specified and agreed by a water user and WUA's personnel are filled in the second part of application:

- A rate of water application for each crop, m3/ha;
- An agreed flow rate of irrigation water supply into a farmer's off-take, l/sec;
- Duration of irrigation water supply, hrs;
- The beginning and end of irrigation water supply (date and time).

A WUA's irrigation specialist has to register an application submitted by a water user in the registration book of applications for irrigation water supply. Further, based on registered applications for irrigation water supply, the irrigation specialist is scheduling the water distribution process among WUA's members, taking into consideration the following factors:

- Belonging of irrigated farmlands to specific crop water requirement zones;
- An irrigation schedule (duration and rates of water applications); and
- A carrying capacity of irrigation canals and off-takes of water users.

All these factors closely link each water user with others within WUA's irrigation system.

4 days before a forthcoming ten-day period, an irrigation specialist submits the WUA's summary application for irrigation water supplies to the WMO. In its turn, the WMO, after reviewing the applications and expected water availability, notifies a WUA about possible irrigation water supply in the forthcoming ten-day period. Along with the total irrigation water demand, the WUA's summary application for irrigation water supplies contains information on volumes of planned irrigation water supplies or water use limits to enable the WUA and WMO to monitor its adequacy to the planned indicators in a forthcoming ten-day period. Big main irrigation canals deliver water for irrigating a hundred and more of thousands of hectares. Volumes of water diversion into the main irrigation canals are established by higher water management organizations based on water availability in the water sources (reservoirs) by the beginning of a next ten-day period.

After receiving information on water volumes allocated to the given main irrigation canal, its administration calculates a water availability factor (relative to the plan or water use limit for a forthcoming ten-day period). Further, the CA specifies irrigation water volumes that can be allocated to WUAs based on water availability in the main canal and makes an appropriate record into the WUA's application.

After allocating irrigation water volumes to a WUA for a forthcoming ten-day period, its irrigation specialist calculates a water availability factor and adjusts the schedule of daily water distribution into irrigation canals within the WUA and makes appropriate modifications in the summary table of daily irrigation water distribution.

Monitoring water use within a WUA

Tabulated indicators of planned and actual irrigation water supplies to WUA's canals including the schedules of daily water distribution within WUGs need to be available for monitoring irrigation water allocation and use within a WUA. Monitoring water use in a WUA is carried out in two successive steps:

Step 1:

Analyzing actual irrigation water supply by the WMO into WUA's irrigation canals. At this stage the following tasks should be solved:

- Monitoring the implementation of irrigation water delivery relative to the water use limits established and plan:
  - ✓ Over a WUA as a whole;
  - ✓ Over the WUA's major irrigation canals.
- Evaluating the stability of irrigation water delivery to a WUA over a specific period;
- Calculating irrigation water supply by progressive total:
  - ✓ Over a WUA as a whole;
  - ✓ Over the WUA's irrigation canals.
- Evaluating the uniformity of irrigation water distribution between WUA's irrigation canals over a specific period;
- Calculating an efficiency factor of WUA's irrigation canals over a specific period;
- Specification of the water sources (a main canal, irrigation or drainage tubewells, collector-drains etc.) that provide the necessary volume of irrigation water supply over a WUA as a whole and its separate irrigation canals;
- Adjusting daily volumes of irrigation water distribution among water users.

Analysis of the factors of daily and ten-day period's irrigation water delivery into WUA's canals enables to evaluate the stability of irrigation water delivery to WUAs by the WMO relative to the plan/water use limits, applications and agreed volumes and flow rates of irrigation water supply. Actual irrigation water delivery by the WMO into WUA's irrigation canals ranging from 90 to 110% of the plan indicators over a specific period is considered as satisfactory and not affecting adversely crops [21].

Step 2:

Monitoring water distribution among water users within a WUA that allows solving the following tasks:

- Keeping track of implementing the plan, water use limit and applications for each WUA's canal;
- Monitoring the number and quality of water applications during the growing season;
- Monitoring the terms and rates of irrigation water supply for each water application during the growing season;
- Record keeping of planned and actual areas under crops that were irrigated;
- Record keeping of irrigation water withdrawn from different water sources (a main canal, irrigation or drainage tubewells, collector-drains etc.) for growing crops in a WUA during the growing season;

- Calculation of actual efficiency factor for WUA's canals;
- Monitoring the uniformity of irrigation water distribution among WUA's water users; and
- Evaluating the infringement of interests of water users whose off-takes are located along the tail section of WUA's irrigation canals.

Shortcomings in water distribution and use are revealed and proper operational decisions for their eliminating are made based on the analysis of a situation after each water application of crops during the growing season. For the purpose of involving water users in the water distribution process and improving access to monitoring findings the basic indicators are demonstrated on special-prepared stands of publicity. Schedules of daily water use per each off-take and group of water users with information on crops, dates of irrigations, flow rates and order of receiving water by each water user are demonstrated on these stands. WUAs' irrigation specialists should daily record and then demonstrate an actual progress in water distribution and use. Based on keeping track of implementing the schedule of daily water distribution and in case of deviation from planned indicators, a WUA's irrigation specialist together with water users adjust the schedule of daily water distribution.

Participation of WUA's members in the process of water distribution

Participation of WUA's members in the process of water distribution depends on the form of relations of water users with the WUA's management. For example, in Uzbekistan, farmers sign the agreement on irrigation water delivery directly with the WUA's management while owners of plots attached to their houses sign the agreement on irrigation water delivery with the WUA's management through the village administration.

In Tajikistan and Kyrgyzstan, there are isolated cases when some water users sign the agreement on irrigation water delivery directly with the WUA's management, but joint interests of most of small water users (having an irrigated area ranging from 0.04 to 0.6 ha) are represented by dekhkan farms, cooperatives or self-government institutions.

Every year, at the end of February or at the beginning of March, the WUA management collects information on the crop pattern on the command area of each off-take and groups the plots of water users according to their belonging to specific crop water requirement zones. Water users are subdivided into a few groups according to cultivating of specific crops in each crop water requirement zone. If one water user cultivates a few crops then he can be a participant of a few groups, which cultivate those or other crops.

At the end of February or at the beginning of March, WUA's irrigation specialist drafts the schedule of daily irrigation water delivery for each crop. Based on the schedule of daily irrigation water delivery, the WUA's management signs the agreements with each water user or a WUG.

After planting each crop, time and duration of irrigation water supply to water users established in the schedules are adjusted based on their applications and depending on actual water availability. Each water user is informed about a modified schedule of daily irrigation water delivery.

