# INTEGRATED WATER RESOURCES MANAGEMENT:

# PUTTING GOOD THEORY INTO REAL PRACTICE

## Central Asian Experience

Tashkent-2009

**Reviewer: Dr. Yuliya Shirokova**

**Integrated Water Resources Management: Putting Good Theory into Real Practice. Central Asian Experience.**
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This book is aimed at a wide range of specialists – water management professionals, including policy-makers in the water sector who define trends and meaning of modern reforms of water governance and management.

At the same time, this book is also intended for a wide range of civil society representatives interested in implementing proper reforms within water management. Content of this book allows readers to recognize that civil society and nature all over the world are facing serious problems concerning water resources. At present, these challenges cannot be tackled efficiently using the customary, prevalent during last decades, traditions, governance structure, and methods of water management. Therefore, Integrated Water Resources Management (IWRM) is here treated as a promising new approach to solve above-mentioned problems. The experiences gained while introducing this new approach to Central Asia are generalized in the present book.

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAC | Aravan-Akbura Canal |
| BAC | Big Andijan Canal |
| BFC | Big Fergana Canal |
| BISA | Basin Irrigation System Association |
| CA | Canal Administration |
| CIDA | Canadian International Development Agency |
| CWC | Canal Water Committee |
| CWUU | Canal Water Users Union |
| DB | Database |
| DF | Drainage Flow |
| DSS | Decision Support System |
| EF | Efficiency Factor |
| ESCAP | Economic and Social Commission for Asia and the Pacific |
| FAO | Food and Agriculture Organization |
| FWC | Field Water Capacity |
| GEF | Global Environment Fund |
| GIS | Geoinformation System |
| GWP | Global Water Partnership |
| GWP CACENA | Global Water Partnership for Central Asia and Caucasus |
| ICID | International Commission on Irrigation and Drainage |
| ICWC | Interstate Coordination Water Commission for Central Asia |
| IWRM | Integrated Water Resources Management |
| IWRUP | Integrated Water Resources Use and Protection |
| IWRA | International Water Resources Association |
| KB | Knowledge Base |
| KBC | Khoja-Bakirgan Canal |
| MLRWM | Ministry of Land Reclamation and Water Management |
| MPC | Maximum Permissible Concentration |
| NATO | North Atlantic Treaty Organization |
| NGO | Nongovernmental Organization |
| PF | Private Farm |
| SA | System Administration |
| SCADA | Supervisory Control and Data Acquisition |
| SDC | Swiss Development Cooperation |
| SIC | Scientific and Information Center |
| SFC | South Fergana Canal |
| SMP | Strategic Management Planning |
| VAT | Value-Added Tax |
| UNDP | The United Nations Development Program |
| USAID | US Agency for International Development |
| WEMP | Water and Environment Management Project |
| WMO | Water Management Organization |
| WUA | Water User Association |

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# PREFACE

**(V.A. Dukhovny)**

When water occurs in the atmosphere, or infiltrate into the earth's interior or occurs in the origins of streams and rivers (that are fed by precipitations or melting glaciers), it does not surmise (although Japanese scientists discovered that water is possessed with memory and sensitiveness) further down its' intended use. Human beings could use it for drinking or sanitary purposes, for industrial production, to grow crops, or sent through turbines to generate electric power. In spite of impacts of modern life, water may still remain as a part of virgin nature that existed over thousands of years. In the very same nature, which humankind has selfishly subjugated with its ruthless actions to satisfy its own daily wants.

The integrity of water resources, as the great natural substance, requires that its management is implemented in an integrated manner, meaning the total consideration of all kinds of waters on earth; all kinds of water users; and all consequences that determines whether the water use is sustainable, effective, and/or harmless. Therefore, integrated water resources management (IWRM) is quite accessible for understanding and is considered as a specific objective that is perceived and recognized by the society and its political leaders. This is reflected in numerous declarations, decisions, and slogans. Today, if, a public opinion poll is called to answer a single question: "Do you support IWRM or not?" The answer is clear and loud. Most of people will say, "Of course, we support it.".

However, the modern world is divided by means of political boundaries, natural barriers (mountains, oceans, and deserts), administrative frameworks and corporative interests, as well as by local features and social (communal) formations.

In addition, there are sectoral and professional priorities, political ambitions and confrontations. In the end, water meets the needs of six billions people (in future, it may be even ten billions!) as end users. In order to meet all needs of the society and nature (needs of the present population and its future descendants, as well as of flora and fauna – everything that God or other supreme intellect has created), it is necessary to review and overcome all divides and antagonistic barriers on our way!

We have stated earlier that the IWRM objective is to achieve a balance between water resources availability and it's use over the time and area (therefore, the integration of all kinds of waters and uses is important) [3]. However, an assessment of the consequences in the process of integrated water resources management are equally significant. Because, the consequences are having a feedback that can affect on water sources and the uses that are integrating. It is known that these affects can result in reducing of available water resources (or change the conditions of their availability in such a way that they cannot be used anymore); or deteriorate their quality (salinity, pollution, and eutrophication); or increase O&M costs; etc,. Many things can happen with water due to our own activities, which are supposedly implemented for the general benefit. One of the most visible consequences is the occurrence of return waters that, up to a certain extent, can be used without much of damage, but beyond that, it can deteriorate river or groundwater quality, affect soil fertility due to salinization, and cause the problems with water use as a whole.

As soon we transform this balance the between "resources and consumption" as previously proposed by us, into this new triangle of "resources – consumption - consequences", there at once reveals a number of more complicated interrelations in the integration process. They include inseparable pairs, both according to their mutual dependence and their specific colliding: "water resources – land resources"; "quantity - quality"; "upper watersheds – downstream areas (deltas)"; "climate – water resources"; "seas and rivers"; and many others (see Figure 1). It is also necessary to mention about multi-stage relations and those impacts that each water user exerts on macro- and micro-economic and social indicators, public environment and welfare, as well as on other sides of the existence of a human beings and nature.

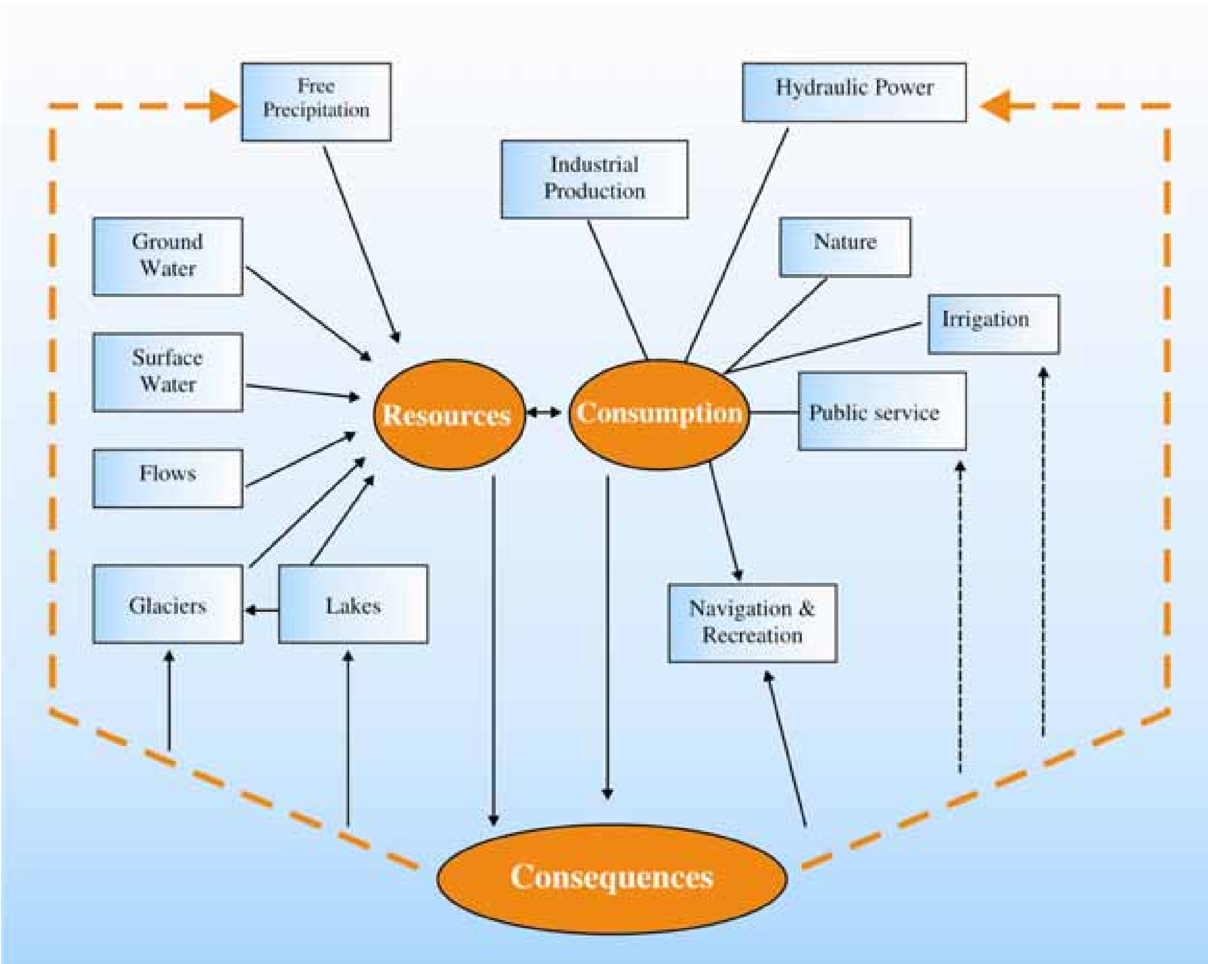



**Figure 1 Interrelation in the Triangle: «Resources – Consumption – Consequences»**

There are some additional aspects for the integration similar to consequences. They are: integration of changes in resources over time (for example, due to climate changes, glacier melting or depletion of aquifers); changes in consumption (on either directions); changes in conditions of natural or man-made watercourses (meandering and erosion of riverbeds, deteriorating of water infrastructure; increase in seepage losses, sedimentation in water reservoirs and irrigation canals etc.).

Proclaimed objective, for the introduction of IWRM principles, at a certain stage, was the sustainable co-existence of a human being and nature to be reached. We should remember that this integration has to be provided in three dimensions: over an area, through all levels of social hierarchy, and over time. Obviously, the integration of all the above components and aspects cannot happen only through water management organizations; This should be the joint activity of all stakeholders and society as a whole, in which politicians and representatives of the integrated sciences (social, political, natural, and engineering sciences) should play a leading role. A place within this process should be provided for all, because it is difficult to find an economic sector or aspect of science, in which the water as a factor of their environment or a subject of investigation is not considered.

Why our society does only now addresses to integrated water resources management? Because, in contrast to the 20th century, when we lived in habitual conditions, in the current millennium we carry a grave burden being witnesses of a growing water deficit almost everywhere. If now, fresh water resources available for use are estimated as about 750 m3/year per person living on our planet, in 2050, this amount will decrease, on average, to the level of 450 m3/year per person, even without considering climate changes. It means that the line of water deficit, according to the UN classification, will be crossed by more than 80% of countries in the world. Only Canada, Russia, Brazil, most of Europe, northern part of the USA, and some tropical districts in Africa, South Asia and South America will remain as blessed oases in this global desert.

Whether our society will overcome this deficit or our world, consumed by egoistic aspirations, will give up its hopes shall depends on its wisdom! There arises the question – water is not the only resource that will be depleted in this century; oil, natural gas and many other minerals are close to extinction. Why are we trying to integrate only water resources management? May be the integration of all-scarce natural resources in the world would be useful. The problem is that all scarce natural resources became the basis for the runaway growth of easy money due to the speculative increase in prices; and it is impossible to stop this process in the capitalistic environment. None of global efforts related to the integration of oil production (for example, OPEC's activity) could overcome the egoism of entities prospering based on extracting of this raw material. On the contrary, such integration has established the community of property owners-monopolists of this raw material contradicting the interests of the entire world. The different countries started to search alternative options for replacing natural minerals; and bio-fuel, thanks to which Brazil has managed with the deficit of energy resources, was invented. There are also other alternate materials: use of wind and solar energy, and the hydropower.

Water is a unique resource that nobody and nothing can replace; and, therefore, in the process of water management and use, our society has to demonstrate that it consists of "homo sapiens" rather than "homo-egoists." Overcoming all temptations to transform water into an economic good, instrument of pressure or profit, the global community may and should avoid the transformation of water into "an apple of discord" and use it as "the basis for co-operation." Just as the situation when the energy crisis has facilitated the development of prosperous European Community, the water should promote the creation of integrated global and rational water community. That is why IWRM, as an advanced concept is the most important and needed direction of development in the new century.

At the regional summit held under the motto: "IWRM is the Basis for Socio-Economic Progress in Central Asia" authors of this book have heard the following remark: "Governments provide the socio-economic progress, not the IWRM." Weak persons' long-standing hopes on God, tsar or political leaders are noticeable in this remark. Meanwhile, IWRM itself, if this process is developing in the right direction, initiates activities and interactions of common water users, political leaders, and society as a whole, and, in such is leading water users, local authorities, and central governments to achieve Millennium Development Goals[1] adopted at the UN Millennium Summit in 2000, namely:

- IWRM, through achieving uniform sustainable and secure water supply and land reclamation, results in eliminating of crop losses and increasing water productivity, and consequently *facilitates the increase in incomes as well as poverty eradication.*
- IWRM, through the development of closely-related economic sectors, attracting own and foreign investments, as well as through water saving and creating the conditions for extending additional areas under crops or areas with double crops, *promotes the increase in the employment and incomes*. For example, in 2002 to 2006, sustainable irrigation water supply into the delta of the Syr Darya River has resulted in the increase of national income in Kazalinsk and Aral districts of Kyzyl-Orda Province almost two times!!!
- IWRM, through establishing the system of sustainable potable water supply and improving water quality in rivers and other water sources, *promotes health improvements.*
- IWRM, by means of accounting diverse roles of water in ecosystems and of saving water for the needs of nature, facilitates the environment rehabilitation and conservation.
- IWRM widely uses energy of water for developing the hydropower sector and for providing its sustainable operation, promoting reliable supply of electricity to the population.
- *Finally, the involvement of the considerable number of people in IWRM facilitates the rise of educational level and the acquirement of new knowledge related to water problems using the knowledge database*.

[1] The Millennium Development Goals – the ambitious program on poverty eradication and raising the living standards, which was agreed by the world political leaders at the UN Millennium Summit in September 2002. One or more tasks were specified within the frame of each goal, most of which should be solved up to 2015, using the Year 1990 as the reference point. Additional information is provided at UNDP website http://www.undp.org/mdg/

Thus, IWRM is “a corner stone” for achieving the UN Millennium Development Goals! Each program on implementing the IWRM principles should show ties of its outcomes with the MDGs’ indicators:

- Reducing the level of poverty and unemployment;
- Health improvements;
- Improving power supply;
- Rehabilitating the environment;
- Increasing the investments;
- Improvement of education;
- Involving women

Just these indicators (in aggregate with indicators of water productivity, sustainability of water supply, and water availability) will characterize the long-term social and ecological sustainability of IWRM as the modern system of solving water problems. Thus, IWRM indicators are not mere technical indicators but also include and can characterize a wide range of impacts that are consequences of introducing the IWRM concept.

# INTRODUCTION - IWRM BACKGROUND

**(V.A. Dukhovny, V.I Sokolov)**

*"Each thing given to us from heaven should be used*
*with special care and benefit, because it is not "our thing",*
*and it is entrusted to us only temporarily."*

The Teaching of Buddha: "The Four Noble Truths"

Understanding the need for a holistic approach to water management was not something just invented today, yesterday, or even in the last century with its progress in technologies and science. Comprehensive water properties and links were not possibly studied and described in detail earlier, as it was done in the UN report "Water – a shared responsibility" [43]. However, as civilization progressed, people intuitively used water in its different states and in various economic activities, understanding perfectly well its role, first of all, in supporting the most valuable thing on Earth – life. It is no mere chance that today the investigations of life existence on other planets arebased on the only criterion – whether traces of water are on them, and only then searching traces of living organisms can be started.

During the hydrologic cycle, water passes through different stages: it evaporates from the earth's surface, condenses in clouds, and then falls back to the earth as precipitation (rain or snow), increasing the thickness of glaciers in mountains and snowfields near the North Pole and South Pole, as well as running into streams and rivers, and replenishing groundwater.

On its way through rivers and aquifers to seas and other sinks, creating waterfalls, lakes and wetlands, waters is used for irrigation, hydropower generation, water supply, recreation and other uses. Water both pollutes and cleans. While the water cycle on the earth is subject only to natural impacts there are no real problems in the natural process. However, if a human being starts to interfere with this natural process, resulting in considerable water abstractions and water pollution, the natural mechanisms are disturbed, and the water environment is degraded. There is a : depletion of water resources, loss of potential for water renewal, and deterioration of water quality etc.

The laws of nature rule water as the holistic "whole" in all points on the earth. Man does not follow this principle due to his disassociation, egoism, consumerism, and, to some extent, owing to a lack of understanding of the relationships and sequence of water processes, in which we often interfere like "a bull in a china shop." This often is not only the result of a lack of understanding the consequences of our own impacts.The fact is that today each economic sector (water users and consumers) is responsible only for its narrow strip of impacts, and usually does not want conceptually, administratively and financially to beyond these limits.

We can use different kinds of water resources: surface water, groundwater and return water. Who manages them, and who maintains records? The Hydro-Meteorological Services keep record of surface water resources, but the Ministries of Agriculture and Water Resources are responsible for water use in all countries in our region, and the Ministries of Geology are responsible for groundwater use. At the same time, return water is managed by all ministries, but actually by none of them. Here is an example of a situation related to the monitoring of water quantity and quality: All the above ministries are responsible for monitoring water quantity and have to be responsible for maintaining water quality (de jure), but de facto only the Ministries of Nature Protection (State Committees on Environment) are monitoring water quality. Let's review the situation in water use: the Ministries of Agriculture and Water Resources are responsible for irrigation; Ministries of Communal Services and local authorities are in charge of water supply and sanitation; Ministries of Energy or agencies that replace them (concerns, joint-stock companies etc.) are responsible for hydropower engineering. In addition, the fishery and forestry sectors have their own owners!!! One can say that “too many cooks spoil the broth.” Such a situation is observed not only in our region but in most countries of the world. Each ministry or organization has its own plans, resources and tasks; and each of them tries to be good in its own shere of activity where water plays a fundamental rolel As a result, we face a situation:called a “cats’ concert.” In our culture. Sectoral interests are at the top level of state hierarchy; however, water is used and consumed at the “bottom level”; and the responsibility of each government is to provide water rights for each water user: farmer, factory, household etc. Each economic sector responsible for water use and its protection at different levels has its own “hierarchical stairs” of governance and management for delivery of water from the source to water users. On this structure a water user or a water consumer stays at the lowest tier being lonely, powerless, and helpless. Israel, where all water issues are covered by the Ministry of Infrastructure and coordinated by the United Water Commission, may be, a single exception.