Two approaches to establishing water user groups (WUGs) on tertiary and lower level irrigation canals can be proposed for efficient and fair distribution of irrigation water:

Under the first approach, each water user singly signs the agreement on irrigation water delivery with a WUA's management. The WUA's management schedules irrigation water distribution among water users in accordance with the irrigation schedule and irrigation water use limits. A WUA delivers irrigation water up to each water user's off-take according to this schedule. In case of disputes between WUA's irrigation specialist and a water user relative to issues of water use, a WUG's leader elected by water users participates in conflict resolution. A WUG's leader is acting on a voluntary basis. The key tasks of WUG's leader are to act as a mediator between water users and a WUA and to assist a WUA irrigation specialist in implementing the schedule of water distribution established for a WUG.

Under the second approach, WUG's members delegate their powers to a WUG's leader. A WUG's leader signs the agreement on irrigation water delivery with a WUA on behalf of a WUG. With technical assistance of a WUA's irrigation specialist, a WUG's leader schedules the sequence of irrigation water delivery to WUG's members. After receiving irrigation water from a WUA, a WUG's leader provides its delivery to an off-take of each water user according to the agreed schedule of water distribution. The upkeep of a WUG's leader and running costs are reimbursed by WUG's members.

Tasks of the WUG's leader are the following:

- Gathering information on crops cultivated by WUG's members and submitting this information to a WUA management;
- Collection and systematization of applications for irrigation water supply adjusted for cultivated crops that are submitted by WUG's members;
- Submitting the summary application to a WUA on behalf of a WUG and setting terms and duration of irrigation water delivery into WUG's canals; and
- Operative adjusting the schedule of irrigation water distribution within a WUG.

WUA's personnel fix a flow rate and water delivery duration for each crop at the WUG's off-take, and a WUG's leader starts to distribute irrigation water among WUG's members. For example, if water is supplied for irrigation of vegetables, the WUG's leader supervises in order that only those who cultivate vegetables should receive this water, and if water is supplied for irrigation of cotton only those who cultivate cotton should receive this water etc. In case of infringing the established sequence of irrigation water receiving by some water users, the WUG's leader together with WUA's personnel take measures for community-based correction.

For both types of WUGs, the Makhalla Committee selects one person (irrigator) for the remunerative work related to arrangement of water distribution at each off-take to homestead lands. He should daily receive water at off-take, in WUA irrigation specialist's presence, and distribute water among water users. WUA's irrigation specialist should assist an irrigator of homestead lands to determine a flow rate for the irrigation network of homestead lands and duration of water delivery towards separate plots.

A role of social initiators in organizing water distribution within WUGs

Under irrigation water distributing, WUA's administration face different problems which require participation of water users for their solving. Specially trained social initiators should be involved in solving these problems. At that, social initiators have to know existing problems and ways for their settling, as well as to enjoy water users' confidence.

At the meetings with water users, social initiators must explain to them the current situation related to water distribution. At the same time, they have to possess knowledge on advanced methods of water distribution and to be able to explain to water users, in a popular and understandable form, their efficiency and mechanisms of introducing new methods of water distribution.

From time to time, a WUG holds meetings for discussing water distribution and other issues and also for electing a WUG's leader or irrigator. Participants of these meetings specify rights and duties of a WUG's leader delegated by water users including the right to sign the agreement with a WUA on behalf of a WUG and to represent the WUG interests at the WUA's sessions.

A campaign of social mobilization for introducing a new method of water distribution lasts until a moment when water users themselves will start to participate in the process of water use planning and implementing in full measure. When specially trained social initiators are absent the WUA's Council takes upon itself the functions of solving water users' problems and appoints one of its members as a person responsible for solving arisen problems jointly with water users.

Experience of establishing WUGs learnt from the WUA "Akbarabad"

In 2005, water users groups (WUGs) were established on tertiary laterals "Damarik", "Navoi-3" and "Navoi-4" in the WUA "Akbarabad." Homestead lands occupy 10 to 30% of a total irrigated area in each WUG. The number of private farms in groups varies from 7 to 8 with an irrigated area ranging from one hectare (the private farm "Mamajanov") to 40 hectares (the private farm "Nurmat-Otai"). Owners of homestead lands delegated their powers to a representative of the Makhalla Committee.

Table 5.7 Information on Water Users Groups in the WUA "Akbarabad"

No	Name of tertiary lateral	WUG	Irrigated area, ha	Number of off-takes	Including homestead lands	
					Number of off-takes	Irrigated area, ha
1	Damarik	«Damarik»	149.6	12	3	52
2	Navoi-3	«Navoi-3»	98	8	1	10
3	Navoi -4	«Navoi-4»	129	9	1	15

All private farms and the representative of the Makhalla Committee have signed the agreements with the WUA. In accordance with the agreement, the WUA has organized water delivery to WUGs in line with the irrigation schedule within limits for irrigation water use and provided the uniform distribution of water withdrawn from the SFC among WUA's water users. Irrigation water received under supervision of the WUA's representative was being distributed among owners of homestead lands by the makhalla irrigators (mirabs). WUGs' leaders assisted WUA's personnel in the following fields:

- Implementing the schedule of water distribution among the WUG's members that was drafted according to their applications;
- Cleaning the WUG's irrigation network two times during the growing season based on voluntary participation of community members in these works;
- Collecting payment for WUA's services;
- Preventing and resolution of different conflicts between WUG's members;
- Recommendations on improving the practice of water distribution among WUA's water users;
- Rising of water users' awareness regarding the proper organization of water applications using science-based rates, terms, and duration of irrigation of crops; and
- Mobilizing water users for construction of gauging stations on WUGs' off-takes.

As shown in Table 5.8, the uniform water distribution between water users located along head and tail sections of the irrigation canal was provided last years. While in 2005, water availability ranged from 129% to 135% of planned water delivery along head part of the irrigation canal and from 60% to 75% of planned water delivery along tail part of the irrigation canal, in 2007, water availability in tail part of the irrigation canal (WUGs "Navoi-3" and "Navoi-4") amounted to 100% of planned water delivery and in head part of the irrigation canal – 96% respectively due to the well coordinated work of WUA's personnel and WUGs' leaders that was based on the method of daily water use scheduling.