An understanding of the need for consolidating all kinds of water resources and all water-consuming sectors and even coordinating all water users (but, of course, not by the only body or even around the biggest round table) was formed long ago and was characterized by many actions undertaken by people and society at different stages of its development. One can recollect, for example, the Valencia Tribunal in Spain (the public gathering and trial), which has met from the 12th century to the present time (on a weekly basis ) in the central square in Valencia in order to discuss water availability for different users, and the efficiency and sustainability of water supply, was a real attempt at participatory coordination of water users. In the history of Muslim countries, there were the councils (“Majlis of Mirabs”), which represented the consulting meetings of “water owners” for solving water problems important for all.

Today, consolidation, coordination and integration of all interested participants in the process of water use and consumption should be linked to the issues of water relations. Step by step, an understanding of the need to apply this approach started to predominate at the end of 19$^{th}$ century and in the beginning of the 20$^{th}$ century. Integrated programs of the Tennessee Valley management in the USA and of river basin management in India (under the sway of Great Britain) were developed. Their action plans covered the interests of all economic sectors in an integrated manner (so-called Master Plans abroad, and Schemes of Integrated River Basin Water Resources Use and Protection in the former USSR). These schemes contained a forecast of water consumption and it’s extent against available water resources within an area under consideration in countries or specific zones in river basins. This took into consideration all sectors: hydropower engineering, irrigation, water supply etc. The schemes were coordinated with all republics for inter-republican watercourses and with provincial authorities for inland watercourses. Of course, these schemes had some shortcomings: they disregarded the requirements of the natural complex and took into consideration only the ecological flows through rivers without accounting for the requirements of the Aral Sea. While planning for increases in the efficiency of water use (the efficiency of irrigation systems; decrease in the rates of flows etc.) they did not include the necessary measures for its realization. These schemes were mainly focused on the planning bodies rather than on water management organizations. The shortcomings of these schemes became especially obvious in the forecasted period of complete use of available water resources (the end of 20$^{th}$ century), when the planned irrigated areas were developed, but the scheduled water saving measures merely remained on paper.

In 1992, the modern concept of integrated water resources management was proposed at a well-known conference in Dublin[2] in the form of four principles that became the basis for reforms in the water sector [34].

**Principle 1: Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.**

The notion that fresh water is a finite resource arises as the global hydrological cycle on average yields a fixed quantity of water per time period. This overall quantity cannot be increased significantly by human actions, but it can be considerably reduced owing to anthropogenic contamination; and this is happen very often. Fresh water is the natural resource, which needs to be maintained ensuring necessary water services. This principle suggests that water is necessary for different purposes, functions, and services; therefore,

[2] The international conference on water resources issues and the environment, Dublin, Ireland, January 1992.

water resources management should be holistic (integrated) and take into consideration both the opportunities to meet water demands and risks of depleting and contaminating water sources.

It is logical that according to this principle, the river basin or its catchment area should be a unit of water resources management. Hence, it follows that it is necessary to use the so-called hydro-geographic approach for institutional establishment of a water resources management system.

**Principle 2: Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.**

Water is a subject in which everyone is a stakeholder. Real participation only takes place when stakeholders are involved in the decision-making process and in implementing the decisions or, at least, monitoring the implementing decisions. A participatory approach is the only means for achieving a long-lasting consensus and common agreement. Participation means an acceptance of responsibilities, recognizing the effect of sectoral actions on other water users and aquatic ecosystems, as well as accepting the need for charge to improve the efficiency of water use and allow the sustainable development of this resource. However, the possibility of across-the-board participation is absurdity, in the literal sense of the word; and realization of this principle is possible only through forming representative non-governmental organizations, of local and production organizations created on a democratic base, that are expressing shared, territorial and other public interests. It should be noted that participation not always results in consensus and, therefore, arbitration processes or other conflict resolution mechanisms will also need to be put in place.

Governments also have to help in creating participatory capacity, particularly amongst women and other marginalized social groups. It has to be recognized that simply creating participatory opportunities will do nothing for currently disadvantaged groups unless their capacity to participate is enhanced. Decentralization of the decision-making process up to the lowest appropriate level is the only strategy for strengthening public participation in solving water problems.

Participation of all stakeholders is one of the ways that promotes the development of poor countries. A restrictive factor for development is a lack of information or limited access to necessary information in these countries. Opportunities, potential, and motives of public participation require further investigations and support.

**Principle 3: Women play a central role in the provision, management, and safeguarding of water.**

The role of women, as major providers and users of water in households, as well as defenders of the environment, is widely promoted in mass media for demonstrating those hardships and concerns, which they are bearing under low incomes. However, their role is seldom reflected in institutional measures aimed at water resources development and management. It is widely acknowledged that women play a key role in collection and safeguarding water for domestic purposes, and in many cases they, carry out hard manual labour in agricultural activity, and suffer, more from receiving less output due to irregularities in irrigation and drainage services. At the same time, they have a much less influential role than men in management and problem analyses and in the decision-making process related to water resources.

IWRM requires gender awareness. In developing the full and effective participation of women at all hierarchical levels of decision-making, consideration has to be given to the way different societies assign particular social, economic and cultural roles to women and men. There is an important correlation between the equal status of men and women, correct use of their different gender features and sustainable water resources management. Participation of men and women, who are playing influential roles at all levels of water resources management, may accelerate achieving sustainability. At the same time, water resources management in an integrated and sustainable manner makes a considerable contribution to achieving gender equality by improving the access of women and men to water resources and related services in order to meet their essential needs.

**Principle 4: Water has an economic value in all its competing uses, and should be recognized as an economic good.**

In the frame of this principle, first of all, it is necessary to recognize the basic right of all people to have access to clean water and normal sanitary conditions under acceptable payment. Water management, considering water as an economic good, is the important method for achieving social objectives such as effective and equitable water use and incentives for water resources saving and protection. Water, after diversion from its source, can be evaluated in cost parameters as an economic, ecological, and social substance. Most of the previous shortcomings in water resources management were related to the fact that in the administrative system and structure, economic indicators were used in a distorted form, in particular, a cost characteristic of water (as a resource) was not recognized, as well as the structure of full water value and sources for cost recovery were not considered. Eventually,during the period of transition to a market economy, this results in the financial instability of the water sector, loss of its production potential and general degradation. At the same time, such a situation is typical not only for CIS countries built on the ruins of "imperfect" socialism but also for Eastern and Central European countries, which preserved some features of "primitive" capitalism in their economics. These realities are described in the section "Water and Globalization" (see Chapter 6).

An economic value of water is considered in works of many authors. In some countries, for example, in Asian countries, water has a social, cultural, and religious value, which here is more important than an economic value. It can be explained by less developed economic and market relations here than in European countries or in the USA. Cultivating high-value crops for profit in developed countries, undermines the food security of the poor in developing countries.

**Value and charges** are two different things; and we have to distinguish clearly between *valuing* and *charging*. The *value of water* in alternative uses is important for the rational allocation of water as a scarce resource, whether by regulatory or economic means. *Charging* for water, along with governmental regulation in the form of subsidies, is applying an economic instrument, which is used for covering necessary expenditures and supporting vulnerable social groups [34]. One cannot but take into account that the correct use of these economic categories in the process of governance affects the behavior of different entities in terms of conservation and effective water usage, to provide incentives for demand management. This is to ensure cost recovery, and to the signal consumers' willingness to pay for additional instruments in water services.

It is important to recognize the fact that water, which is used under specific conditions, especially, when there is a water deficit, takes the form of an economic good, and becomes the important instrument for decision-making related to water distribution between different economic sectors or among different water users within the sector. This is especially important when a further increase in water supply is impossible and also when evaluating competing demands, for example, in dry years.

In many countries of the world, the basic principle of water resources management with some elements of integration was employed long ago when water users gave preference to long-term interests rather than opting to receive quick personal profit, and started they to co-operate,. Instances of collective activity related to water resources management show the advantage of such an approach, especially taking into consideration the dynamics of water relations, which never can "harden" in "status quo":

1. Under the introduction of a united management structure within the integrated hydro-geographical system, water consumption is adjusted in accordance with real *water requirements;*
2. The system of agreed rules specifies rights and duties of each water user and, at the same time, organizes the water sharing process and input in O&M of irrigation and drainage systems;
3. There is a general understanding that such coordination is profitable for all, i.e. an average profit of each water user becomes higher when all water users co-operate rather than compete with each other.

Arguments in favor of using this system are quite convincing; and it is possible to expect that, at present, the growing shortage of water as a whole and water of good quality in particular can stimulate establishing and developing the basin organizations. However, the real situation is different from a desirable one. There are examples of basin water resources management in the world, but what efforts were spent? Today known systems of cooperation at the basin level have a long history of overcoming many problems. For example, to create a modern system of basin water resources management, the Murray-Darling Basin Commission in Australia has spent almost 80 years overcoming many environmental conflicts and institutional problems, since the states within this basin have refused to transfer their rights on water resources to each other or to the Commission. However, even this system is not completely perfect, since the problems of soil salinization and increasing water salinity are growing in the basin. Another example is the Rhine River which was a sink of wastewaters in Europe as the agreement on joint actions was not signed by countries in this river basin. It took 50 years until the 1997 Agreement was signed on joint management of the river system Apalachicola-Coosa-Tallapoosa-Alabama-Chattahoochee-Flint (ACT-ACF) in the south-eastern part of the USA.

One of the first experiments in the world relating to the realization of the hydro-geographical principle of water management was carried out in Spain based on the concept of the joint body - association that united the interests of the State and water users. This idea of independence from the state administrative system in the process of grouping national territories having common hydrographic boundaries was the starting point for establishing the Hydrographical Confederations or simply "basin organizations".

The Creation of Basin Confederations was approved by the Royal Decree dated March 5, 1926 that has clearly defined the national water resources management system. This system is in place to date. Drawing up plans for the use of water resources and coordinating the interests of different water users in each river basin were entrusted to the Basin Confederations. Irrigation which uses about 70 to 80% of water resources is the biggest consumer in some river basins. It is important to note that 24% of territories in Spain have a surplus amount of precipitation; 72% of territories have precipitation amounting to 300-800 mm/year, and 4% - less than 300 mm/year. Irrigation is concentrated in the second and third zones; and the total irrigated area in Spain makes up 3,400,000 hectares. A total river discharge is evaluated at 93.4 $km^3$ of which only 24.3 $km^3$ are annually used for irrigation. The first basin confederation was established in the Ebro River basin, and then confederations were created in all other river basins.

In compliance with Article 19 of the 1985 Water Law (heretofore the 1879 Water Law was in force in Spain), basins with rivers flowing through a single autonomous region are managed by the Basin Water Councils *(Confederaciones Hidrograficas)*. These are organizations with their own legal status, different from the state, which are coordinated by the Ministry of Environment and have complete autonomous authority. Therefore, a river basin is considered as the territory (including the network of tributaries of the main river), through which water flows from the source of the river towards the sea. A river basin, as the water resources management unit, is considered indivisible. Thus, the activity of the basin organizations covers the territory of one or a few river basins, which can be limited only by international boundaries. For purposes coordination, aquifers located within these territorial boundaries are under control of the basin organizations as well.

The French water resources management system based on three conceptual principles is also quite interesting:

1. ***Legalization of decentralization***. This principle permits each autonomous hydro-geographical basin organization comprising of all parties (interested in water supply and responsible for its realization), to solve, at the local level, all conflicts of interests of industry, irrigation, fishery, communal administration, different associations and local population. Key decisions are locally made by the basin organizations. Funds, collected as a result of water supply services, are mainly used for developing the water supply infrastructure. The polluter pays principle was adopted in the French legislation in 1964.
2. ***Water is a common property of society***. All people responsible for water management or interested in this should come to an understanding that water is an integral part of the environment and belongs to all. However, water has a cost because it should be cleaned and delivered to consumers, and these activities require a certain expenditure.

3. ***Water pays for water***. The French system is based on the principle that water consumers including "bottom" users, local organizations and national departments should completely cover all expenditures related to investing into water infrastructure development and its O&M, distributing these reimbursements among them in the specific proportion.

The French experience is the fine demonstration of creating the clear-cut operational organization that united all stakeholders for conflict-free water resources management within the hydro-geographical basin. Basin organizations perform not only planning and regulative functions but also implement operational and monitoring functions. This unique system for financing all necessary functions for environmental protection, practically using the "polluter pays principle adopted" in the legislation, was established in France. France also has considerable experience in public participation in the water resources management process.

Readers can look through the information on the above –mentioned experience of Spain, France and other countries in detail on the website: **www.cawater-info.net/library/refer.htm**

Water resources management organizations can be of different forms. According to data from World Bank experts [27], at present, a few hundred "basin agencies" all over the world are operative over a sufficiently long period with good results. Data on institutional models of agencies different in their tasks and structures were collected. Presently, there are more than 20 different types of organizations. On the other hand, these "models" have many general characteristics or components and institutional principles as well. There is no doubt that any basin agency should perform the specific *management functions;* and its institutional structure has to have a number of corresponding *components (characteristics) and principles of structuring.*

It is important that basin management is the only iplatform for developing integrated water resources management. Therefore, the required structure and functions should be mentioned for specific activities being implemented in all sectors of water use. In other words, a basin management organization has to co-ordinate and supplement activity of all interested agencies. According to the global experience, many basin agencies, being either secretariats or commissions, only carry out coordinating functions and sometimes financing, while local authorities are engaged in developing water infrastructure, O&M, and land reclamation activity. Therefore, the establishment of a new basin organization or analysis of the activities of already existing organizations should begin with clear-cut specifications of functions. Functions, in their turn, define the institutional structure of a basin organization. An optimal structure of basin organization depends on specific administrative, legal, natural and socio-economic conditions, hydrological factors, and a time period for its creation. An acceptable structure for specific regions depends on the following factors:

- Physical and morphological characteristics of the water management system, its expected changes, and opportunities for the development by means of realization of infrastructural and institutional measures;
- The framework for specifying water requirements, expected changes, potential and possibilities of water users for paying for services;
- Administrative, legal and legislative aspirations of society and the government for improving and strengthening the structures. In Europe and the USA there was such a transition from "state interference" in the 1930s to 1950s to the political consensus based on market principles in the mid 1970s. In China, the transition from the planned economy to the two-storied semi-market economy took place after the 1980s;
- Historical experience and preferences conditioned by existing culture (traditions) regarding the governance, collective actions, settling of conflicts etc.
- Implementing joint actions both at institutional and physical levels.
- A main principle of creating the institutional structure consists in differentiating the spheres of influence and activities. In modern economic and social spheres, it is recognized that the most effective approach consists of the separation of regulating and executing functions. It was said that one of the causes for disrupting the activity of water organizations in England in the

1970s was distrust towards organizations that simultaneously had both supervisory and executive functions i.e. the organizations were both "forester" and "poacher." A basin organization should have only those functions, which it can execute to the best advantage – more efficiently, actively and stably than other organizations existing in the country. Thus, other agencies also need to execute their part of the functions only within the framework of the overall water resources management system.

- In some cases, new agencies for integrating basin water resources management are not created. In this case, adequate basin management can be established by means of voluntary co-operation of existing engineering organizations. Such an institutional structure is suitable for small and sustainable basins in the presence of a high level of public awareness, especially if administrative or another activity is already in progress; and/or establishing a new agency will not provide sufficient advantages. The most simple but the least effective form of basin management is fixed distribution, when an amount of water that can be withdrawn by each water user is specified beforehand. Such a system usually arises as a result of political negotiations (for example, the agreement between India and Pakistan concerning the Indus River signed in 1960).
- In-depth understanding of the role of an integrated approach in developing the water sector in Central Asia was intrinsic to the great Russian scientist and water professional, professor G. Rizenkampf who in the beginning of last century in his book "Golodnaya Steppe Irrigation Project" [12] has written; "The irrigation network is a canvas on which "life" will be embroidered; and in the process of its creation it is necessary to clearly see all aspects of future life. Development of an irrigation system should not be the end in itself; it is part of the integrated whole – the revival of a desert, from which the basic assignments arise and with which the irrigation system should be inherently linked … A key requirement is to provide the most rational arrangement of all life rather than only construction of irrigation networks, as well as achieving of the maximum effect as a whole rather than in any details. Among different engineering and economic requirements those which lead to the best organization of all life should be met, first of all. It is necessary not only to design the irrigation system but also to draw up the plan of developing an area under consideration including the scheme of roads, sites for industrial and market centers and pointing the most rational sources of energy in order to supply future factories and workshops. It is also necessary to prove that the designed irrigation system is inherently linked with future livelihood needs and is a good-designed part of the integrated whole."
- In this manner, the integrated development of large areas of virgin land in Central Asia was implemented in practice (Golodnaya Steppe, 1956; Karshi Steppe, 1964, and others); and these projects, in fact, are unique examples of the integrated and comprehensive development of large irrigation districts. However, this integrated approach had some shortcomings - lack of public participation and incomplete consideration of ecological requirements. Nevertheless, in all other aspects it has fully met modern requirements of the IWRM concept. Developing desert lands in the Golodnaya Steppe based on irrigation included the following activities:

- Irrigation and agricultural development;
- Construction of drainage systems to control soil salinization;
- Developing the residential area;
- Implementing measures for water saving at all levels of water management hierarchy;
- Construction of water and engineering infrastructure (water supply pipelines, roads, transmission facilities, communication lines, gas pipelines); and
- Institutional development and establishing the O&M system for both water infrastructure and other facilities.

As a result, in the 1960s to 1980s, sufficiently high indicators of irrigation systems' operation (irrigation system efficiency – 0.78; specific gross water requirement – 8,500 to 10,500 $m^3$/ha under an average crop yield of 2.8 – 3.2 tons/ha) were provided on the area of 320,000 ha in the Golodnaya Steppe.

After independence, the existing realities in Central Asian countries confirm the need for reforms in the governance of the water sector. These reforms, taking into consideration market conditions, have to provide adequate water management structures with farming on irrigated lands, as well as the co-ordination of all other economic sectors - water consumers, and, at the same time, to ensure a sustainable environment.Most importantly, the reforms are to be the basis for general sustainable development.

It is our firm opinion, that the introduction of IWRM is a process of long-term development taking a spiral path rather than linear one. Each cycle must have specific objectives, and its realization should be accompanied by appropriate monitoring and evaluation and adjustment of initial plans. A basic requirement of IWRM is to change the existing operational methods of water management organizations, taking into account the overall situation in the region. By introducing IWRM, we aspire to put elements of decentralized democracy into the practice of water management with emphasis on the participation of all stakeholders in the decision-making process, at all levels of water management hierarchy. Such an approach while providing new opportunities also creates new risks. IWRM needs to develop the mechanisms that allow all participants in water management and its use, often with obviously opposite interests, to work together.

An **agreed action plan,** containing the methods of reforms' realization in each country, is needed to introduce IWRM in Central Asia. Reconciliation of the regional water strategy, which should be based on national strategies and reflect the principles of sustainable water resources management, should be a starting point for its development. Undoubtedly, putting his strategy into practice will require reforming the water legislation and activity of water management organizations. This process has already started. It will be rather long and has to be accompanied by intensive consultations with the public and organizations that will be reformed.

An objective of this book is to demonstrate the experience of introducing the IWRM principles in Central Asia, including the advantages, comparing it to global achievements, and shortcomings that should be remedied in order to promote the adequate and effective practical realization of integration processes in the region.