Table 5.8

Dynamics of Uniformity of Water Distribution (in % of the irrigation water use limit)

No	WUG	2005		2006		2007	
		Head part of the WUG's canal	Tail part of the WUG's canal	Head part of the WUG's canal	Tail part of the WUG's canal	Head part of the WUG's canal	Tail part of the WUG's canal
1	«Damarik»	135	60	105	85	100	97
2	«Navoi-3»	129	70	110	82	95	100
3	«Navoi-4»	130	75	103	87	96	100

While in 2005 the number of disputes between the WUA and WUGs' members amounted to 5 in 2006 their number decreased up to 3 and in 2007 only one incident was registered. As a result of the active explanatory work of WUGs' leaders, the considerable progress was made in improving the situation related to collecting of a fee for WUA's services. While in 2005 only 58% of services have been reimbursed in 2007 95% of WUA's services were paid for. Especially it is necessary to mention the practice of collecting a fee for services of the WUA "Akbarabad" from owners of homestead lands (Table 5.9).

Table 5.9

Disputes between WUA's Personnel and WUG's Members and Fees for Services of the WUA "Akbarabad"

No	WUG	2005		2006		2007	
		Number of disputes	WUA's services paid, %	Number of disputes	WUA's services paid, %	Number of disputes	WUA's services paid, %
1	«Damarik»	2	56	1	60	1	95
2	«Navoi-3»	1	55	1	68	0	94
3	«Navoi-4»	2	62	1	54	0	95
Over WUG		5	58	3	61	1	95

Table 5.9 shows positive changes in both the situation related to disputes between WUA's Personnel and WUG's Members and in collecting of fees for WUA's services.

The information-management system "Fergana"

Under drastic increasing in the number of water users, the traditional practice and methods employed by water management organizations cannot undoubtedly provide collecting, processing, and analyzing a huge volume of information formed at all levels of the water management hierarchy for decision-making. Modern technique with its advanced capabilities in the field of computerization and informatics is one of IWRM pillars. Therefore, the information-management system "IMS-Fergana" aimed at evaluating and validating different methods of water resources allocation in the agricultural sector with the purpose to improve the efficiency of water use has been developed in the frame of the IWRM-Fergana Project. The "IMS-Fergana" solves various water management tasks at different stages of managing the water distribution process.

As was already mentioned, the IWRM pillar is the multilevel hierarchy of the water management framework and integrating of all its components. This framework is completely serviced by the set of

mathematic models and information flows of the database built-in into the information-management system "IMS-Fergana." Optimal water resources distribution among all stakeholders when each level of water management hierarchy has own efficiency criteria is provided through processing information flows (simulated models and the database) on an annual, monthly and ten-day period basis. An overall target function supports the integrated water management strategy established for the system as a whole.

The information-management system "IMS-Fergana" allows:

1. to monitor the following aspects within the irrigation scheme:

- changes in crop patterns;
- modification of crop water requirement zoning;
- modification of the irrigation network structure (water sources, canals);
- variations in parameters of the irrigation network elements.

2. to keep records of actual water withdrawal per off-takes and canals
3. to register the applications for water delivery on the ten-day period basis
4. to simulate different options of water distribution among all water users within the irrigation system taking into account alternative applications and different volumes of water supply into the irrigation system:

- under annual planning;
- under operational planning.

5. to search out optimal options for water allocation:

- taking into account different water sources (annual planning);
- in case of water resources deficit (annual or operational planning).

6. to analyze the efficiency of water distribution:

- to estimate indicators of water distribution efficiency;
- reporting and preparing production documentation.

The information-management system "IMS-Fergana" was developed on the basis of DBMS ACCESS and the modeling system GAMS [4]. At present, Version 3 of "IMS-Fergana" is operated on all pilot irrigation canals. All abovementioned kinds of works (planning, calculation of operational and summarized indicators etc.) are carried out in the real-time mode. On the ten-day period basis, the results of calculations are transferred to the CA, CWUC and CWC for analyzing the water distribution process and decision-making for next ten-day period. A comparative analysis of water resources management level on the pilot canals and in WUAs per years is conducted based on summarized indicators (see Tables 3.2 and 3.3 in Chapter 3).

Evaluating water distribution

In this case, the evaluation is the process of comparing indicators to reveal deviations in water resources management quality on the regular basis. The process includes comparing of indicators for:

- different time periods (day, ten-day period);
- any estimated period (seasonal, annual, mean annual);
- different irrigation systems;
- different hydro-operational sites (balance sites);
- different water users (a farm, WUA, administrative district, province, republic);
- actual and planned (normative) situations.

If baseline information is reliable the evaluation has both theoretical (scientific) and practical value. The evaluation has a practical value, i.e. actually facilitates improvements in water resources management quality, only in case of when decision makers:

- want and obligated to make assessment;
- are able to make assessment;
- want or obligated to make decisions for improving the water resources management quality;
- have opportunities (financial, technical, human resources) to implement accepted decisions.

Restrictive factors for improving the quality of evaluation and water resources management:

- Financial and economic factors:

- Water professionals are not interested in improving the quality of water management because their wage does not depend on this;
- Establishing effective monitoring requires considerable investments;
- Lack of payments for water services;

- Social and organizational factors:
  - Efficiency of water professionals' activity is evaluated by water professionals rather than water users (deficit of public participation); and
  - Other factors.

Evaluating water distribution can be internal and external. An external assessment characterizes costs and results of irrigation systems' functioning; it allows comparing the functioning of one irrigation system with others. An internal assessment characterizes the processes progressing within the system and resulting in the internal results; it provides the comparison of actual results with planned ones.

In the process of analyzing water distribution it is necessary to find out answers to the following questions: "Whether all my actions are correct?" and "Whether my actions are correct in general?" [17]. Answering to the first question you evaluate the quality of water management (comparing the actual results with planned ones); and answering to the second question you evaluate the quality of water governance (comparing the achieved results with target ones).

Let us assume that indicators of water availability, sustainability and uniformity in the pumping irrigation zone in the SFC command area are adequate (i.e. the actual results are close to planned ones). This assumption results in the fact that irrigation water is correctly supplied; and the SFC administration manages water resources well. However, the internal assessment does not allow finding out whether planning water distribution is correct or whether the water policy is correct? In order to answer to these questions the external assessment should be done. The external assessment (for example, low technical and economic water productivity was revealed) arouses doubts in the expediency of irrigation water supply into the pumping irrigation zone or denotes the need of introducing water saving technologies and cultivation of more valuable crops.

Analyzing operational indicators (on the daily or ten-day period basis) is implemented during the whole growing season; and analyzing summary indicators is made after ending the growing season. It is expedient to evaluate water distribution in the following sequence: 1) calculating indicators per ten-day periods and growing seasons for off-takes, pumping stations, water users, administrative districts and provinces, balance sites, check stations, pilot canals etc.; 2) plotting contrastive diagrams; 3) detection of sharply-divergent values of baseline data or indicators on diagrams (obvious understated or overstated values); 4) studying and explaining why these deviations take place; 5) eliminating errors (if revealed) of baseline information; 6) analyzing the diagrams and evaluating trends (over time and area) in governance and management of water distribution and causes of these trends.

Considerable deviations can result from errors in baseline information or due to other causes:

- an efficiency factor more than unity can result from unrecorded lateral inflow etc.;

- abrupt drop in an efficiency factor can result from stealing of irrigation water or lack of assessing tail releases of irrigation water etc.;

- overstated values of irrigation water supply or water availability per an unit area can result from incorrect record keeping of irrigation water transit and other factors;

- understated values of irrigation water supply can result from lack of record keeping of return water in the plan of water use, stealing of irrigation water, unreliable data on irrigated areas etc.;

- higher level of irrigation water supply stability can result from the presence of regulating capacities (reservoirs), unreliable report information etc.;

Trends and reasons causing them can be revealed in the course of the evaluating process:

- increase in the values of coefficients of uniformity and stability can result from rise of the ublic participation level in water governance;

- increasing the water availability factor can result from both increased water availability in a specific year and adjusting water demand (decrease in planned irrigation water supply);

- decreasing the water availability factor can result from both lower water availability in a specific year and more exact definition of irrigated areas (taking into account secondary and interim crops), as well as due to introducing payment for water services;

- a relatively high coefficient of physical water productivity in the SFC command area does not mean that a coefficient of economic water productivity is also high. In this case, a major cause is low purchasing prices of cotton (relative to world market prices); and

- lowering the values of those or other indicators of water distribution can result from impacts of external causes on the water sector: social shock, mass participation of water professionals in activities directly not related to their professional duties, as well as sudden meddling in the process of water distribution: stopping water releases from reservoirs etc.

The basic diagrams that illustrate indicators of water distribution along the pilot canals over the period of 2003 to 2007 that show the progress in improving canals' operation based on introducing the IMS are given below (Figures 5.18 to 5.23).