# CHAPTER I. IWRM PRINCIPLES

**(V.A. Dukhovny, V.I Sokolov, H Manthrithilake., N Mirzaev.)**

As was stated in our previous publication [3], we understand IWRM as follows:

*"IWRM is a management system, based on taking into account all kinds of water resources (surface water, groundwater, and return water) within hydrological units, and coordinating the interests of different economic sectors and hierarchical levels of water use, involving all stakeholders in decision-making, and promoting the effective use of water, land and other natural resources to meet the requirements of eco-systems and human society through a sustainable water supply."*

IWRM is based on the following key principles that define its practical backbone:

- Water resources management is implemented within the hydrological units in concordance with geomorphology of the drainage basin under consideration;
- Management takes into consideration assessment and use of all kinds of water resources (surface water, ground water, and return water) and the climatic features of the regions;
- Close co-ordination of all kinds of water users and organizations involved into water resources management, including cross-sectoral (horizontal) co-ordination and co-ordination of hierarchical levels of water governance (basin, sub-basin, irrigation system, WUA, and farm as the end user);
- Public participation not only in the water management process, but also in financing, planning, maintaining and developing water infrastructure;
- Setting the priorities of eco-systems' water requirements into the practice of water management organization;
- Participation of water management organizations and water users in activity related to water saving and control of unproductive water losses; water demand control along with resources management;
- Information exchange, openness and transparency of the water resources management system; and
- Economic and financial sustainability of water management organizations;

In our opinion, IWRM may be considered as the complete system when all the above-mentioned elements and principles are put into practice, although forms and methods of introduction can differ. Partial introduction of some principles, for example, the basin method or participatory approach, cannot be the basis for statement and recognizing of the fact that IWRM is the complete system.

Let's describe the crux of main IWRM principles, because it is important to understand what kinds of measures are necessary for its practical realization.

## 1.1. Management within the Hydro-Geographical Boundaries or according to the Hydrological Principle

As known, water does not recognize the administrative division. Following the laws of physics, almost all the water on the earth has passed through the hydrologic cycle countless times - it evaporates from the earth's surface, condenses in clouds, falls back to the earth as precipitation (rain or snow), and eventually either runs into rivers, from which it can be withdrawn for use, and into the seas or re-evaporates into the atmosphere. An Earth area, where surface stream (river) is formed, is called a catchment area (hydro-geographical or river basin). Within the river basin, water is in permanent motion and naturally crosses the administrative boundaries delineated by human beings on the basis of geopolitical considerations. Thus, it is understandable that to manage all factors affecting the hydrological cycle, it is necessary to keep control over the entire river basin by a body or consortium of closely interacting organizations. An organizational set-up within the administrative boundaries, which does not usually coincide with hydrographic boundaries, results in loss of record-keeping and control of some components of the hydrologic cycle, affecting the sustainability and equality of water supply i.e. the key tasks of water management.

Most water professionals feel that river basin boundaries should be adopted following the catchment area pattern, in compliance with the regulations of Article 2 of the Helsinki's Rules (1966). However, in the so-called runoff dispersal zone, the effects of water management often transcend the boundaries of catchment areas and spread, especially, under pumping irrigation, over the command areas of irrigation canals. For example, the command area of Amu-Bukhara Canal (water abstraction from the Amu Darya River) covers practically the whole territory of another river basin (the Zerafshan River). The same takes place in the command areas of Karshi and Kara-Kum canals, which cover the basins of several rivers, and in many other water management systems in the region. A more complicated situation is observed in the Fergana Valley where the modern dense network of main irrigation canals with water diversion from the Syr Darya River, which have been designed and constructed during the second half of 20$^{th}$ century, has overlapped the ancient system of oasis irrigation with water abstraction from small rivers, local streams and aquifers, forming a complex combination of water ways with double and, sometimes, triple feeding.

**Figure 1.1**
**A Leaf of Tree as a Single Organism with the System of Feeding Capillaries**

Thus, reviewing the boundaries of water management following the hydrological principle in each specific case, it is necessary to define clearly the limits of real and appreciable impacts of water sources, and territories, which are significant for IWRM. Infrastructure for regulating river flows, especially large dams for irrigation and hydropower, as well as ramified irrigation systems form the intricate anthropogenic morphology of water management systems within the basin as a whole or in part. These are very complicated systems for all kinds of water supply and for drainage as well. As a rule, they have the form of a complex "tree" of water system hierarchy with subordinated branches (main, inter-farm, on-farm irrigation and drainage canals).

Interconnection of these systems creates the intricate complex of objects related to integrated management, use, protection, and development of water resources, which should be covered by the specific governance system. Apart from water resources themselves and water infrastructure, this complex includes related land and other natural resources not only on the catchment area but also in the zone of so-called intensive water-economic influence. It absolutely does not require, and it is often impossible, to manage the territory of a whole hydro-geographical complex by using one water management organization. A good example of a possible approach is the French basin management organizations, which rely on the public participation in the framework of the so-called basin agencies that interrelate respectively with the subordinated public organizations at the sub-basin level.

Governance based on the hydrological principle, thus, can have a united organizational structure at national level; however, more often, it should coordinate a complicated hierarchical configuration vertically, and that will be described below. A major instrument of water resources governance within the hydro-geographical boundaries is the build-up of organizational structures according to the hierarchy of watercourses, first of all, natural streams and then man-made ones.

So, what does water governance in compliance with the hydrological principle mean? An illustrative example of the hydro-geographical principle under organizing water governance can be a leaf of a tree on which the configuration of arteries and their integration into a single organism are visible (Figure 1.1). Any water management system where the whole area of water use is linked to the hydrography of a major watercourse – a river or main canal with many off-takes into its laterals, through which water is delivered to the end user , is arranged in the same manner. Nature itself created the hydrological cycle, which is related to the specific territory, and this approach should be applied without disturbing the natural harmony of vital functions.

Let's imagine what can happen when an administrative border crosses a leaf as the border between two countries or, in other words, water (nutrition) supply over a leaf will be arranged within these "administrative borders" in the non-coordinated way. For example, the upper part of this leaf draws more water than necessary and intercepts water supply to its lower part. It is clear that such water distribution can result in partial degradation of the leaf or even complete damage. Water does not recognize the administrative borders established by mankind in line with geopolitical or other considerations. Therefore, water governance should be built up for a single hydrographic network rather than according to the administrative borders.

A system of the South Fergana Canal (SFC) in the Fergana Valley can be used as a model of the hydro-geographical unit (Figure 1.2).

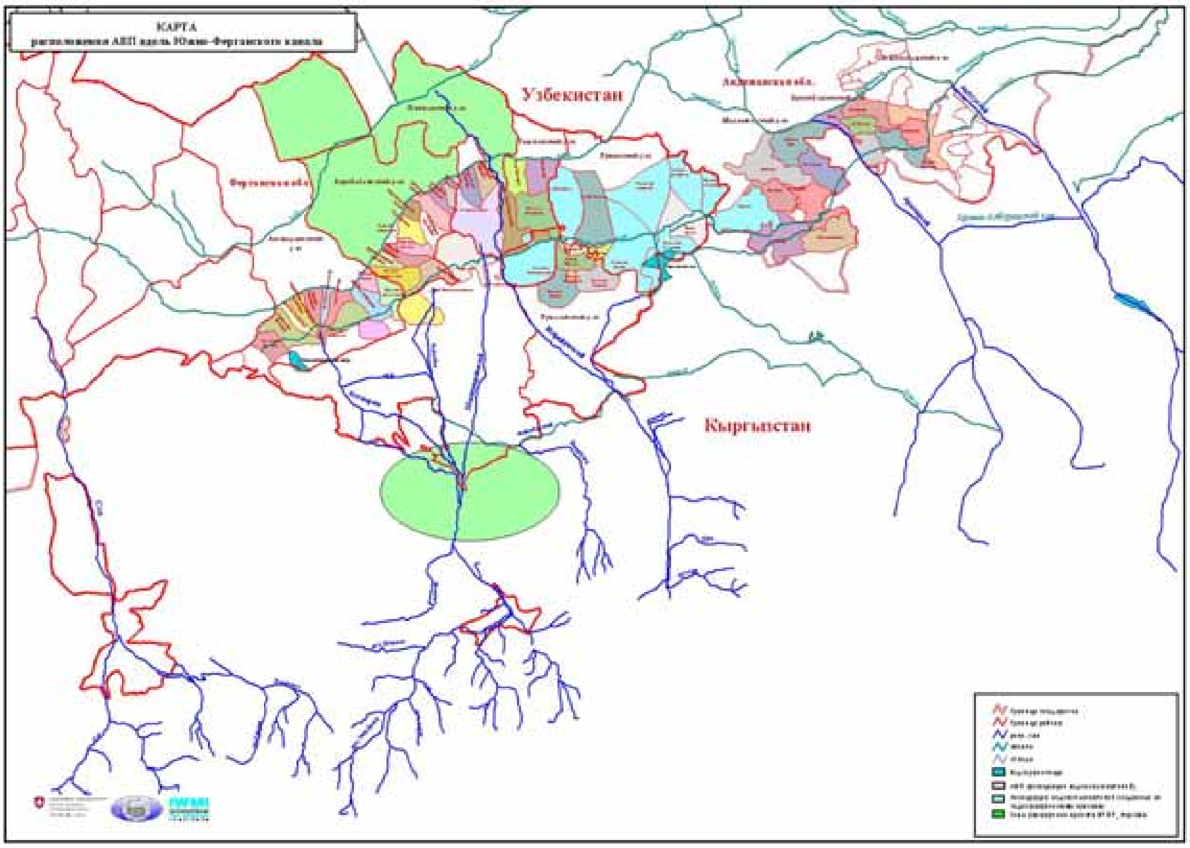



**Figure 1.2 Irrigated Lands in the SFC Command Area**

The head works of the SFC is located on the Shakhrikhan-Say that is the tailrace canal of the Andijan Dam on the Karadarya River. The total length of the canal amounts to about 120 km. The size of the SFC command area is 83,844 ha, and it covers mainly the territories in the Andijan and Fergana provinces and partly in the Osh Province in the Republic of Kirgizstan (about 2500 ha). In 1962, in order to increase the water availability in the SFC command area, the Kirkidon Reservoir (having a capacity of 218 million $m^3$), which was partly was filled by water from the Isphara-Say River, was built. to fill the reservoir during periods of excess water resources in the SFC, the supply canal 26 km long with a carrying capacity of 18 $m^3$/sec that diverts water from the SFC, was built 6 km upstream of Markhamat Settlement. Since 1967, the Kirkidon Reservoir is annually filled up to a total volume of 170 – 180 million $m^3$. The lined tailrace canal is 2.7 km long and with a carrying capacity of 50 $m^3$/sec it releases its water back into the SFC during periods of water shortage. Since 2003, this entire system, from the outlet of Andijan Dam to the tail section of this canal in the Altyaryk District of the Fergana Province, was handed over to the SFC Administration for integrated management. However, in the process of introducing IWRM within the SFC system, the need to link this management with operational regimes of a number of small rivers, which cross this canal, has arisen; because their unregulated flows considerably affect the operation mode of the SFC system as a whole.

Thus, the morphology of basin or system is a key factor for transition to management based on hydro-geographical principles, in the framework of which appropriate limits and requirements should be specified in accordance with specific features of this morphology to provide the sustainability of natural complexes. At the same time, the monitoring and drawing up of the water balance for the basin as a whole, separate sub-basins or irrigation systems (their close coordination with using institutional, economic, technological, and managerial instruments and involving stakeholders) should be provided.

An overall co-ordination of all hierarchical levels of water resources management (Figure 1.3) is founded on two fundamental principles:

- Achieving potential water productivity at all hierarchical levels right up to the basin level;
- Reducing specific water consumption within the system (against water diversion) up to the level of water consumption being equal to the evapotranspiration of crops.

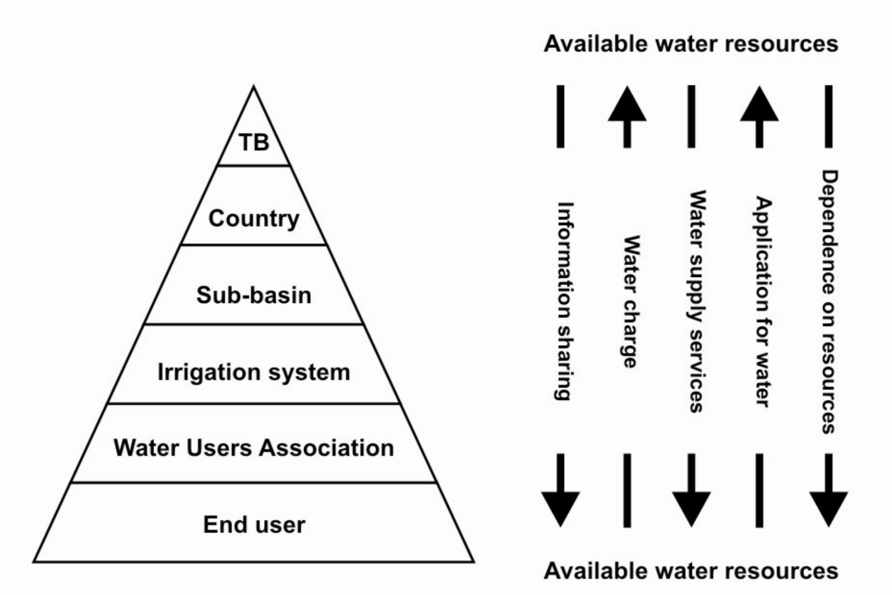



**Figure 1.3 Levels of Water Governance Hierarchy and Main Links in the IWRM System**

One more feature of water resources management grounded on the hydro-geographical principle is the fact that it is unique for each basin, irrigation system, and WUA because the basin morphology, soil and hydro-geological conditions as well as organizational and economic relations of water suppliers and water users are extremely diverse. We should not look for general patterns or solutions for different systems; it is necessary to develop only the overall principles of implementing IWRM.

## 1.2. Accounting and Use of All Kinds of Water Resources

Water resources used within the boundaries of a drainage basin are abstracted from surface and underground sources. One problem is that the different organizations are responsible for the assessment and record keeping of water resources in these sources. However, a more serious problem is that the different organizations control and manage the use of these water resources without the necessary coordination. Such a practice results in chaos in collecting of data on water resources status, and failures of equality and equity in water use. This problem is especially obvious in dry years.

Mr. Sorokin has clearly shown the shortcomings of existing water monitoring and record keeping in the Syrdarya River basin by analyzing of the water shortage situation in 2007 (the project CAREWIB). Figure 1.4, adopted from this analysis, shows that water releases from the Toktogul Reservoir (a major regulator of river flows) considerably differed from target indicators. Under these conditions, national water management organizations, and accordingly water users, were receiving water with high deviations from target amounts, approved by the ICWC as their water use limits (quotas), due to the following factors: unreliable forecast of water releases from the reservoirs, inaccurate information on flow rates, and lack of data on drainage water disposal into the river.

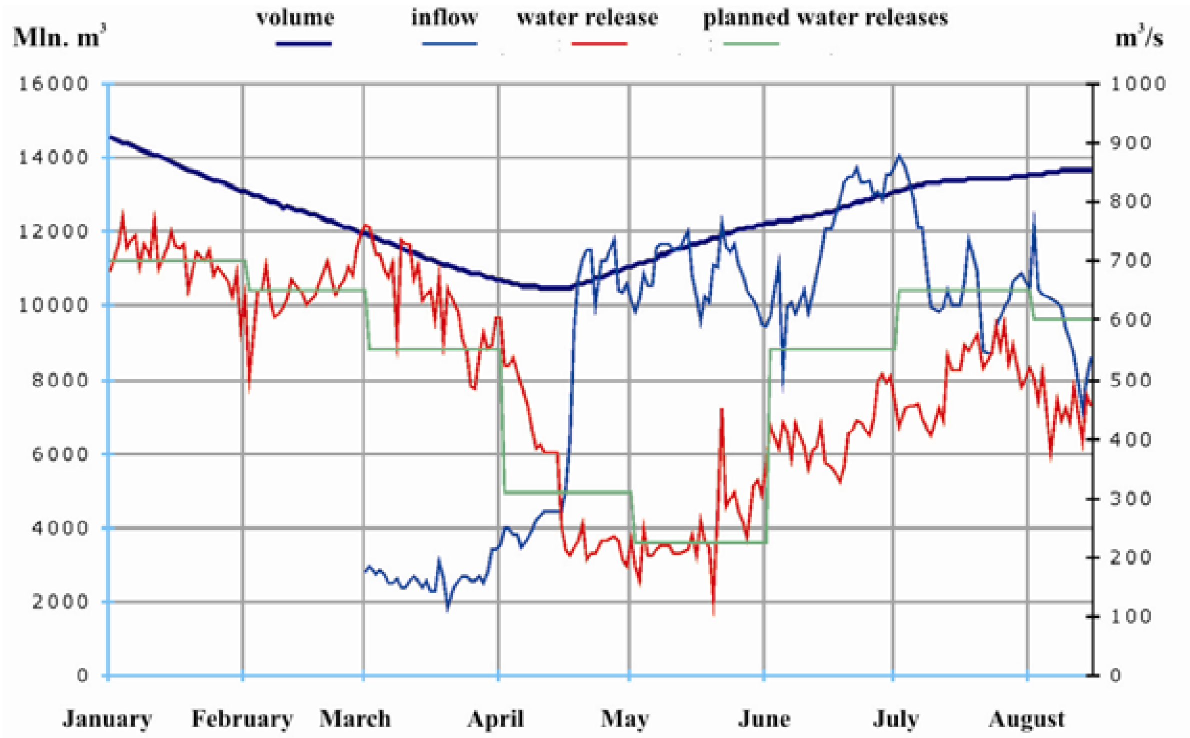



**Figure 1.4 Deviations in Water Releases from the Toktogul Reservoir against the Planned Regime**

You can image the constrained circumstances of a water user who knows that he will receive less than a planned amount of water, but doesn't know how much and when. Naturally, he tries to adjust his water needs but he does not have a forecast of weather conditions (temperature, rainfalls etc.) for revision of his irrigation schedule.

We do not think that the united system of forecast and record keeping can be today provided by one organization for the entire region (such an attempt was undertaken in the USSR by means of introducing the special statistical reporting in the Ministry of Water Resources: the Form “2-TP Vodkhoz”). The main idea is to establish: a) a monitoring and record keeping system that will meet standard requirements and be adopted by all states in the region; b) an information exchange system, using standard indicators and prescribed accuracy of data; c) access to all databases on all kinds of resources; and d) a reliable system for forecasting the flow rates (based on joint activity of all national hydro-meteorological services in Central Asia).

Most of naturally renewable water resources are formed over the surface of a catchment area and drain into the river network. Formation and transformation of run-off along the rivers are monitored by national hydro-meteorological services. Water management organizations are in charge of delivery and distribution of the water, diverted from rivers, among water users. Small water sources are under the jurisdiction of local authorities.

Another component of renewable water resources is groundwater, which according to its genesis can be divided into two types: groundwater is naturally formed in mountains or over a catchment area; and groundwater is formed due to infiltration on irrigated areas. Groundwater resources within the basin are assessed based on hydro-geological exploring, and following it, useful groundwater resources that can be used are approved. Ministries of Geology are in charge of assessment and use of useful groundwater resources without sufficient co-ordination with water management bodies.

Return water that is formed after primary use of natural run-off makes up part of waters used within the boundaries of river basins. It is formed due to releases of excess water from fields and by natural or man-made drainage. Owing to its high salinity, return water is the major source of contaminating water objects and the environment as a whole. Under current conditions in the river basins with an arid climate, 90% of return water consists of drainage water disposed from irrigation land, and the remaining part is waste water from industrial enterprises and public utility companies. Water management bodies and hydro-meteorological services are mainly responsible for monitoring and record keeping of return water, however, nobody practically controls the reuse of these waters. Although many research and promotional works were implemented to assess the possibility of return water use, up to now there are no comprehensive normative documents and regulations for its use. As a result of the haphazard use of return water for irrigation, land salinization takes place, resulting in a considerable decline in land resource productivity.

In addition, it is necessary to bear in mind that return (drainage) water within an irrigated area is a by-product of irrigation; and in the process of improving or changing management methods its volumes can be correspondingly reduced, and at the same time, water salinity will increase.

On the one hand, accounting of all water sources is very important in order to meet the requirements of water distribution in an equitable manner but, on the other hand, from the point of view of controlling water quality, management of return water has great implications, since return water formed under all kinds of uses is the major source of polluting natural waters. At the basin level, tools for controlling groundwater and return water are the following:

- Record keeping of renewable groundwater, linked to zones of their replenishment, and estimating allowable amounts for their use as well as quotas (water use limits) for water abstraction depending on annual water availability. At the same time, it is very important to apply the principle of artificial groundwater recharge in wet years in order to use water reserves during average and dry years. During devastating droughts in 1974 and 1975, in the Fergana Valley more than 1,000 water supply wells, drilled in shallow freshwater aquifers, helped reduce water scarcity in this zone. In areas of its use, groundwater tables have steeply dropped; and underground inflow into the river has decreased, but in subsequent years, when water supply wells were put out of operation, the regular groundwater regime has been restored;
- Regulations on drainage and waste water disposal into international and national rivers and sinks including restrictions for releases of pollutants taking into consideration water availability in rivers; and
- Regulating drainage water quality, including aspects of its intra-system use - the utmost permissible salinity of drainage water may be an indicator to specify the rationality of its use for irrigation.

It is very important to select proper tools for planning and management at the irrigation system level. Applying the Geographic Information System (GIS), areas if possible, economically and technically, using groundwater and drainage water (water abstracted from irrigation and drainage tubewells) need to be specified for each irrigation system, taking into account the texture of soils and water salinity. In order to specify additional water sources, overlapping of thematic maps with water demand zoning maps (thematic layer of the GIS) has to be carried out. These data are included in water use plans to ensure more equitable water allocation. Particularly favourable conditions for return water use at the level of farm, WUAs or main irrigation canals are formed in inter-mountain valleys within cascade location of irrigated areas when return water from upstream irrigated areas can be delivered to canals in downstream irrigation systems by gravity

The use of industrial sewage for needs not requiring a high- quality treatment is an effective method of water resources reuse. In the irrigation sub-sector, such an approach is applied in Australia and Israel for cascade irrigation of salt-tolerant crops, where drainage water formed after irrigation of grain and forage crops is subsequently used to irrigate first sunflower plots, and finally plantations of trees and bushes.

## 1.3. Cross-sectoral Integration of Water Users (Horizontally)

There is an impression that the cross-sectoral co-ordination is needed only during periods of water shortage, and while a water deficit is absent each sector can regulate its own rules for water use. However, it is far from the truth. By way of example, we review the Chirchik River basin – sub-basin of the Syr Darya River that was studied in the frame of the project "RIWERTWIN" (www.cawater-info.net/rivertwin). As a whole, this river basin has excessive water resources, which in average years considerably exceed the water needs of all consumers – hydropower, irrigation, natural complex, water supply, and industry. A surplus of water resources reaches three cubic kilometers; but, at the same time, some irrigation schemes suffer from insufficient water delivery due to lack of co-ordination of different sectoral interests.

The question is that even under the availability of excessive water resources, should the integration of interests of different sectoral water users be implemented taking into consideration a regime of water releases and water supply, requirements to maintaining water quality in rivers and other water bodies, and provision of regular operation of the basin complex? By way of example, we describe the experience learned in the Rhine River basin where, under general excess of water, upstream industrial enterprises, especially factories of the chemical industry and the cellulose industry, released so much harmful ingredients with their waste water, that the river has lost its fisheries and recreational functions. Signing a special agreement and 20-years of joint work were needed in order to rehabilitate the "ecological health" of this river.

From the point of view cross-sectoral (horizontal) integration, water management organizations should fairly represent the interests of all water users in different economic sectors and provide a priority of water saving and eco-system preservation within the boundaries of each hydro-geographical unit. As mentioned, above, the problem is that different departments manage the use of different kinds of waters. For example, surface water is managed by the Ministries and Departments of Water Resources, first of all, in the interests of irrigated farming, and, at the same time, by the Departments of Energy in the interests of power generation etc. At the same time, all the above-mentioned public departments and ministries, as a rule, do not co-ordinate their activity with each other. If during the Soviet period there were statistics on water use in all sectors (Form "2-TP Vodkhoz"), currently nobody has even general information, and this form of reporting is maintained only in some departments and ministries.

Gathering all economic sectors under "a single organizational roof" is not needed at all. Furthermore, as noted correctly in the GWP handbook [31], this approach can be even harmful since a sectoral professional specialization is important for an effective activity of specific production. However, the main basis for cross-sectoral integration is the co-ordination of sectoral interests in the process of joint use of available water resources according to agreed schedules, and use of wastewater derived in one sector by other sectors. At the same time, the mechanisms for conflict settlement should be developed to integrate contradicting interests. It may be achieved by involving the representatives from different sectors in public governance at any level of the water management hierarchy. The public bodies established on an equal footing should provide consensus based on mutually acceptable regulations. There are the following instruments for co-ordination:

- Overall planning and co-ordination of water resources use;
- Coordinating the economic growth of sectors;
- Information exchange; and
- Participation in material and financial inputs of mutual interest

Relevant public conciliation bodies play a positive role in co-ordination, (the participation of representatives of such sectors as hydropower engineering, nature management, agriculture, and water supply in the Basin Water Councils, and correspondingly the participation of representatives of administrative districts and large water users in the Irrigation System Councils, as well as water users in the WUA boards). In many countries, the National Water Councils, consisting of leaders of all sectors interested in the use of water resources as well as key scientists and water professionals, were established under the direct guidance of Prime Ministers of these countries.

## 1.4. Coordinating Different Levels of the Water Management Hierarchy (Vertically)

As known, a modern water management system, especially, in the irrigation sub-sector, is a multilevel scheme of water supply and distribution that starts from a basin, mains, secondary and tertiary canals, irrigation network within water users' associations (WUAs) or the water distribution network of utilities and industrial water users (WUO) and finishes on irrigated fields of farmers (see Figure 1.2 above). Basic water losses and water supply irregularities take place owing to the lack of co-ordination between different hierarchical levels of water management and result in an overall inefficiency of the water management system. We suffer from losses owing to poor water management rather than water scarcity. Therefore, one of the main tasks of IWRM is the proper co-ordination of activities at different hierarchical levels of water management. A situation where each water agency develops its own criteria and approaches that do not correspond to the overall objective of IWRM to reach maximum water productivity needs to be removed. Provincial and basin water agencies have an interest in supplying water to consumers as much as possible, and, in their turn, water users are interested in reducing their water consumption to the minimum (if they pay money for water).

Each level of governmental water management hierarchy tries to take the maximum possible water volumes from a water source and to allocate these water resources to those persons who require more, or according to instructions from their superiors. At the same time, water agencies do not sufficiently take care of maintaining a high efficiency of irrigation systems and of preventing operational water losses. In addition, having excessive water reserves, they often dispose of unused water (considerable financial resources are spent for water delivery, especially under pumping irrigation) into the drainage system.

To create the overall interest of all hierarchical levels in minimizing unproductive losses and in uniform and equitable distribution of water among consumers, the specific goals of the government and society to develop and support a set of management measures and instruments needs to be promoted.

A basic tool needed for coordinating activities at different levels of the water management hierarchy (both according to horizontal and vertical links) is public participation in decision making of the properly established institutional structure. An organizational chart of the modern institutional water management structure is shown in Figure 1.5. There are the following levels: the upper level is a basin that can be divided into sub-basins; the next level is irrigation systems (having a common water intake and main drainage network) or an administration of single main canal; further, the level of WUAs (in the sub-sector of irrigation) or of WUOs (in case of other water consumers); and finally water users (farmer, enterprise, residential district etc.). In case of an inland drainage basin, a basin water organization (BWO), which is usually established within the framework of the National Ministry of Water Resources and can consist of territorial water management agencies, is responsible for water management in the basin and sub-basins according to the regulations of the BWO (similar to the BWO in the international basin). Basin Councils, consisting of the representatives of different "interested entities" with different rights and duties depending on national legislations (for example, with the consultative status as in Kazakhstan or the decision making status as in France, Spain, and The Netherlands where they are called "Committees" and "Boards") can be established under the BWO.

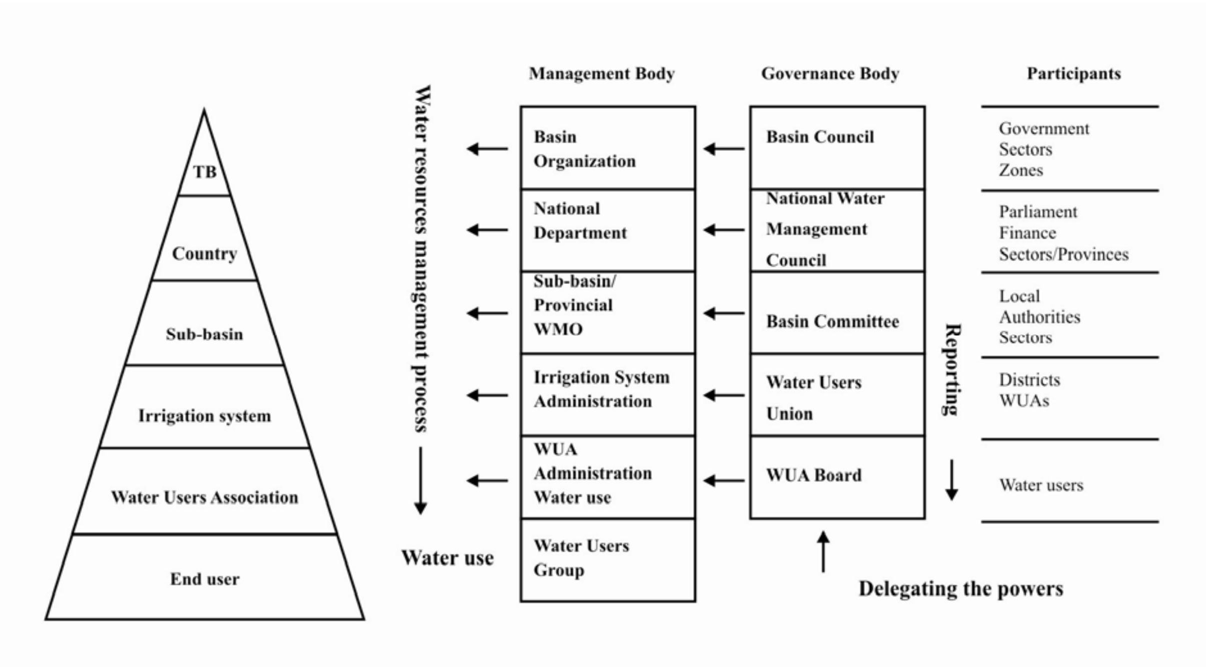



**Figure 1.5 Levels of Vertical Water Management Hierarchy and its Key Actors**

The management of irrigation systems diverting water from basin water sources is the prerogative of an organization located at the next hierarchical level, and which may be subordinated to the BWO or may be a coorporative public-and-governmental organization. In any case, at this level of the water management hierarchy, the representatives of public or public-and-governmental organizations should be involved in works of the governing body "BWO Council." WUAs, with their own administrative staff and mechanisms of public participation and with the similar proportion of rights and duties in managing of irrigation systems or single canals, are the next hierarchical level. Such a principle was applied in the governance and management of all pilot irrigation canals in the frame of the IWRM-Fergana Project. Although, it was necessary to take into account the presence of one more complex structure of the irrigation hierarchy (inter-district irrigation canals), because in contrast to the command areas of Aravan-Akbura and Khodja-Bakirgan canals, here only some of the WUAs were supplied with water directly from the SFC, but other WUAs were supplied from the canals of the lower level.

The next element of co-ordination is contractual relationships based on the practice of applications for necessary resources that are formed according to the "bottom-up" approach with restrictions in the form of water use limits and relevant water supply schedules that are formed according to the principle "top-down." Contractual relationships between BWOs and irrigation system administrations have to be regulated by the specific planning system in the frame of the overall state regulation, where the water rights and duties of both sides are fixed within a range of permissible deviations. A water management organization should ensure implementation of the planned parameters of water supply agreed on by both parties. Similar relations are established between the irrigation system administration and WUAs, but they are already grounded on the specific financial relations and relevant sanctions.

When the irrigation administration is a subdivision of BWO, the contractual relationship is formed only between the BWO and WUAs. In parallel with management according to the "bottom-up," principle, participatory water management is formed in the following succession: WUA – the Canal Committee (or the Irrigation System Committee) – the Public Basin Council. Apart from institutional tools of the co-ordination, there are also management, legal, and financial tools. In the framework of IWRM, the priority functions of these organizations are not only water management itself in agricultural, industrial, hydropower, and trade sectors but also the responsibility for effective water use in those sectors. It is clear that in order to perform these functions it is necessary to have appropriate mechanisms and instruments of dialog and coordination.

**Management instruments (see more details in Chapter 5):**

- Record keeping of water at all levels of the irrigation system from basin to farm; and strict water consumption rationing;
- Drafting the coordinated plans of water allocation and use at all hierarchical levels of water management that include organizational water loss control;
- The reporting system that shall provide not only annual and quarterly reports but also an operational report with planned criteria and indicators for timely adjustment of water supply;
- Improving dispatcher control to ensure equitable and sustainable water supply,. upholding the priorities of eco-systems and municipal and industrial water users as well as the observance of restrictions related to water infrastructure safety; and
- Adjustment of water use plans based on tailor-made computer models in case of changes in hydrologic, climatic, economic, and other conditions.

At the same time, the above-mentioned instruments should be an integral part of the management information system (MIS) that is an important component of introducing the IWRM principles (see details below).

**Legal and economic instruments** are closely interrelated and mutually complementary. Principle instruments are given below:

- Water user rights and their protection by the State;
- Contractual relationship between water users and water management organizations, and also between water management organizations operating at different hierarchical levels;
- Legislation covering a liability for infringing water rights and contractual relationships;
- Payment for water supply and other servicing of water users (it has to be differentiated depending on water service quality);
- Penalties for water pollution;
- Fee for water as a resource;
- Government control of rights and duties of water management organizations and water users, as well as the state liability regarding the support of both parties;
- Incentives and preferential terms for water users and water management organizations to rationalize the water use; and
- Fines for surplus water abstraction.

It needs to keep in mind that public participation was, is, and will be the main instrument for coordinating water users according to their horizontal and vertical links.

## 1.5 Participatory Water Resources Management and the Government's Role

An extremely important component of putting the IWRM principles into practice is the broad involvement of public organizations and other stakeholders (local authorities, municipal water users etc.) in the management process. Water resources management issues need to be considered in the context of interactions between civil society and the State.

The participatory approach has to create an environment of *transparency and openness*, where the likelihood of decisions not meeting the public interests is reduced.. The higher the level of public participation the less favorable conditions for corruption and ignoring of public interests. This is an instrument for preventing local or sectoral egoism in water use. This is the platform for making equitable and well-thought-out decisions regarding water allocation, taking into account nature preservation requirements and economic growth under conditions of increasing water scarcity.

Based on the principle that water is not only a private good but also a public one may arrive at the conclusion that public participation is the most important component of water management.

Public participation also is the most critical factor to control any kind of "*hydro-egoism*"[3]. The previous administrative system of water management threatened water users with "administrative hydro-egoism," under which the management of administrative and territorial bodies used the water supply systems, first of all, for their own sake, and, at the same time; there were conditions for corruption, arbitrary rule, and infringement of interests of others. A transition to water management based on hydrological principles cannot, in itself, provide genuine IWRM because there are prerequisites for "*professional hydro-egoism*," since due to lack of public control, water management organizations themselves plan water allocation, establish water use limits, adjust these water use limits, and finally audit their own activity. Therefore, public participation is the guarantee of fairness, parity, and consideration of all stakeholders' interests in the process of water management. A role of public participation is enhanced by means of *establishing public bodies such as the Unions of Canal Water Users, Basin Water Committees (Council) etc. in parallel with existing water management organizations.*

They are public representative bodies that govern water management activity within the appropriate irrigation system. Broad representation implies the participation of all stakeholders in the water management process, namely: representatives of water agencies, representatives of water users from different economic sectors (irrigated farming, municipal water supply, industry, fishery etc.), and representatives of local governments, conservancies, and non-governmental organizations. A Union, Committee, or Council should co-ordinate the activity of legal entities and individual persons related to water management and use this within an irrigation system or the command area of a single irrigation canal. A major objective of their activity (together with their executive bodies and under broad participation of all stakeholders) is to put integrated water resources management principles into practice

No matter how employees of existing water management organizations (WMOs) operate, there is an issue related to establishing public organizations of a new type that enable us to provide grreater involvement of water users in water management as a matter of ensuring fairness and using the potential of collective intellect; and, in the future, these can become genuine governing bodies bearing complete responsibility regarding water management. Our experience shows that the management of WUAs and the Canal Water Users Committees do not participate enough in the processes of water resources planning, allocation, and management, as well as in decision making related to maintaining and rehabilitating of water infrastructure and seeking funding sources. At the same time, the practice and methods tested at pilot irrigation systems are gains for the future. We need to prevent the conversion of these bodies into ones with only advisory functions or into "an adjunct" of WMOs.

The system of public participation in water resources management should be built up in such a way that representatives of water users and other stakeholders could really participate not only in monitoring of water agencies' activity but also in planning and implementation of water-related works at the expense of

[3] A term "hydroegoism" is widespread in publications and is treated as a dominance of group and corporative interests in the process of water allocation and use over the national interests.

their own financing or other funding sources. Public participation has to provide "transparency" of water agencies' activity and to prevent transforming of former administrative bureaucratic systems into a new professional and sectoral bureaucracy with its "hydro-egoism." Water Councils of basins and sub-basins have to be composed of representatives of concerned regions (districts), principal water users, and water-conservation bodies. The Water Committees of irrigation systems or canals should be composed of representatives of water management organizations, WUAs, and other water user associations. Finally, WUAs themselves should establish such a system of partnership with the State and private sector, which could be a driving force for transforming activity related to water sector development into national action.