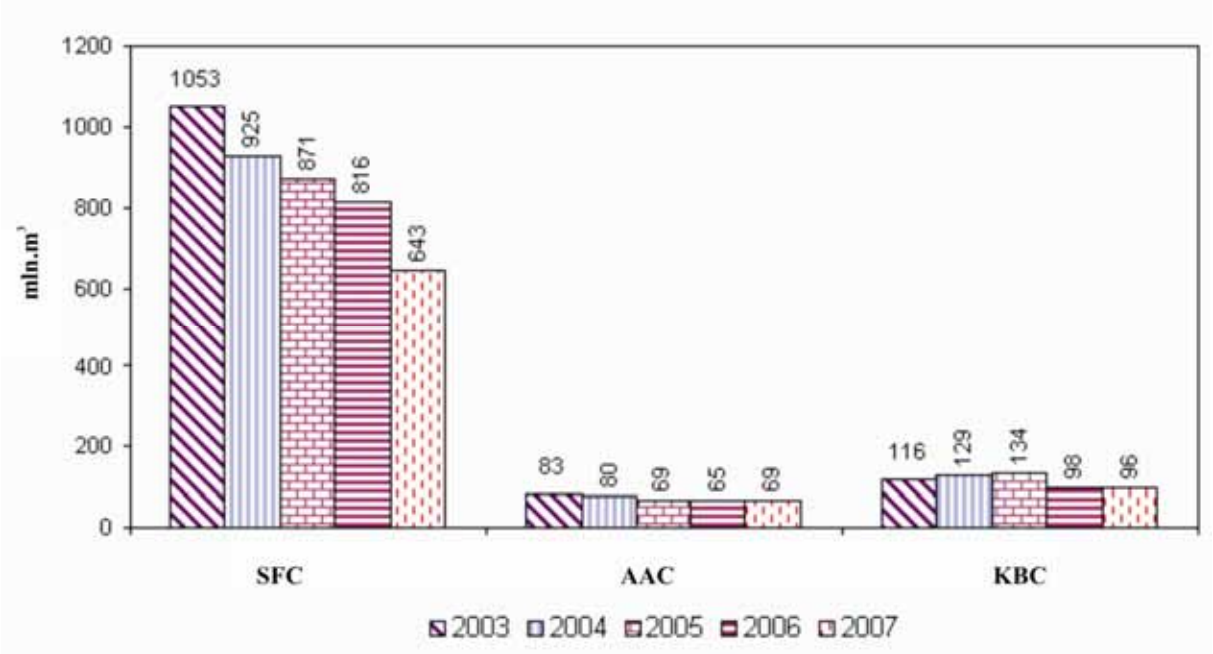

Figure 5.18 Actual Irrigation Water Supply through Pilot Canals

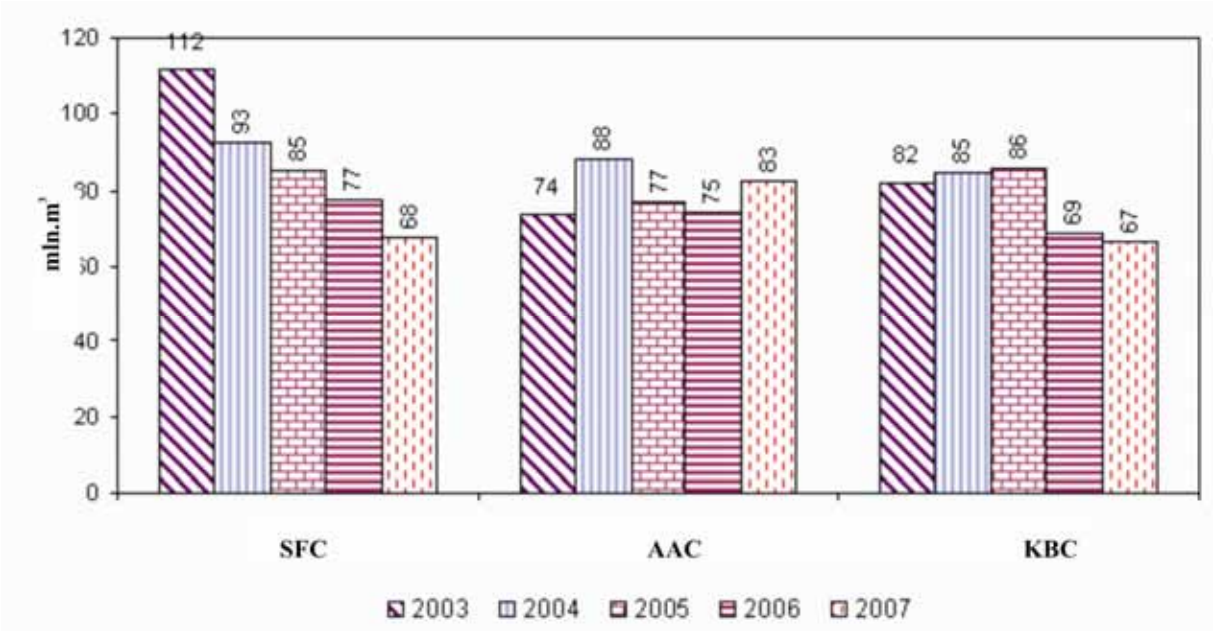

Figure 5. 19 Water Availability on Pilot Canals

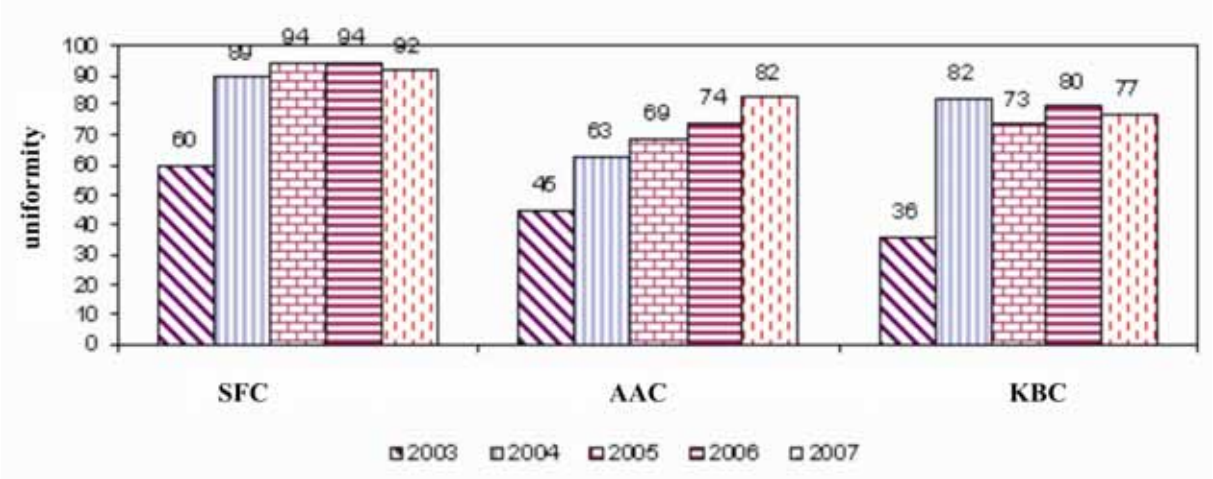

Figure 5. 20 Uniformity of Irrigation Water Supply

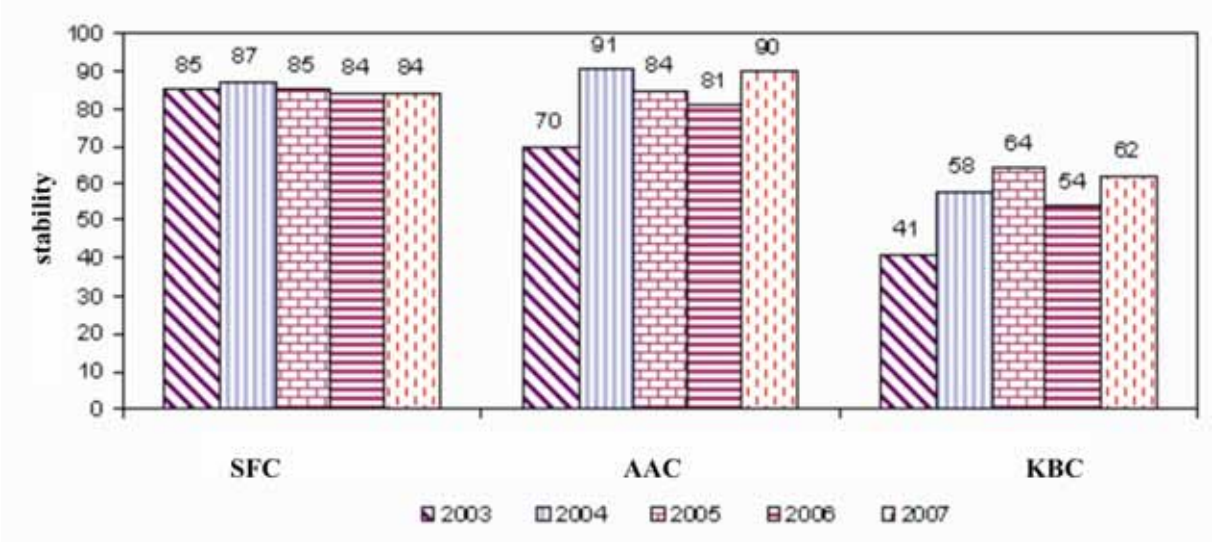

Figure 5. 21 Stability of Irrigation Water Supply

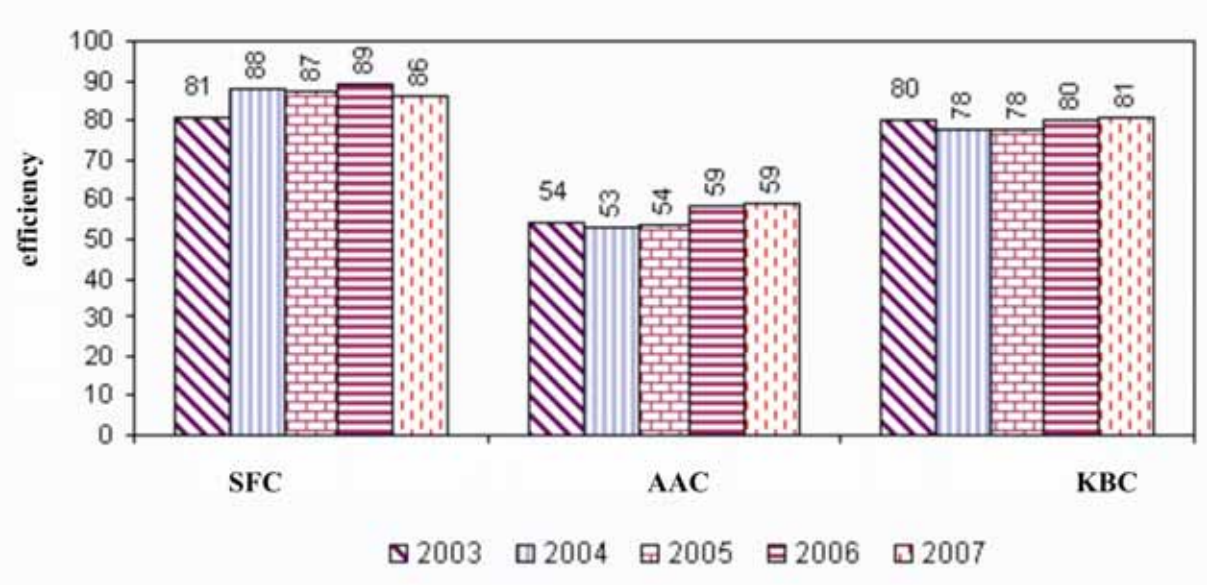

Figure 5. 22 An Efficiency Factor of Pilot Canals

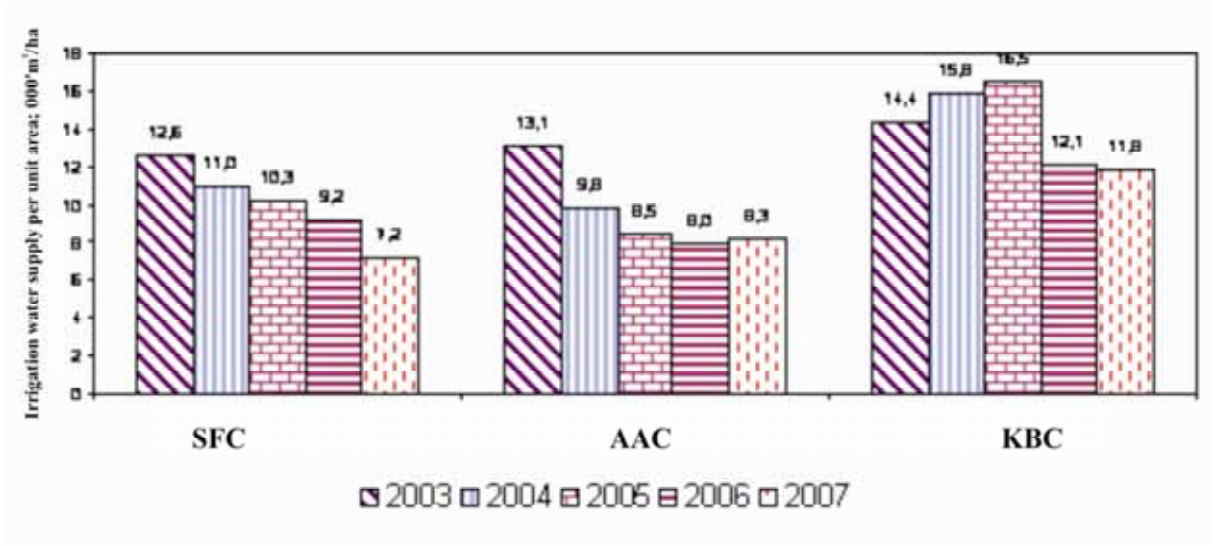

Figure 5.23 Irrigation Water Supply per Unit Area over the Growing Season

The similar analysis of WUA's activity (Case Study of the WUA "Akbarabad") was conducted in the following sequence:

- Identification of irrigation water delivery from the SFC into the WUA "Akbarabad"; and
- Assessment of irrigation water distribution diverted from the SFC and other water sources among WUA's members.

Figure 5.24 shows that there is the trend of reducing actual irrigation water supply into irrigation canals of the WUA "Akbarabad" during the growing season over the period of 2003 to 2007. While in 2003 (the beginning of establishing the WUA) irrigation water supply into WUA's canals amounted to 24.6 million m^3 in subsequent years (2004 to 2007), irrigation water supply was 23.1, 21.5, 20.3 and 17.6 million m^3 respectively [17].

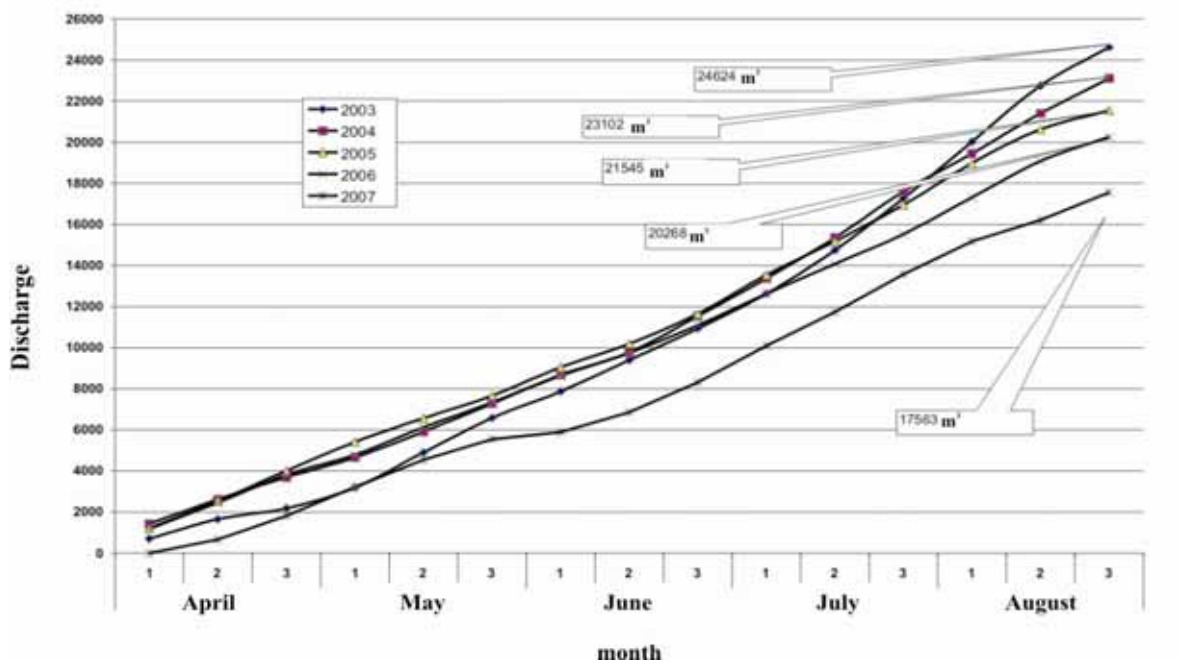

Figure 5.24 Trends of Actual Irrigation Water Supply into Irrigation Canals of the WUA "Akbarabad"
(a Progressive Total over the Growing Season, 000' m^3)

The WUA accounts the use of all kinds of waters; and a positive trend in using a little brackish water for irrigation with reducing water diversion from the SFC is observed. In dry years (2006 and 2007), water availability in the WUA was increased by 15 to 20% at the expense of drainage water.