Public participation is especially important in the process of developing principles and methods of water distribution within the former on-farm irrigation network. It became obvious that engineering tools alone are insufficient, especially now when the number of water users has considerably increased. The process of water management becomes extremely labor-intensive when a WUA consists of one thousand water users or even of a hundred water users. No WUA could efficiently manage water resources without grouping water users or without the teamwork of farmers in command areas of on-farm irrigation canals. In the Fergana Valley, big number of water management sites were established on each on-farm canal within the pilot WUAs. This is evidence of the complexity of equitable and stable water distribution at this level of irrigation system under implementation of the planned irrigation schedule.

Water distribution along main irrigation canals is also very complicated, because during the period of administrative subordination to local authorities, the number of off-takes that were not designed has increased many times (both gravity and pumping off-takes). The South Fergana Canal is a typical example; according to design documents, only 112 off-takes had to be constructed but at present, there are 260 off-takes including 100 off-takes with a carrying capacity less than 100 l/sec.

Under these conditions, along with planning water use according to the "bottom-up"principle, taking into consideration the requirements of water applications on fields and operational modes of on-farm canals (applying computers and optimization models) it is necessary to implement a number of measures to involve water users in the process of planning and management including water distribution. It should be done on the basis of thought-out operational regulations and schedule for irrigation canals within WUAs taking into account a land use pattern and characteristics of water supply at a higher level of the irrigation network. At the same time, taking into consideration ten-days planning of flow rates in irrigation canals by a superior water management body, it is advisable to apply water rotation among groups of water users that divert water from one canal. However, specially trained professionals in water management together with sociologists have to identify each WUA and each irrigation canal within an association's area. This includes procedure of water distribution, its cycles in the growing season, and grouping of water users for each water supply shift, implementation of intra-group monitoring, as well as an order and sequence of water distribution between and within groups.

All this engineering-management activity should be accompanied by social mobilization of water users that form these groups and relevant inter-grouped units on one irrigation canal, in order to organize the system of rational water supply and to see the potential for its adjustment.

As known, the institutional aspects of IWRM include: (i) transition from the principle of water resources management within administrative boundaries to management within hydro-geographical units; and (ii) public participation. In the process of introducing the principle of water resources management within hydro-geographical units, there are no problems because it was objectively beneficial to water management organizations. As for public participation, the situation is quite different. As a rule, public participation is beneficial to employees of water management organizations but not to some water officials. Recognizing by word of mouth the leading role of water users presented by the Canal Water Users Council (CWUC) the opponents of such an approach will try to transform the CWUC into an obedient "pocket" body. Therefore, disallowing the legal registration of the CWUC as an independent, non-governmental and non-commercial body of water users and in opening its bank account just contributes to the dependency of CWUC on the Canal Administration. In this context, the rejection of legal registration is beneficial to water officials rather than water users.

At the level of WUAs (the former on-farm level), some problems can be solved only with public participation. Under the prevalent practice, a primary water user (a large farm - former collective farms, and nowadays co-operative farms) supply water to secondary water users (private farms) at their own discretion, and as a rule, after satisfying their own needs. Relations between primary and secondary water users are not specified even by a contract. Therefore, large co-operative farms infringe upon the rights of private farms. Primary water users do not incur any liability for failed water supply to private farmers that should be provided according to planned schedules and volumes. Private farms often do not have offtakes equipped with water meters, and water is supplied to them without actual water accounting ("by eye").

The status of private farms (secondary water users) is changing under establishment and operation of the WUA. A water users association itself enters into contractual relations with water management organizations (district water authorities or irrigation system administration), and supplies water equally to all water users (members of WUAs) independently of their location along an irrigation canal (at its beginning or in a tail section). One of the major functions of WUA is distribution of available water resources among its members in an equitable manner, and in that way, to provide *sustainability of their water supply*.

## 1.6. Environmental Approach: Nature is an Equal Partner

Over a long period of time, mankind considered itself as all-powerful and able to bend nature to its will. However, instead of the slogan: "We cannot wait for favors from Nature …" has come the understanding that "a human being has got nature not as a gift from his ancestors, but borrows it from his descendants." Such a concept adopted in the water sector, first of all, implies the recognition of rivers, lakes and other water bodies as "water consumers" along with other economic entities, and without specific ecological water flows they can lose their natural essence. Today, the priorities of water management organizations, frankly speaking, are aimed at current momentary needs of mitigating the consequences of floods and droughts as well as the satisfaction of daily wants. It is easy to see that even people living in the vicinity of the epicenter of environmental disaster in the Pre-Aral region in the end of 1980s and suffering from a decline in fisheries and loss of the river delta, nevertheless have preferred to take away the water from their sea for increasing rice production in Karakalpakstan and Kyzyl-Orda Province in Kazakhstan. After independence, some shifts in raising ecological awareness of society affected by this crisis took place. However, on the whole, conservation and especially restoring the disturbed environment are staying in the "backyard" of water policy and, to some extent, are being an obvious attempt to follow the fashion. the water culture level of a country, region, zone, and even water management administration is defined by the observance of nature protection regulations in current practice. This concerns such areas of activity as: (i) maintaining the minimum ecological flows in natural streams supporting their eco-systems and capability for self-purification, (ii) sanitary water-releases for dilution of harmful ingredients, and finally (iii) satisfaction of water requirements of deltas and estuaries. At the same time, this approach should be applied not only to large rivers and water bodies, but also to small streams, water sources and affected entities.

The environmental aspects of IWRM specify activities and awareness going in two directions: to prevent harmful events related to water resources, and to meet the water requirements of eco-systems. From the ecological point of view, the main features of water are its high mobility and ability to dissolve different chemical components of the natural complex. A key condition providing the sustainable natural and anthropogenic cycles is to minimize the negative impacts of interacting sources of water and territories in use, as well as the interaction of surface and ground water.

In respect to providing environmental sustainability in the drainage basin, it is possible to propose an approach under which such principles and interrelated conservation factors, as water quality in its sources and accumulation of pollutants over areas under economic use are taken as sustainability criteria. In other words, the criteria of well-being in the drainage basin would be represented as follows:

- The pollution level of the area under economic use and affected eco-systems should not exceed the permissible concentrations, and trends of accumulation of toxic pollutants are to be negative, i.e. gradual reducing of pollution over the concerned area is in progress;
- Concentration of contaminants in water sources over all zones of the drainage basin, from headwaters to its mouth, shall not exceed the maximum permissible concentrations for all water users utilizing water from these water sources; and
- Anthropogenic pressure on eco-systems over the catchment area should not exceed the optimal limits that ensure maintaining of their biodiversity and bio-productivity.

An another important issue is the observance of ecological requirements for water resources, when we keep in mind the requirements of eco-systems for water supply as the basis of sustainability of flora and fauna, as well as of aesthetic characteristics of natural complexes. It is important not only to preserve natural flora and fauna of small and large rivers, but also to keep their natural attractiveness for people. Undoubtedly, many natural streams have lost their original status: rivers Zarafshan, Murgab, and Tejen have lost their links with the Amu Darya, and in a similar manner, rivers Chu, Talas, and Assa have lost their links with the Syr Darya River. However, our task is to stop this grievous process.

It is clear that IWRM shall provide the real observance of ecological requirements of water as a key task of hydro-ecological management. A number of the provisions that need to be considered in the practice of water resources management may be formulated from the positions of an ecosystem-defined approach.

1. In compliance with the IWRM principles, water, land, and other resources within a catchment area should be considered *as components of joint use, management, conservation, and development.* Responsibility and duties should be distributed among water users at national, sectoral, local and "bottom" level in such a way that the regulation of water demand and use would provide sustainable preservation and/or development of the natural potential as well as preventing its reduction. Based on those considerations, all water resources within the basin have to be considered in their interaction with economic activities, taking into account some limitations in use of water, land, and other resources, and reclamation measures in order to ensure sustainable development.
2. On the basis of the legislation, regulations, and international agreements, the State assumes the responsibility, with the assistance of its conservancy agencies, water management organizations and public mobilization, to monitor ecological and sanitary flows and the norms on preserving natural streams that were discussed above.
3. Step by step inclusion of the environmental component into IWRM in the form of the participation of conservancy agencies in decision making at all levels of the water management hierarchy as equal partners should be accompanied by the introduction of hydro-ecological management, as a top stage of IWRM. This type of management is formed by means of priority-driven consideration and observance of environmental requirements, assessment of ecological service and transforming the Basin Water Council into the Basin Council of Natural Complexes that should consider maintaining the sustainability of ecosystems as its primary task. In the BWOs "Amudarya" and "Syrdarya", the initial phase of such an approach should be the inclusion of the Delta Water Users Association as the most important and full member into the Basin Council for defending the interests of natural complex.
4. Water resources management has to be based on the rigid principle of *ecologically permissible water abstraction* (EPWA) to prevent the possibility of irrevocable water consumption. When this level is exceeded (such a situation took place in the past), countries-consumers shall make their contribution to the international basin fund as a payment for excessive use of natural resources and implement mitigation measures. For example, in the Aral Sea basin, this recommended level of total water abstraction from water sources is about 78 $km^3$ against the present water abstraction of 106 $km^3$, and 123 $km^3$ in the past (1990)! If each water consumer who exceeds the ecologically permissible water abstraction will make a contribution to the fund for ecological safeguarding of the basin, then opportunities to use these funds to improve environmental conditions within the basin as a whole will arise.
5. For the purpose of preserving rivers and water bodies as natural ecosystems, drawdown of water of reservoirs and river flows *should not be less in summer and more in winter than mean annual runoff (that is specified based on long-term flow rate measurements)* in respective seasons. The observance of this rule can prevent transformation of rivers into runoff ditches. Water requirements of ecosystems in deltas and estuaries and flow-through and closed water bodies should be specified taking into consideration their bio-productivity and sustainability, based on monitoring data along with taking into account requirements of countries that are using water resources.

6. Environment aspects should be included into IWRM plans at the levels of basin, sub-basin, and region. Ecological problems that need to be solved exist in each irrigation systems or WUA. These activities includes: (i) rehabilitation of disturbed natural landscapes due to water erosion, water logging, and deforestation; (ii) correcting such matters as excessive abstraction and use of local water sources; and (iii) inventory of sources of pollutants and damaged zones, and their control and localization. All these activities have to be implemented within the environmental component of IWRM and by public bodies established for management of irrigation canals and WUAs. At the same time, a department of ecological control should gradually introduce the management practices at basin and sub-basin levels as an effective measure for rehabilitation of natural ecosystems.
7. Drainage and drainage water management is an important component of nature protection complex. The interrelations of surface water, groundwater, and drainage is a very sensitive aspect of water and land reclamation management because excessive water supply for irrigation or leaching of soils results in not only water losses and deterioration of water as a resource, but also degrades the land and loss of soil fertility. The incorrectly designed drainage systems mobilize vast volumes of salts from lower stratums. In addition, unevenness of irrigation and drainage results in increasing water losses and non-uniformity of crop over an irrigated area. In order to identify these shortcomings in water management in a timely manner, it is necessary to enhance the activities of land reclamation services, to equip them with relevant equipment and measuring instruments, to introduce GIS and remote sensing methods for monitoring and evaluation of land conditions. It is note worthy to remember that land salinization and water logging are some of the main factors causing decreased crop yield and water productivity in irrigated farming, because apart from the fact that there is a reduction in yield, water consumption is high.

It is clear that at present, water requirements of ecosystems cannot further be met according to "a residual principle" (delivering of residuary water after satisfaction of the economic needs). Meeting of water requirements of ecosystems should be one of priority activities within IWRM.

## 1.7. Principle Concern: Water Conservation and Rational Water Use

Efficient and effective use of the water diverted from water sources should be planned and conducted according to two directions. It is clear that water use by direct water users is the first and, likely, most arresting aspect for water saving activity. However, there is another direction that shouldn't be out of attention of actors in the water sector. High reserves are in hands of managers in the water sector due to mismatching of water demands and supply, as well as due to the instability of flow rates in any water management system.

A key objective of IWRM is to achieve the potential water productivity based on "the norms of water consumption under applying advanced methods of water use" or "the promising level of technologies in water-consuming sectors." Practical findings of some projects (the WUFMAS, Best Practice, IWRM-Fergana etc.) implemented in the region over the period of 1997 to 2004 demonstrate that it is quite substantively to achieve potential water productivity. On the basis of the experience and results of these projects the following recommendations can be made regarding large-scale dissemination of water saving technologies in the region:

1. Improving the system of water resources monitoring and assessment;
2. Introduction of the progressive water charging system applying incentive stepped tariffs and penalty sanctions for each cubic meter of water used in excess of planned rates etc.;
3. Revising all water use standards based on the scientifically-founded computer programs “ISAREG” and “CROPWAT” [32] that enable us to computerize the water use planning process and, at the same time, to take into account characteristics of different infrastructure and water availability in various years as well as to provide a basis for effective adjustment of water consumption rates depending on different water availability;
4. Based on these water consumption rates, it needs to revise water use limits that are overestimated in most cases causing extensive organizational water losses, excessive expenses, and increase in drainage rates;
5. Developing the zonal indicators of potential water productivity, and on their base granting of preferences to water users that provides the achievement of these indicators, in the form of reduction in taxes or fee for water services;
6. Creating the system of pilot water saving projects, as a primary measure to demonstrate rational water use;
7. Application of water rotation and other organizational measures and technologies to control water losses or unproductive water use at the field level (short-length furrows, careful land leveling, alternative furrow irrigation etc.)
8. Introduction of the state-of-the-art irrigation technique and methods; and
9. Establishing an extension service for water users providing a technical assistance in rational water and land use and in achieving potential productivity of water and land resources.

Along with organizational and engineering measures for water saving, high implications consist in water demand management that is based on the state policy aimed at rational water resources use and includes the following actions:

- Establishing the legal basis for water use and supporting water users;
- Introduction of the economic incentives for water saving by water management organizations and water users at the State level;
- Implementing the curricula that include water saving issues starting with school education;
- Motivating the pioneers of water saving by means of dissemination of their knowledge and creating of their positive image;
- Training of water users, including study tours;
- Manufacturing equipment, instruments, and appliances to promote effective water use; and
- A state support of procuring water meters for water users;

The introduction of advanced and ecologically sound technologies should base on the thought-out mechanism providing the enabling environment (with applying financial, organizational, legal, and engineering tools). Low rates of introduction of these technologies were mentioned even in the European Water Directives. There are a few causes for this situation:

- Ecologically sound and state-of-the-art equipment, for example, for biological sludge removal based on in-built micro-filtration modules is very efficient and has longer operational life (dozens of times in comparing with existing equipment), however, does not meet the present requirements to an internal rate of return. *To put this equipment into practice it is necessary to provide specific discounts or incentives for investors, for example, at the rate of cost of additional water resources that are received as a result of applying this water treatment technology (in opposite case these funds would be confiscated by the State at more considerable rates);*
- Introduction of water saving technologies for domestic purposes (faucets, shower-bath appliances, lavatory pans etc.) enables to reduce water consumption per capita up to 100 l/day. However, if all water users reduce their consumption, then a capacity of water treatment plants is not completely used. Therefore, *an extent of the introduction of water saving technologies is to be adjusted to the actual needs and alternative measures in that way when investments into water saving should less than investments into developing water treatment facilities without implementation of measures for water saving;*
- Usually, in the process of bidding for Works, the contract is awarded to bidders that proposed the least bidding price. However, as a rule, a new technology cannot be cheaper existing one, but it is more profitable regarding long-term and environmental aspects. *It means that bidding criteria should be changed in favor of publicly profitable decisions*; and
- Water prices established on the basis of complete reimbursement of all operational costs plus profit unlikely will facilitate the introduction of more advanced and ecological sound decisions because they are based on the normative volumes of water consumption and treatment and specific current technology. Therefore, *municipalities interested in conservancy should cover a part of expenses related to the introduction of ecologically sound technologies*.

Measures aimed at water saving and increasing water productivity are described in detail below.

It is usually considered that efforts to combat irrational water use within the water management systems consist in improving two types of the efficiency - technical and organizational. It is well known that the enhancement of the technical efficiency can be provided by means of eliminating leakages in water pipes, lining of irrigation canals or replacement of earthen canals by pipelines and flumes etc. to prevent seepage losses. Enhancing the organizational efficiency is reached by means of preventing unproductive irrigation water disposals into the drainage network; idling runs of water through irrigation canals, and unauthorized water diversions, as well as by means of construction of intra-system reservoirs accumulating and storing excessive water supplies and daily regulative basins that smooth the daily unbalancing of water supply and water diversion from the sources. However, substantial attention also should be paid to eliminating lack of uniformity in water distribution between subordinated canals or among water users.

Entropy, which is higher if increase in the number of hierarchical levels and a lesser extent of regulation and limitations take place, is intrinsic to any distribution systems, including water management systems. Increase in deviations from average water supply, as moving away a water source, is also typical for water management systems, and this fact is obviously illustrated in the diagram below (Figure 1.6).

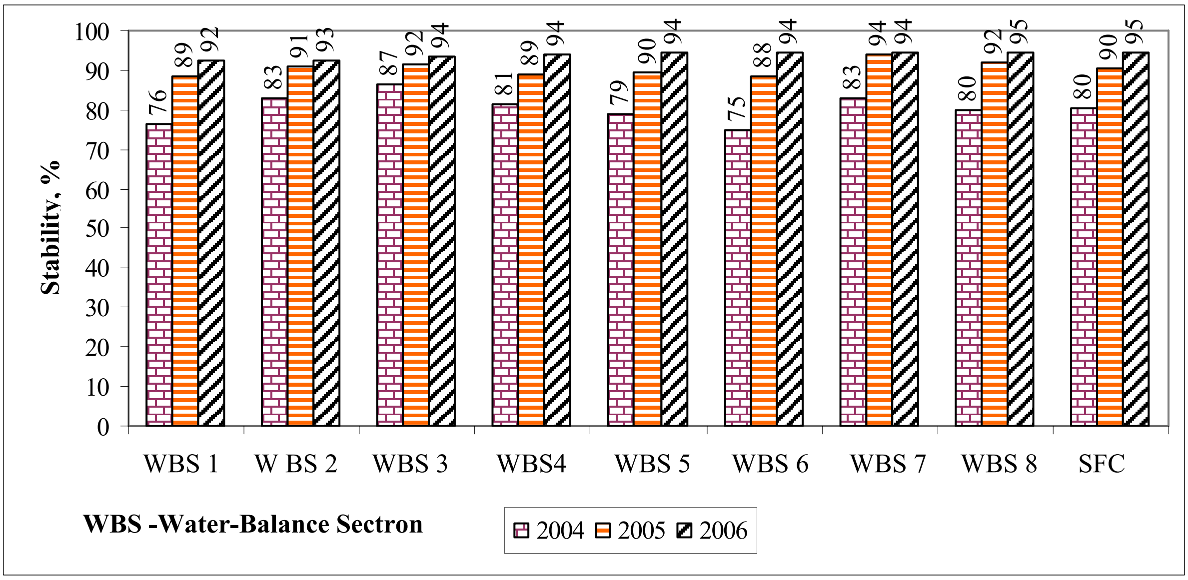



**Figure 1.6 The South Fergana Canal: Stability Index of Water Supply during the Growing Season**

This figure shows that in dry years the deviations are less considerable due to the enhanced control of water supply and distribution speaking about the extent of operational orderliness. Thus, the task of reducing unproductive water use comes to proper organization and control of O&M activity.