In addition, daily water distribution through each irrigation canal and collector-drain for each crop was organized in the WUA. After completing each water application of crops during the growing season, WUA's personnel carry out the operational analysis of water distribution among water users in accordance with applications submitted and find out causes of reduction in irrigation water supply against their applications. Analyzing of indicators of delivering irrigation water to farms located along the tail section of WUA's canals confirms that after introduction of the daily planning of water use, the infringement of water users' interests in tail parts of irrigation canals are losing its topicality (see Tables 5.10 and 5.11).

Operative dissemination of adjusted schedules of by-turn irrigation water delivery to water users prevents disputes between water users and WUA's personnel. Water users being informed on terms and duration of receiving specific flow rate of water for irrigation can efficiently plan soil treatment, fertilizer application and hiring additional irrigators for water applications.

The new methodology of daily planning modifies the approach to evaluating water availability i.e. the assessment is conducted based on the results of water application rather than on indicators of a ten-day period and allows objectively evaluating implementation of the plan of irrigations and coordinating water availability of farms with activity of the WUA and WMO.

Table 5.10

Assessment of the Extent of Infringing Water Users' Interests in Tail Parts of Irrigation Canals in the WUA "Akbarabad" during the 2007 Growing Season

Irrigation and drainage canals in WUAs	Crop	Average water availability of WUGs located along a head part of the irrigation canal, %	Average water availability of WUGs located along a tail part of the irrigation canal, %	Ratio of water availability of WUGs in a tail part and a head part of the irrigation canal, %
Akbarabad 1 and 2	Cotton	107	130	121
	Wheat	82	96	117
	Vegetables	37	42	114
	Orchards	74	77	104
RP - 1	Cotton	130	132	102
	Wheat	91	96	105
	Orchards	105	97	92
RP - 2	Cotton	116	93	80
	Wheat	87	90	103
Gandabulak	Cotton	87	91	105
	Wheat	122	118	97
	Vegetables	63	63	100
	Orchards	84	80	95
Okkuduk	Cotton	111	98	88
	Wheat	115	104	90

The system of monitoring water use was also introduced in newly-established WUAs along the SFC and KBC based on the training of WUAs' specialists on matters of monitoring water use including the methodology of daily planning and analyzing water use.

Organization of daily water use and its adjustment in the WUA in accordance with submitted applications for irrigation water has shown their high efficiency. Some water users refused from conducting water applications because of shallow watertable that enabled to reduce volumes of water delivered into the WUA. The timely convenience of irrigation water delivery, water availability of water users and WUA's activity during the growing season can be evaluated based on data on daily water distribution.

Table 5.11

Assessment of Infringing Water Users' Interests in Tail Parts of WUA's Pilot Canals in the SFC Command Area during the 2007 Growing Season

WUA	Name of canal	Crop	Average water availability of WUGs located along a head part of the irrigation canal, %	Average water availability of WUGs located along a tail part of the irrigation canal, %	Ratio of water availability of WUGs in a tail part and a head part of the irrigation canal, %
Ismailiv	K-11	Cotton	101	102	101
		Wheat	114	94	83
		Orchards	91	109	120
Mashyal	Kommunizm	Cotton	74	68	92
		Wheat	89	72	81
		Сады	109	113	104
Omad Zilol	Guliston	Cotton	90	87	97
		Wheat	91	100	110
Povulgon Obi Khaet	Isokov-2	Cotton	72	91	126
		Wheat	94	101	107

Regular monitoring allows revealing shortcomings in the organization of water use on timely basis and eliminating them. Water management organizations, local authorities, research institutions annually need information on irrigation water used by cultivated crops. Prior to introducing the daily planning system, this information was quite approximate and gave rise to doubt its reliability. A daily planning allows collecting reliable information and providing necessary data for strategic planning of agricultural sector development, adjusting the irrigation schedule, and rearranging irrigation lands according to specific crop water requirement zones. A daily planning of water use also allows establishing effective water allocation and reducing water losses in WUA's canals. In 2007, the daily planning of water use introduced in the WUA "Akbarabad" allowed raising the operational efficiency factor of WUA canals from 0.66 to 0.78.

Table 5.12
Water Withdrawal from Different Water Sources and Cumulative Area of Irrigation[5] per WUAs Located along the SFC

No	District	Total irrigated area, ha	Total water withdrawal during the	Including from (in %):	Cumulative area of irrigation	Including area irrigated by water diverted from (in

[5] Cumulative area means an area that was irrigated one or a few times according to the irrigation schedule

			growing season, mln. m^3			(area* the number of irrigations)	%):	
				the SFC	other sources		the SFC	other sources
1	Khujaabad	3,450	25.35	**85**	**15**	15,419	**84**	**16**
2	Bulakbash	8,630	59.27	**68**	**32**	39,522	**68**	**32**
3	Markhamat	18,624	116.3	**87**	**13**	43,209	**91**	**9**
4	Kuva	22,037	204.4	**90**	**10**	121,065	**89**	**11**
5	Tashlak	9,855	54.2	**82**	**18**	41,781	**87**	**13**
6	Akhunbabaev	4,258	40.55	**87**	**13**	23,660	**90**	**10**
7	Altiaryk	5,763	49.32	**86**	**14**	29,640	**86**	**14**

The proposed procedure for coordinating activity of the SFC Administration and WUAs in water resources management proved its high efficiency. At the beginning of each ten-day period WUAs receive reliable information on water delivery to WUAs' canals based on the current water availability in the SFC itself. In 2007, the analysis of water use results was being carried out by specialists of WUAs established in the frame of the IWRM-Fergana Project and WUAs that were established in command areas of the SFC and KBC. This analysis has shown that the percentage of water withdrawals from additional sources within WUAs was ranging from 10% (Kuva District) to 32% (Bulakbash District) that were used for irrigating 9 to 32% of irrigated areas in districts.

Table 5.13 shows that only 4 of 46 WUAs in the SFC command area do not have additional water sources; the percentage of water withdrawal from additional sources varies over the range of 1 to 20% of the total water withdrawal in 54% of WUAs, and from 21 to 40% in 37% of WUAs.

Table 5.13

Water Withdrawal from Additional Water Sources

Total number of WUAs	Water availability in WUAs at the expenses of additional sources, %				
	0	1 – 10	11 – 20	21 – 30	30 – 40
46	4	13	12	6	11

A part of the SFC command area in Andijan and Fergana provinces has considerable internal reserves of water at the expense of additional water sources that allow raising water availability of irrigated farmland. For efficient use of these water resources the nature of their forming should be studied and specified.