## 1.8. Information Management System – Management and Feedback Instrument

In the management process, all-round information on a controllable object is the foundation for successful operation. It is impossible to maintain any machine or mechanism, construction or production process without information on its current status, available resources, interrelations of its components etc. It is also important to know the future needs and to be ready to meet future requirements to avoid failures in operation.

Much more information needs to be provided when we deal with water management. Mistakes in water management threaten not only to damage sufficient water supply but also to cause floods, droughts, and diseases, loss of crop yield, famine and many other hardships and even disasters. Nevertheless, a well thought-out information management system (IMS) should be the backbone of IWRM under all the diversity of interrelations with the outer world. Lets us look at Figure 1 given in the preface. We see all-round links of water resources, on the one hand, with different factors and effects, which are far from complete presentation, but, on the other hand, with impacts of outer and inner factors on state, regime, available resources, and quality of water and all water-related aspects. It is understandable that it is quite difficult to establish the information management system including directly all necessary entities due to the need to set data of both temporal and spatial measurements. Therefore, in the process of establishing the information management system (IMS) for IWRM it is necessary to stick to specific rules and principles. An attempt to formulate these rules and principles are made below.

1. The IMS is formed as a structured storage in which data is arranged in major data sets of thematic information. The following data sets, most often, are represented: “Water - Resources”, “Water - Consumption”, “Social Environment”, “Land Resources”, “The Environment – Biodiversity & Bio-Productivity”, “Climate”, “Infrastructure”, “Hydropower”, “Irrigation & Drainage”, “Water Supply”, “Industry”, “Micro-Economy” and so on. A series of data sets may be different depending on the specific character of IWRM.
2. The IMS is built up for three time periods: retrospective, current information, and outlook. A retrospective series length depends on the set of planned tasks of management and analyses. It is recommended to include all hydrological and climatic data over the whole length of existing series of observations, since forecast, recurrence assessment or calculating the probability of emergencies provide more reliable results if there is longer series of observations. It is important to have additional series of observations related to the status of land resources, vegetation cover, and soil fertility, however, taking into account more smooth changes of their characteristics, it is not necessary to store in the IMS data of each year, but, for example, to store averaged data over each 5-year period or even decade, if series of observations are long enough. It is desirable to have the socio-economic indicators, at least, over last 25-30 years, since the length of retrospective series specifies the reliability of socio-economic analysis and forecasts. Taking into consideration the long period of implementing water management projects, their efficiency assessment for prospect should be made on the basis of retrospective series of observations, the length of which exceeds the planned period, at least, one and a half or two times.
3. Current time series for a planned year, usually, have daily intervals, but in some cases one-hour intervals may be required. After certain time, these daily data series can be either annihilated or aggregated and archived. Retrospective or long-term time series can consist of the series of 10-day or monthly average data.
4. Spatial location of objects is contained in the IMS in the form of GIS thematic layers (Geographic Information System) that allows to set position data in absolute coordinates and to link IWRM interacting components over area or linearly, and this is very important for solving many practical tasks of management and planning. For example, only with a help of the GIS, the detailing of forming snowmelt runoff depending on land gradients, soils, precipitation etc. is possible. Information on soil conditions, hydro-geological cross-sections, crop patterns and other components is the reliable basis for calculating water requirements of irrigated areas. The GIS allows to link return water formation with an area affected by the drainage network and with water supply over this area, as well as to set the source zones of different pollutants.
5. A set of models that allows analyzing various operational and emergency situations and making forecasts should be provided for in the frame of IMS. A legislative base of planning, operational management together with O&M regulations and rules of controlling different functional components should be a special part of the IMS. This part of the IMS is included into the database (DB)
6. Various data and indicators necessary for solving IWRM operational and long-term tasks related to developing information data sets, mentioned in Para 1, and the GIS (Para 4) should be specified by managers of the IMS in co-ordination with technologists and governmental bodies.

**Establishing the Information Management System provides for the following target activities:**

- Establishing database on all operational processes, including annual and long-term planning and operational water supply and distribution;
- Water quality monitoring and management;
- Analyzing and adjustment of the water management process;
- Providing the transparency of water management and trust among water users;
- Assistance to water users in economical water consumption and achieving its potential productivity;
- Preparing the analytical reports for improving management methods and informing decision makers and stakeholders; and
- Assessment of current trends and adjustment of the water use strategy; and so on.

In Central Asia, the first steps in establishing the IMS for IWRM were done. In particular, under financial assistance of Swiss Development Cooperation, the regional information system CAREWIB, which serves stakeholders in the Aral Sea basin at the interstate level, was created by SIC ICWC's specialists. Another example of the established IMS aimed at servicing stakeholders at the levels of irrigation canal, WUA, and selected farmers is the IMS of the IWRM-Fergana Project that contains the database for pilot irrigation canals. Finally, the IMS aimed at long-term planning and improving water management practice, by example of water management in Chirchik River Basin (sub-basin of the Syr Darya River) was established in the frame of the RIVERTWIN Project. Detailed description of above projects can be found at website: www.cawater-info.net.

# CHAPTER II
# WATER GOVERNANCE AND MANAGEMENT – THEORY AND PRACTICE

**(V.A. Dukhovny)**

If imaging humanity as a certain structure, its supports are four potentials: natural, productive, financial, and human. They are in permanent relations and quite dynamic, depending on to such an extent the political system (governance) being a foundation of this structure is true and thorough, to such an extent the social environment created by this system being air of this structure is advantageous, and to such an extent the management system being its communications and impulses are operating correctly and clear. A combination of development potential, governance, and social environment defines the degree of development stability and its prospects. Water is a substantial part of the natural potential, and at the same time, it actively interacts with all other potentials; and therefore studying the correlation of water governance, the social environment, and resources management is important. Let us demonstrate the practical application of this approach through an example of water management in the Aral Sea basin.

The nature or the superior intelligence, while creating the civilization over a period of eight thousands years, has reached the modern society, as a combination of environment and social medium – community of “homo sapiens.” Original primitive society was a simple unity of natural and human potentials. In that era of beginning of mankind, this unity was developing through the interaction of human being and nature. Gradually when social forms were created, and the productive potential has simultaneously raised as it’s derivation - firstly, in the form of wooden plough, spade, and potter's wheel, later as manufactures, mines, and factories, and at present, as huge production conglomerates and monopolies. Emergence of money as a means of exchange and trade has promoted the creation of another potential – financial. Today, the sustainability of life and development is predetermined by the availability and development of these four potentials in any territorial unit of the human environment: district, region, and even continent (Figure 2.1).

The productive potential as well as financial potential are the derivatives of natural and human potentials development. Moreover, there is an opinion that we should consider more rationally two potentials of humanity - natural and social; the latter consists of three constituents – productive, human, and financial potentials (in the judgment of N. Mirzaev). It may be possible to agree with this proposal; however, it does not change the idea of interactions in principle, but predetermines a subordinate role of each constituent. We assume, it is more accurate to consider four constituents. Their development, to a considerable extent, occurs due to transformation of capacities of nonrenewable natural resources into productive and financial potentials, as well as with renewable natural and human resources use. Development of the productive potential feeds the financial potential, but at the same time, the financial potential strengthens and develops a capacity of productive potential by multiplying production capabilities. In a similar manner, human, financial and productive potentials should provide mutual support and simultaneously stabilize the use of renewable natural and human resources and compensate the natural potential of nonrenewable resources. If all these potentials are developing in such proportions that provide a “mutual covering”, i.e. create a positive balance in accumulating their capacity, then a capability for reproduction is also maintained within each potential. Thus, in the frame of natural potential a self-adaptation of natural conditions is provided. At the same time, in the frame of human potential, a human being develops himself and his likes. In the frame of the productive potential, one kind of economic activity generates another, and money makes money in the structure of financial potential.

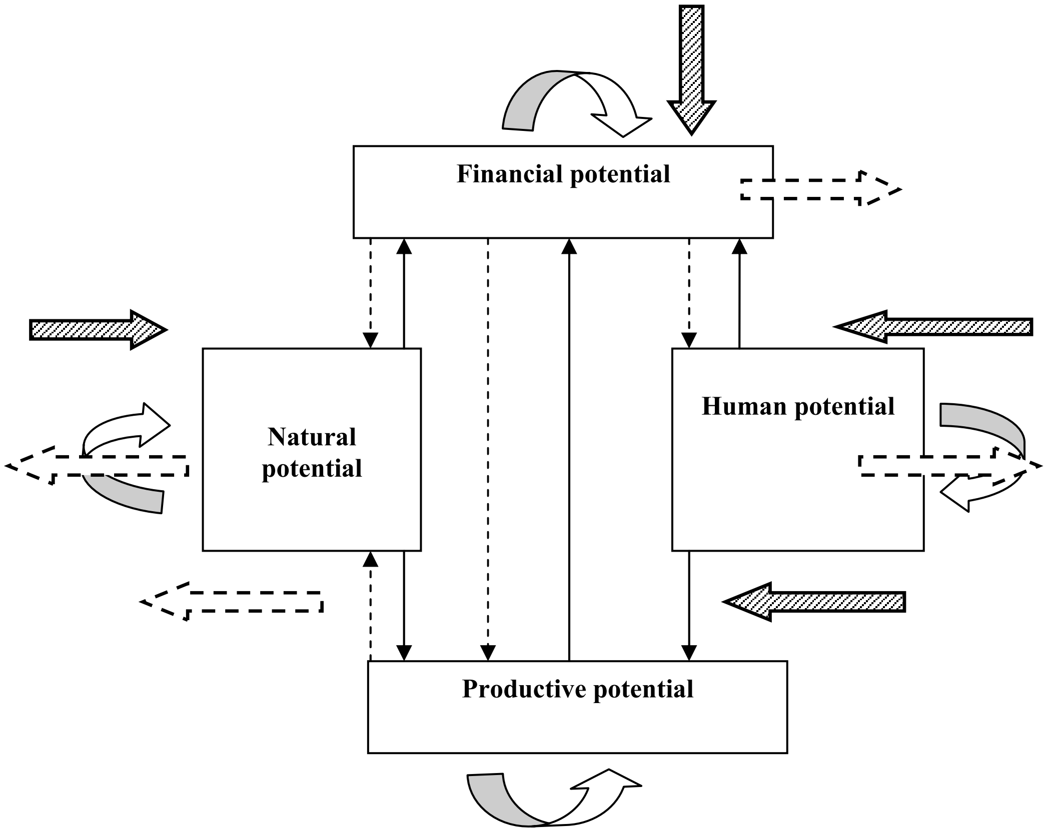
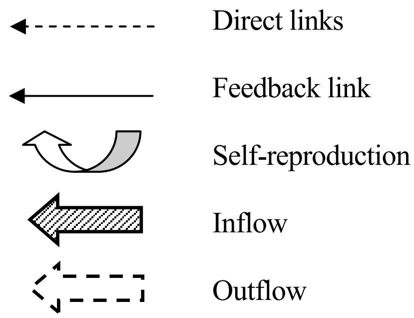



**Figure 2.1. Diagram of Interacting Four Potentials that Provide the Sustainable Development**




Within the territorial units (zones, countries or regions), exports and imports of human potential (labor force and experts) and financial potential (loans, credits, donors' grants, and outflow of funds by legal and illegal means) are quite important. The productive potential may be also imported or exported by means of exporting raw materials and semi-manufactured goods and importing equipment, transport means, etc. Even natural potential, especially water, can be imported or exported through redistributing water resources or exporting and acclimatization of flora and fauna.

*Sustainable human development is based on the abilities of human beings to support a balance of four potentials and their capacities for reproduction*. The success is guaranteed due to the followings:

- Limitlessness of the technical progress and intellectual abilities of a human being;
- Some limits of reproduction within the framework of productive potential; and renewal capabilities of resources;
- Clear-cut understanding of the system of links and interaction of these potentials as well as of the limits of their use;
- Aspiration of achieving the potential productivity per unit of natural resources and building-up of the efficiency on the basis of the dynamic development;

- Presence of the obligatory universal regulations, postulates and rules for maintaining the policy that can and has to provide rational use of all four potentials, on behalf of not only some regions, nations, but also the human community as a whole.

Each of above-mentioned potentials consists of a diversified set of constituents and supporting components, composition and structure of which can change in the process of development, but a balance of key elements should be stable.

As a rough approximation, the composition of potentials can be presented as follows:

| | |
|---|---|
| ***I. Natural potential***<br>1.1. Climate<br>1.2. Water resources<br>1.3. Land resources<br>1.4. Mineral resources<br>1.5. Fauna<br>1.6. Flora etc. | ***III. Productive potential***<br>3.1. Industry<br>3.2. Agriculture<br>3.3. Transport<br>3.4. Communication<br>3.5. Information technologies<br>3.6. Roads<br>3.7. Energy<br>3.8. Construction<br>3.9. Business environment<br>3.10. Priorities, etc. |
| ***II. Human potential***<br>2.1. Population<br>2.2. life styles<br>2.3. Traditions<br>2.4. Education<br>2.5. Public health<br>2.6. Culture<br>2.7. Religions<br>2.8. Science<br>2.9. Public associations | ***IV. Financial potential***<br>4.1. Reserves of resources<br>4.2. Gold and precious metals<br>4.3. Funds<br>4.4. Loans<br>4.5. Capital assets<br>4.6. Tariffs, dues<br>4.7. Taxes, benefits<br>4.8. Grants and awards |

Each of above potential is very dynamic due to the needs in development and some destabilizing factors. Soil degradation, depletion of mineral resources and climate changes are observed within the frame of *natural potential*. Changes in a birth rate, death rate, population growth, consumption and social environment play a similar role in the frame of *human potential*. A depletion and deficit of funds in the frame of *financial potential*, and depreciation of assets, and technical progress, especially in related economic sectors, exert considerable impacts on the *productive potential*. At the same time, interrelations of these potentials and their dynamics, as well as the efficiency of these interactions are specified through three key aspects:

- Political environment that forms so-called governmental (legislative and regulative) and public relations – “governance”;
- Social environment that defines the status inherent in society and its attitude to the future – “social medium”; and
- Management system – methods and arrangements; means and regulations, information exchange, monitoring and evaluation – “management”

In other words, *the sustainability of developing human “complex”* is described by the collective notions: steadiness and appropriateness of its basis – political environment (governance); a public climate in the social medium that is formed under the influence of governance and development of all other potentials, especially, human potential (Figure 2.2). A management system that predetermines the sustainability, efficiency of use and rehabilitation of development potentials is formed on this basis. A distinguishing characteristic of this “complex” is not the steadiness, like in a building, but permanent dynamics (endogenous and exogenous) that specify both the internal state of each element of the potential and its status as a whole, and a proportion between them. At the same time, the steadiness of “complex” can be maintained only while there is certain equilibrium (between its major supports - potentials), which does not allow to upset the proportions in development and the balance. Otherwise, skewed structures of this “complex” are possible. Excessive development of the productive potential threatens, on one hand, by the loss of attention to support and preservation of the human potential or results in its one-sided development, but, on the other hand, by degradation of the natural potential, for example, due to excessive abstraction of nonrenewable mineral resources or contamination of the environment.

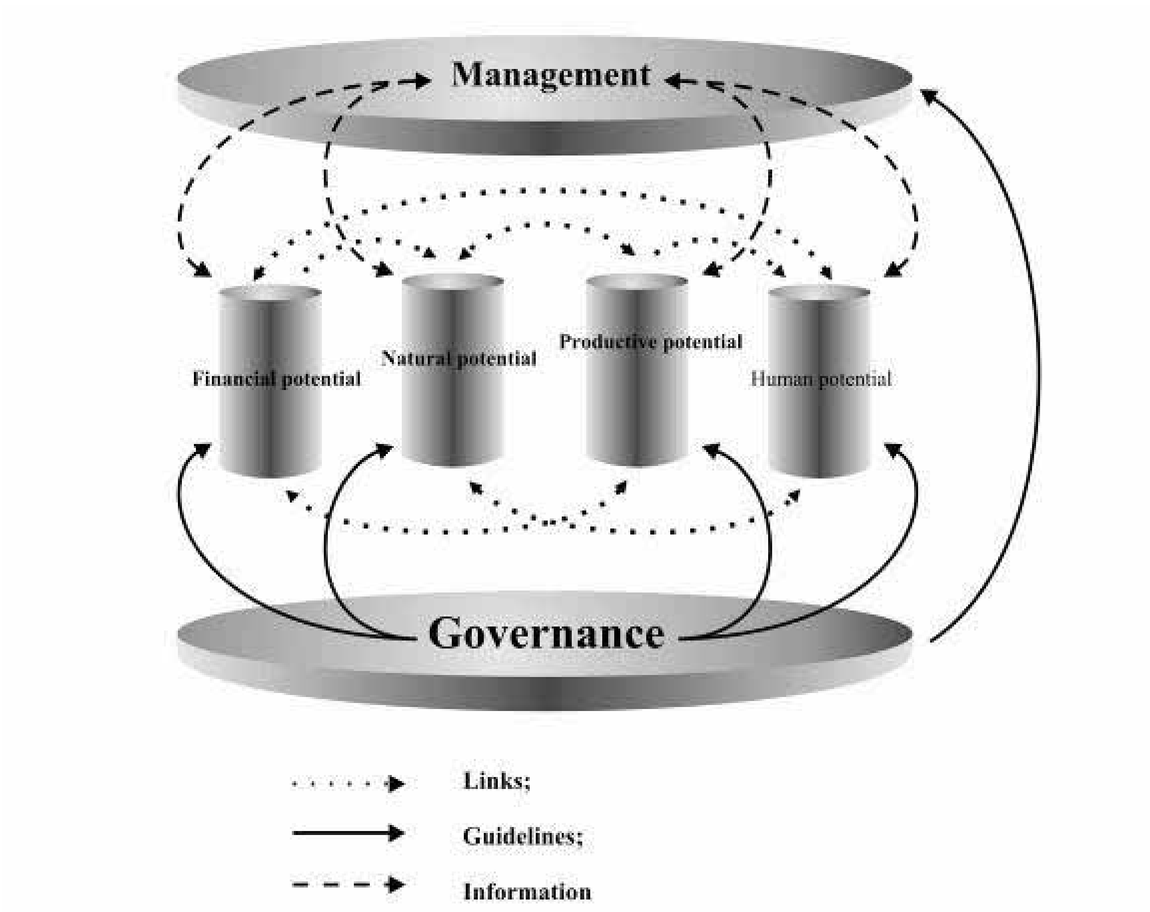



**Figure 2.2 Links of Four Potentials of Sustainable Development with Water Governance and Management**

The status of each potential and its elements (representing the process of accumulation or depletion) is also very important. In compliance with the principles suggested by our colleague Dr. Michael Glantz from the USA, the degree of risks in any natural or man-made event, the assessment of “current status” of the potential should be present in the form of a cone. In a phase of filling/ increasing – the base of the cone is directed downwards and in a phase of emptying/ depletion – the cone is turned upside-down. In the first case, a degree of risk is minimal, but in the second case, the degree of risk is catastrophic. Representing each potential and even its elements we can thus receive an “indicator for upsetting” the steadiness of development (Figure 2.3).

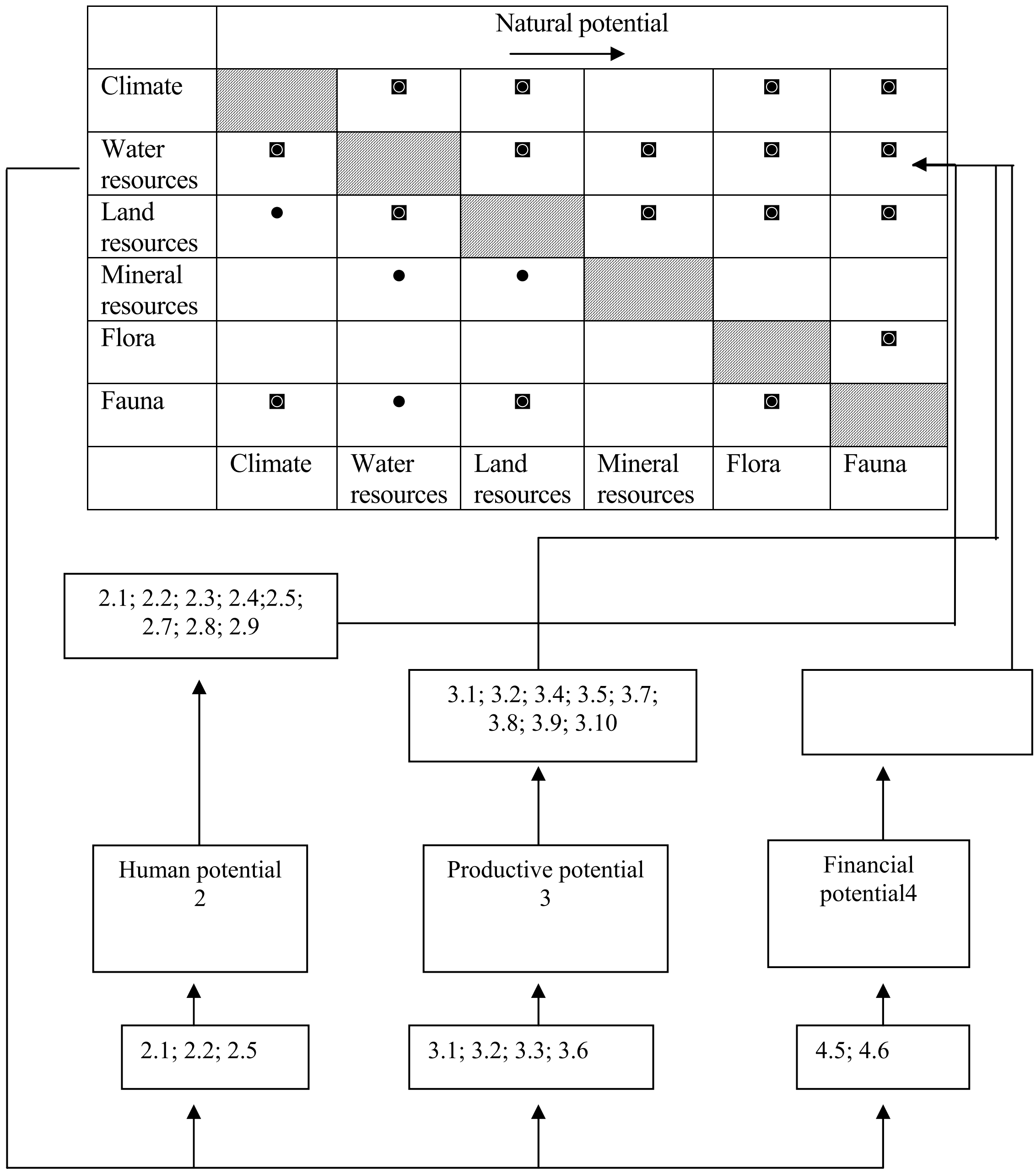



**Figure 2.3 Block of Natural Potential (No 1) and its Links with Other Potentials of Sustainable Development**

Let us review all situations, taking into consideration the role of water resources and the water sector in the “framework” of this complex and in sustainable development as a whole. Water is the most important element related to all potentials and plays the following roles:

- resource element in the natural potential;
- consumption element in the human and productive potentials;
- element used in financial and productive potentials;
- supplying element in the human, natural, and productive potentials; and
- element predetermining the development in all potentials.

In sections above, we already came to realize that governance is the specific political environment, which with the help of different mechanisms forms the system of control over the society and should ensure its sustainability and development[4]. Governance, generally, as a basic platform of any country, society and economy, should meet some fundamental criteria, which are guarantees of sustainable existence and development, namely:

1. Understanding its role and responsibility towards society;
2. nature of integration;
3. Participatory nature;
4. Transparency;
5. Equality;
6. Efficiency;
7. Law-abiding and effective;
8. Accessible;
9. Ethical

A set of mechanisms and principle regulations concentrates in five major systems of governance: political, legislative, social, financial and institutional. Concerning water resources, all these criteria and guidelines are well grounded, but they gain the specific character related to water. At the same time, a ratio between "governance" and "IWRM" is kept in that form which was pointed in the publication [3, Page 13]. As was mentioned there, *"governance" specifies rules of play and establishes the (regulative) mechanisms of incentives, but "management" (IWRM) is responsible for their detailed elaboration and implementation in the process of water distribution, regulation and protection in the framework of water management activity and regional water use at the level of water users*.

First, let us review criteria concerning water governance, taking into consideration that *water resources and the water sector are top-priority factors for the system of sustainable development of the world, regions, countries, and some areas*.

Therefore, the first criterion is *"Understanding the role of water and responsibility of governance towards society regarding the contribution of water to sustainable development"*. Responsibilities of "governance" here are quite broad and multifaceted. Let us indicate them:

- *Guaranteed water availability in water supply sources* (transboundary surface waters and aquifers, local rivers and sources); in our conditions, as will be shown below, the level of guarantee is yet very low and vice versa, the level of risk is very high. The experience gained during the dry years (2000-2001), less dry year (-2006) and even in years of average water availability proves this fact. Governance should be specified both as the system of water rights and as the administrative and

[4] This meaning corresponds to a sense of Greek word "politics" which is translated as the art of managing the State, "Dictionary of Foreign Words", Moscow, 1955 or "Science of ruling the State", V. Dal, "Explanatory Dictionary", 1882

organizational setup of transferring rights and duties to water management authorities and water users associations that have to create the counteraction to these risks. Procedures and regulations for allocating and using both national and interstate waters should be clearly indicated in legislative forms.

- *Technical capacities for water supply and drainage,* under present conditions and scope of implementing repair and rehabilitation works. Governance, based on analysis, has to correctly specify to whom in the country and in what way, those assets can be distributed between national, provincial and local water authorities and among water users united (or not) into their associations or co-operatives; their financial and technical capabilities. In Central Asia, most of the assets of large and small water management systems were created in the 1960s-1980s. The operational life of most infrastructures has reached the end of their economic life. O&M works are not properly organized; and aging of assets is going fast, and numerous failures of operation of some structures and systems, therefore, are regular. Detailed information concerning the drainage systems is given in the publication [6].
- *Governance should prepare the country for adaptation to unsustainable climatic conditions and climate-related hydrological trends, as well as for potentials of considerable natural changes.*

Influence of climate on shifts in a water management situation is a key factor that affects water consumption and the status of water resources as a whole (water reserves, floods and droughts). Continental climate in the Aral Sea basin results in alternations of dry years with droughts and wet years with abundant spring precipitation and floods. In addition, the basin can be characterized by substantial instability of poorly-predictable weather conditions in spring and autumn periods. One may recall the extreme floods in 1969, which created a catastrophic situation on all rivers, and only huge capacities of the former USSR allowed coping with this natural disaster. Then, 1974 and 1975 were extremely dry resulting in considerable economic losses in spite of the fact that according to the decision of the Cabinet of Ministers of the USSR even the dead volume of Toktogul Reservoir (5 km$^3$) was released through the construction tunnel. The need, to be prepared for such natural events, is growing because during last 15 years the recurrence of extreme natural events was increasing – since 1990, we were witnessing of as many floods and droughts as during previous 40 years (Figure 2.4). Our experience shows that, even with a smaller deficit of water resources, uncoordinated actions, essentially, affect the socio-economic development as a whole.

On the other hand, water bodies with larger surface areas are creating or at least affects the climate. Shrinking of the Aral Sea and its effects, including salt and dust transfer, as well as the increase in the aridity on adjacent areas are well known, and have been sufficiently studied and described.

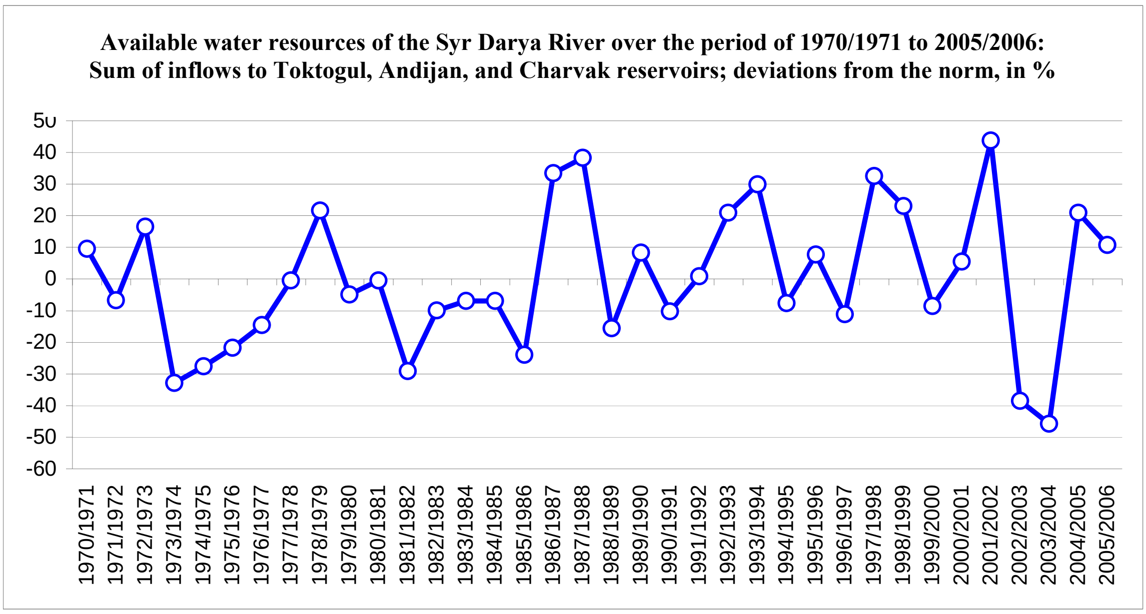



**Figure 2. 4 Recurrences of Droughts and Floods in the Syr Darya River Basin**

*An integration nature* of governance has to withstand the multi-faceted influence of water factor (see Chapter II), implementing interlinked measures, legislation and integrated approach, which prevents making narrow-sectoral or fragmentary decisions in water supply. For an example, in the irrigated farming sector, to the prejudice of water supply in sectors of public utilities and fishery and, especially, in meeting the environmental needs. We all look with melancholy at drying streams and rivers, but, at the same time, averting our eyes from them; we require additional water quotas for our district, province or republic. Integration reveals itself right in the environmental perception of water resources.

Water bodies are landscape's elements, and landscape, including water bodies with their specific water regimes in combination with flora and fauna, specifies *ecological water requirements* (ecological and sanitary flows). A certain *political will and governance* are needed to meet these requirements: inter-state agreements and national laws and regulations, etc,. The governments should clearly state the procedures of their implementation, as well as mechanisms for monitoring and evaluation.

In the Central Asian region, these requirements have to be reflected in the Agreement on Maintaining Ecological Requirements of Water Objects, the draft of which was already prepared in 6 versions, but "things are still where they started" (negotiations on this document are going on). There is an idea to include the controls of implementing ecological requirements into the functions of BWOs; at the same time, it is necessary to introduce compensation mechanisms to punish violators. On the other hand, clear-cut rules of implementing the established water quotas and preventing water-abstractions in excess of ecologically permissible levels, on all watercourses should be stated in national legislations.

**Attention should also be paid for the following aspects related to natural potential of water resources:**

- Preventing harmful impacts on climate, in order to avoid the reductions in glacier mass below a certain level, which could cause decrease in runoff fed by glaciers be catastrophic for existence of streams and can adversely affect the productive potential;
- Establishing joint monitoring of the conditions of natural objects' by all countries and sectors; this requires a political will and the overcoming ambitious, and sometimes egoistic, requirements concerning national sovereignty;
- Establishing national systems of meteorological and hydrological monitoring; at the same time, the regional organizations should have free access to hydrological information in the regime "on-line" without direct participation in joint monitoring, but co-financing of data collection by all stakeholders.

*Participatory approach and transparency of water management systems* are two very important aspects of water governance. These issues are described in special paragraphs. It is necessary to note here that *governance* needs to organize involving all stakeholders at each level of water management hierarchy in such a way that public representatives participate in decision-making in partnership and parallel to water administration. At the same time, if the latter should form water use limits and other restrictions, the public representatives should form the demand through the principles of "bottom-up" approach, concerning water supply regime, quantity and even quality. Such an approach will provide simultaneously *equality* of participation and accessibility, as well as important public initiative and funds along with creating trust, fairness, and openness in water distribution and use.

*Efficiency and ethical aspects of* "governance" will depend on the following factors: i) as far as governance will be able to form public philosophy; ii) creating such a social climate, under which all members of the society will get into the habit with their mother's milk . At all levels of educations notions such as futility of damaging natural processes, sanctity of respecting water, its rational use should be introduced i.e. the return to former traditions and social climate, which we have lost during the Soviet epoch and continuing to loose now in the epoch of market relations and monetarism.

How public climate and ethical status of the society are formed? *Governance* is an understanding of the top circles, what is opposed to equitable and wise approaches to water use. What is the nature of local, sectoral, and professional hydro egoism? How to overcome the inertia of officials and employees of water administrations? How to move from 'fragmentary' to 'general' vision of water problems? How to struggle against corruption and aspiration for easy money using water (although, it would seem, the clean water is not compatible with dirty business, but corruption takes place in the water sector, too!!!)? What can withstand these negative things? Here, one remedy will help; it is necessary to establish "all-round defense" (Figure 2.5). How to establish it? This is public awareness - preparing the next generation in the family, school, and production sphere. This is use of the program "Water for Society", and the advocacy of traditions in communities and production teams. This is encouragement of the healthy style of living (for example, healthy diet requires water one and a half times less)! However, ethical efforts should be supported by a system of legal and institutional measures and, not in the last place, by a style of management!

*The role of governance in water resources management and the water sector* is especially important for the formation of the world-view that we should meet the needs of economy and society in water only with the meeting of water requirements of the natural complex. It can be provided under the associability of natural potential with other potentials concerning water resources. Constituents of *human potential* such as the population, life style, education, traditions, the status of public health, science are determinants for total water consumption, as well as such constituents as the attitude of society to water saving, conservation and protection. However, all above constituents result from the political environment in society and those ethical and legal frameworks which society has formed.

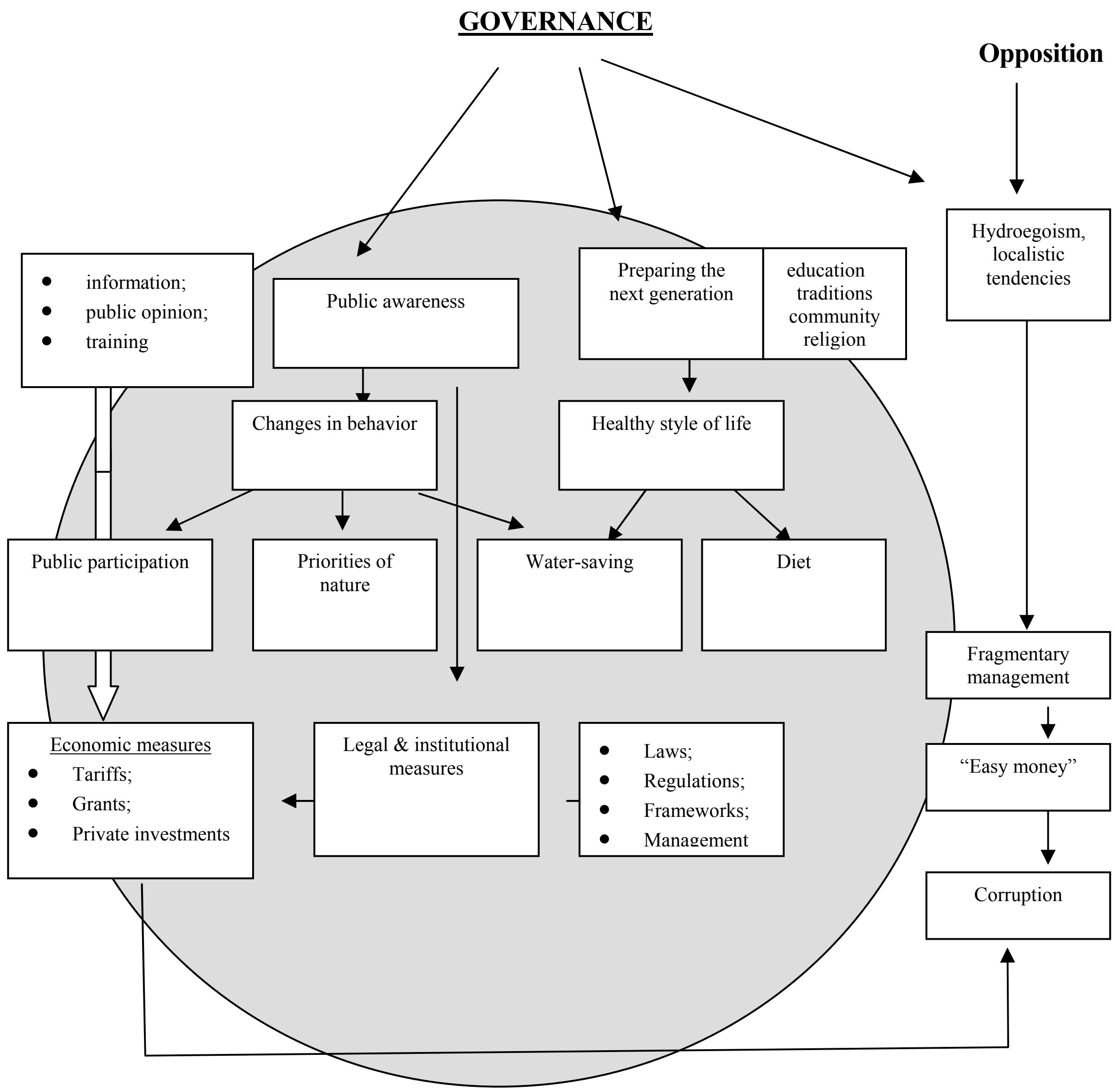



**Figure 2.5 Governance as "All-Round Defense" to Provide Equitable Water Use**

Let us review some mechanisms of the *government* in detail. The most important of them are political aspects (Figure 2.6), which specify:

- The place of water resources in the Constitution and the understanding of their role by politicians;
- Acknowledging UN Millennium Development Goals;
- Specifying the water policy and selecting priorities taking into consideration long-term objectives;
- Approving key provisions of the national water strategy and priorities;
- Recognizing IWRM as the basic direction for improving water management system;
- Acknowledgement of the principles of international water law;
- Participatory approach in water governance;
- Goodwill and support for the co-operation in respect of transboundary waters;
- Recognizing the ecosystem approach;
- Aiming at potential water productivity;
- Specifying the supporting policies of the State;
- Accounting the globalization processes; and
- Formation of water-ecological climate

Social mechanisms are directly linked and adjoin to political mechanisms. An important social mechanism is the recognition of water as a substance of public concern and responsibility to comply with centuries-old traditions.