Interrelations of WUAs and the WMO need to be arranged according to the system, which was developed by the Project, providing for informing WUAs, on timely basis, on forthcoming water delivery based on the current situation reflecting water availability within the SFC command area. Conditions for stable operation of the SFC without all-out efforts were established based on the system of submitting well-arranged applications for irrigation water by WUAs.

The IWRM-Fergana Project has suggested to all WUAs a new methodology for planning water use. However, all existing WUAs, as successors of former collective farms, employ the outdated method of the planning (for ten-day periods). Therefore, it is necessary to develop all normative documentation for the office work in WUAs based on the daily planning of water use and to disseminate these documents among the Ministries of Water Resources of countries having irrigation lands in the Fergana Valley to put them into water management bodies' practice.

The command area of Pilot Khoji-Bakirgan Canal: the water rotation between two administrative districts was put into practice. A full cycle of water rotation amounts to 6 days (during three days, irrigation water is delivered into Gafurov District and then into Rasulev District). The same order was employed in Rasulev District where the one-and-a-half-day water rotation between WUAs and farms was established. Water users were subdivided into two groups. The first group of water users received water for irrigation during the first time step of three-day water rotation and the second group during the next time step. Daily flow rates of irrigation water supply for each group were separately calculated; and during each time step of water rotation an adjustment coefficient for volumes of water allocated for irrigation of one hectare was calculated based on a ratio of allotted water volumes and daily irrigation water demand. A schedule of daily water rotation was being modified using the adjustment coefficient. The adjusted daily schedule was the basis for monitoring water use within a WUA.

Table 5.14 shows that water availability of farms varies over the range of 27 to 52 % in the command area of the Ak-kalya Canal. However, water availability of farms located in the tail part makes up 93.2% of water availability of farms in the head part of this canal. Additional water resources diverted from the Syr Darya River by pumps and partly-collected tail-water released from irrigated fields were used to improve water availability of farms serviced by the Ak-kalya Canal.

Table 5.14

Indicators of Irrigation Water Supply along Different Sections of the Ak-kalya Canal

No	Laterals	Irrigated area, ha	Indicators of water delivery, 000' m^3		Average water availability, %	Ratio of water availability in tail and head parts,%
			Plan	Actual		
I. Head part of the canal						**(41 / 44) * 100 = 93.2**
1	Yarmagz	16.1	165	58	35	
2	Khudgif-1	14.6	153	64	42	
3	Khamadov	60	734	300	41	

No	Laterals	Irrigated area, ha	Indicators of water delivery, 000' m^3		Average water availability, %	Ratio of water availability in tail and head parts,%
			Plan	Actual		
4	Yarmagz -2	50.7	525	274	52	
	Total	**141.4**	**157.7**	**696**	**44.0**	
II. Tail part of the canal						
1	Sughd-1	16	187	81	43	
2	Somon-1	46	575	266	46	
3	Sughd-2	25	332	123	37	
4	Sughd-3	40	463	164	35	
	Total	**127**	**1557**	**634**	**41.0**	

The pilot WUA "Zarafshan" operates under conditions when the Khoji-Bakirgan Canal does not have a regulative reservoir; and irrigation water supply mainly depends on climatic conditions. The WUA cannot usually meet planned water demand (15 to 16.5 million m^3 depending on a crop pattern). Relative increase in irrigation water supply over the period of 2003 to 2006 (from 5,679,000 to 7,256,000 m^3) can be considered as the positive tendency, but in 2007, actual volumes of irrigation water supply have decreased up to 5,678,000 m^3 due to drought (Figure 5.25).

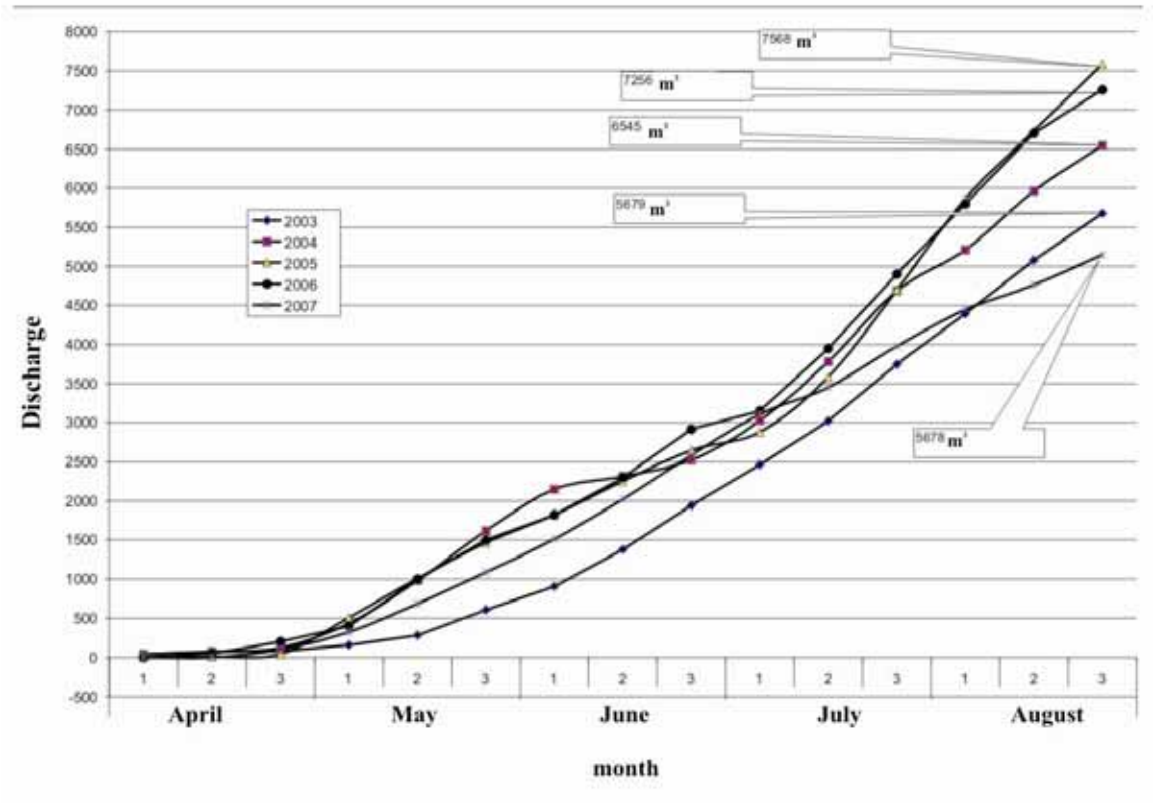

Figure 5.25 Dynamics of Actual Water Availability in the WUA "Zarafshan" (the progressive total) during the Growing Seasons over the Period of 2003 to 2007