*The role of society in the water use and governance of the water sector* is of primary importance. Another mechanism is the education of younger generation, and all that from "child's pot." Child should grow with the understanding that each droplet of water carries an element of life and has to use for somebody's good, and if we do not do this, we do not allow somebody to quench his thirst or to satisfy his hunger. There should be a realization that poverty in rural areas results from water deficit (or water and land deficit), and that if we save water, we can give it to nature or use for developing virgin lands that provides new jobs and livelihood to many people.

Based on centuries-old traditions and modern progress in land reclamation, it is necessary to introduce the importance and the need for public and state partnership. All these mechanisms have to be applied in IWRM by means of developing the social mobilization as a key instrument of IWRM for social reforms.

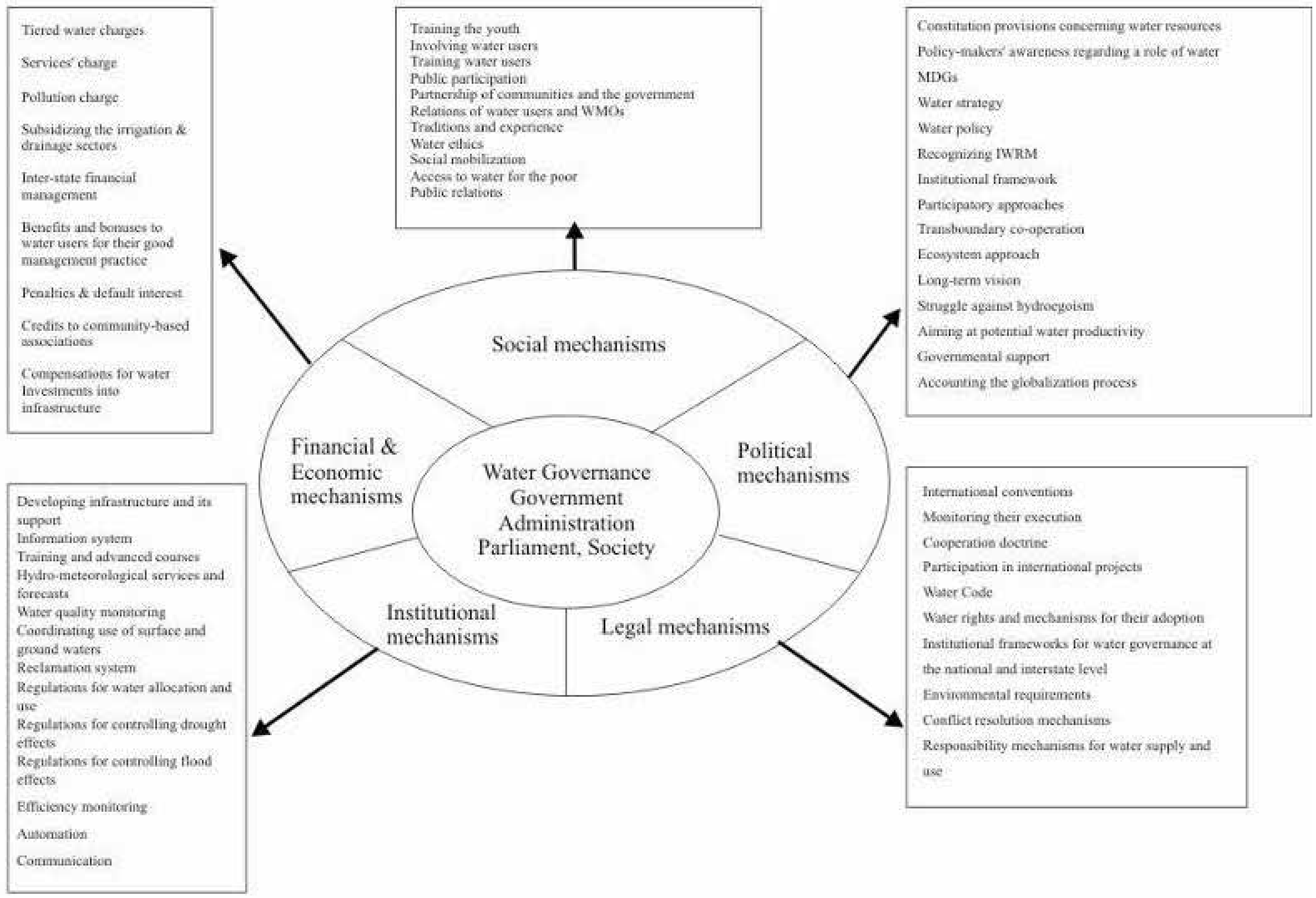



**Figure 2.6 Elements and Links of Water Governance Mechanisms**

In this context, although the social climates in five Central Asian countries are different, but too little guidance is given on water saving and retrieval of centuries-old traditions (prior to the Soviet period) of public participation in water management. A special gap is the lack of attention to education related to water agenda and developing a special water management curriculum. Currently, we are trying to develop them, and hope for assistance of international donors. However, restoring the prestige of water economy as a whole is much more important. In the past, mirabs (irrigators) were playing a leading role in the state governance, for example, in the 16$^{th}$ century Alisher Navoi worked as the Grand Vizier and Chief Mirab. Now, water education has lost its attractiveness, as well as the profession of water manager. Our task is to rehabilitate their prestige.

Transition from the administrative system of water management, the "top-down" principle inherited from the former USSR command system, to the market economy with numerous actors - water users, requires the drastic involvement of the society in the water management at all hierarchical levels. If, at lower levels of irrigation and water supply, WUAs or WUOs should play this role, at upper levels (main canals, irrigation system, or river basin) the combination of state governance with involvement of interested entities - Basin Committees or Irrigation System Committees is required. As a whole, this activity has been initiated and is in progress in the region, but in different forms. Thus, there is a vast field of activities related to social mobilization that should be promoted by the State.

The productive potential is the largest water consumer. It exerts the most pressure on water resources, and causes failures in the water cycle, especially in the irrigation sector. To promote effective water use in production sectors, a clear-cut state policy is required on the following matters: establishing institutional and technological mechanisms; support to the water sector; regulating activities of water management authorities and their relations with water users; attitude to IWRM and technical upgrading the water infrastructure; use of specific water-related norms and standards, and stimulating this activity. The role of the State is especially important in establishing institutional reforms of IWRM, providing self-descriptiveness, openness, and refusal to administrative pressures. Only such a framework can create the foundation for governance and the enabling environment for public participation. The following mechanisms are proposed:

- Establishing a powerful and sustainable structure for state governance at the governmental level that is aimed at solving not incidental problems but embodying the state policy concerning long-term water governance;
- Supporting hydro-geographical principle of establishing institutional structures with the maximum reduction in hierarchical levels;
- Establishing National Water Councils chaired by the national Prime Ministers, involving planning and organizational structures of the States;
- Coordinating activities of hydro-meteorological services and water management organizations and conservation agencies;
- Incorporating governance of surface and groundwater;
- Coordinating irrigation and drainage issues;
- Monitoring water project implementation and efficiency;
- Facilitating the scientific-technical progress, introducing SCADA systems, and upgrading water infrastructure;
- Proper O&M of infrastructure;
- Developing Management Information Systems; and
- Training /capacity building

A clear policy of the government is needed, in order to establish sustainable governance mechanisms for both water management and demand management. Financial and legal instruments developed by the state as well are needed.

What are the mechanisms and actions to support an effective introduction of pricing for water services? These include:

- Introduction of water fee charge and tariffs with the special modular system of progressive payment for excessive water use to encourage water conservation. The introduction of payment for water has already, actually reduced the overall water consumption in Kyrgyzstan, Kazakhstan, and Tajikistan.
- Pollution charges to ensure the 'polluters pay' for the disposal of untreated waste water;
- Subsidies on water infrastructure development and especially up-to-date types of drainage; An unfortunate experience of failed tube well drainage systems in Makhtaaral District in South-Kazakhstan Province is typical example. During the promotion period with subsidies for the operation of tube well drainage systems, sustainable the cotton yield was permanently higher than 3.0 tons/ha at gross consumption rates of water at 8,000-9,000 $m^3$/ha. At present, crop productivity amounts to only 1.8 tons/ha at gross consumption rates 1.2 times higher due to partially failed tube well drainage systems and a lack of governmental will to subsidize O&M costs and inability of farmers to cover all these expenditures. At the same time, in richer USA, cotton produced under irrigation is subsidized to the amount of US$ 1000 per one ton of fiber covering mainly water applications, O&M of drainage systems, and water distribution services.
- A system of benefits and bonuses for wise water use;
- Supporting extension services;
- A system of crediting WUAs; and
- Inputs in support of inter-state water resources management.

One of the most important aspects of water governance is *legal mechanisms.* Their development has to include the following key aspects: the formal acceptance of international conventions and protocols (the 1997 UN Convention, the 1992 Economic Commission for Europe Convention, the 1999 London Protocol etc.); obligatory participation in all international forums and developing their documents concerning rights and duties of nations, regions or special zones regarding transboundary watercourses or waters. A special emphasis should be made on issues related to preserving the environment for the future. Here, it is important to select the correct legal doctrine. Some countries alternately shift from the co-operation doctrine towards the doctrine of national sovereignty and back when this is profitable for them. In our region, the doctrine of national sovereignty reaches a deadlock. Our countries are so closely related within the limited drainage basins, closed by natural barriers that, even under the present technical progress, it is impossible to build up happy life only in one country without its interaction with neighboring countries. Each country, in case of some limiting actions or uncoordinated economic interventions of other countries, can initiate sufficiently troublesome arbitrage litigations, regardless there are certain agreements between them or not. Such principles of the international common law as "do not harm", "equitable and reasonable water resources use", "obligatoriness of notification and co-ordination" are in force based on UN status and documents, however, obtaining of a judgment in the international courts is quite difficult, as it was shown in the case of constructing the Gabchikovo Dam (in the Danube basin).

In our region, there are all opportunities to live according to the co-operation doctrine. Heads of Central Asian states, many times, expressed their political will to cooperate regarding transboundary waters in numerous inter-state declarations and in four inter-state agreements (in 1993, 1994, 1999, and 2003) that stated the need of establishing the IFAS and its executive bodies (including the ICWC) as well as their status, and then development of the Aral Sea Basin Program (ASBP-1 and ASBP-2) etc. Regional water resources management agencies were created and are operational; however, their capacity should be undoubtedly strengthened and developed.

Finally, the region has sufficiently abundant water resources and considerable hydropower potential; it allows meeting the present and future needs in water resources and electric energy under the presence aspirations, and provided open and honest co-operation prevails. Therefore, completing the legal base for international co-operation will allow establishment of a stronger platform for sustainable water supply from transboundary sources.

It is also important to establish the legal base for sustainable water supply at the national level. This activity should include the following actions:

### Preparing a packet of water laws

This process should be transparent and involve water users and other stakeholders – decision-makers, ministries, departments, academic institutions and NGOs. Initiating this process needs to be started with analysis of former and present documents, evaluating their weaknesses and "bottlenecks", where rules do not work.

Thereupon, it is necessary to prepare key matters of future regulations, principles, procedures and an institutional framework based on "basic regulations related to a water policy." It is very important to develop the fundamental law – Water Code. Adopting this key document allows avoiding a lack of agreement in subordination of legal instruments. Water ownership, protection and accessibility should be reflected in the Water Code, its place in the national constitution has to be defined and match with up-to-date requirements and trends of the international water management processes.

### Water resources ownership

Water resources have to be in the public ownership based on the state legislation adopted by the government that establishes the procedures of allocation and awarding water rights to users, as well as preservation of their rights in case of fulfilling commitments by them.

In compliance with the Bonn Declaration (2001), *the Government* is responsible for equitable water allocation and sustainable water resources management. At the same time, water delivery executed by private companies is not a water privatization; and the Government is accountable to members of society for the observance of their water rights.

### Subordinated principles and regulation

- IWRM is one of key principles;
- Water resources use planning should consist of national, basin, and sub-basin plans;
- Guiding principles' list has to include water use priorities; and
- Observance of international commitments is especially important.

### Regulating water use

Regulations include the followings:

- Distribution of responsibilities to ensure water rights and economical water use;
- An authorization-based system (licenses, usage criteria);
- Procedures for use and maintenance of water infrastructure;

- Duties of water users regarding the reservation of licenses;
- Measures for ensuring equality, efficiency; transparency and sustainability of water supply;
- Procedure for transferring water rights;
- Procedure for cancellation of water rights;
- Procedure for encouraging a water saving practice; and
- Procedures for water management during droughts or floods

### Water resources conservation

- Controlling point and dispersed sources of pollution;
- Procedures for disposal of treated and untreated waste water;
- Regulation of land use;
- Establishing national standards of water quality;
- Rules for preserving eco-systems; and
- The "polluter pays" principle

### Regulations for water infrastructure

- A part of legal regulations should be procedures for construction, maintenance, and rehabilitation of water infrastructure, as well as the procedure for implementation of public works;
- Responsibility for preventing emergencies and damages

### Water sector institutions

The organizational framework consists of national ministry, basin organizations, WUAs and other organizational units with established links and procedures of their interaction. It is very important to specify the structure of land reclamation and irrigation organizations and to distribute their responsibilities.

### Financing

The financial system specifies the state contribution in water resources management, and procedures for credit granting and receiving, as well as procedures of payment for water delivery services rather than for water. It is necessary to make efforts, at least, for covering O&M costs, but within the existing capabilities of water users to pay.

Undoubtedly, establishing a perfect governance system requires sufficiently long duration, but its formation is a key activity aimed at the skillful introduction of IWRM. At present, for example, the European Union has defined the needs for general transition towards IWRM, which should be completed by 2015. Prior to the adaptation of this decision, the European Union and its members went through a long way of the IWRM introduction at the national and inter-state level (EU Water Framework Directive; EU Water Initiative), but even today this process moves forward non-unambiguously.

During last years of co-operation, in the epoch of the sovereign states during the declining national economies and followed by gradual economic growth, all countries in our region have gained considerable experience. It became more clear that sustainable development in own countries should be based on joint regional efforts of national governments and communities in overcoming a water deficit, droughts and losses of dry years (2000, 2001 and 2008).

There is full assurance that IWRM mechanisms will be developed and introduced in all Central Asian countries owing to overall understanding that the region cannot survive without the introduction of joint rational use of transboundary waters, based on political will of governments and on long-term experience of mutual collaboration.

Governments of Central Asian countries should develop the systems of inter-state and national *governance* based on co-operation and co-ordination according to the principle of “hydro-solidarity” in order to optimize water resources use in all economic sectors, and especially for irrigation, hydropower generation, and nature protection.

# CHAPTER III. IWRM INDICATORS

**(V.A. Dukhovny, N.N. Mirzaev, A.I. Tuchin, V.I. Sokolov)**

As we ascertained earlier, integrated water resources management is a system that is characterized by specific principles and involves a number of key interrelated components. First, this is available water resource itself with all it's characteristics (indicators) and engineering infrastructure for water abstraction, storage and delivery to water consumers and water users. Management envisages the obligatory water requirement assessments, procedures for water allocation based on the constant balance of water supplies and demands, direct services on water delivery, and finally, the management of the water use process. Water quality control and meeting environmental requirements can also be add to above activities.

**Table 3.1. Components and Indicators of Water Resources Management Process**

| WRM Components | | Tasks | Indicators |
|---|---|---|---|
| Available water resources | Governance | Monitoring<br>Development<br>Protection | Amount, quality, regime, renewability, variability |
| Infrastructure | | O&M | Costs / efficiency / cost recovery |
| Water requirement | | Evaluation<br>Demand management | Level/amount/quality/time/location |
| Water balance and allocation | | Participation<br>Plan (schedule)<br>Regulations | Norm for flow rate<br>Equitability & rationality criterion<br>(rights / share / quota / limit) |
| Water delivery | | Secured water supply | Sufficiency of water supply, uniformity, sustainability, minimum unproductive losses |
| Water use and productivity | | Output and water saving | Productivity<br>(more crop per a water drop) |
| Water use impacts (MDGs) | | Sustainable development | Sustainable use index |
| Management assets | | Maintaining waterworks in operational conditions | Operational indicators |
| Water quality & ecological flows management | | Meeting the environmental requirements | Quality indicators and ecological flow rates |
| Monitoring & Evaluation | | Day-to-day management | Availability of on-line information from all key points of water delivery and distribution |
| Long-term planning | | Adaptation to long-term changes | Water requirements over the planned period are met |

In addition, management has to forecast long-term changes of key factors and water balance components, as well as specify a mechanism for adaptation of the water use system to these changes. Naturally, outcomes and efficiency of management should be regularly monitored and evaluated. Water management also covers a number of additional components related to financing, procurement process, recruitment and appointment of personnel, etc. Each component is aimed at solving specific tasks and can be evaluated with the use of relevant indicators that allows assessment of the actual progress. Key components of water management, their tasks, and proposed indicators for M&E are given in Table 3.1.

Monitoring, assessment, protection and development of available water resources (surface and ground water available for use) are key objectives of the first component. A key indicator, which demonstrates the progress of achieving established objectives is the ‘renewability' of water resources with regards to it's reserves or level at the source, water quality, and variability of these parameters over the time. One of key objective related to engineering infrastructure (reservoirs, irrigation and drainage canals, hydraulic structures, water supply network, etc,.) is proper operation and maintenance (O&M), including the maintenance of necessary operational regimes and design parameters of structures; their repairs, up-grads, and, if necessary, reconstruction. At present, such indicators as costs (financial and material), cost recovery, efficiency and operational life of the infrastructure define the quality of O&M. Next component of water management process (water requirements) is aimed at assessing the needs of all stakeholders in water resources and managing these requirements based on available water resources. Major indicators of this component are a record keeping on all points of water delivery, required amount and time of delivery (some water users may be interested in maintaining necessary water levels or water quality in their systems). After specifying available water resources and water requirements, the next component – water allocation – has to be implemented. In other words, this is the process of drawing up a balance, taking into consideration available water resources and water demands. Here, major objectives are maximum possible involvement of all stakeholders in the process of negotiations (coordinating water allocation) and development of acceptable for all procedures (rules) for water allocation. The proposed indicator for this component is criteria of equity and rationality in establishing quotas or limits for water use. The next component of the water management process – water delivery from a source to water users (water supply) – is water delivery services. Proposed indicators for evaluating the quality of these services are a uniformity and sustainability of water supply with minimum non-productive water losses. Finally, the last key component is water use, including irrevocable water consumption. Here, a major objective is to produce maximum output by using water or its optimal utilization. The proposed indicator is ‘*specific water productivity*' i.e. the amount of water consumed per unit output – product. Producing output and using water, we should be guided by the principles of sustainable development (providing opportunities for future generations to use water in the same extent as today); and a proposed indicator can be a sustainable use index, and exceeding it is unacceptable.

**Additional indicators:**

- indicators related ‘operation capacities', for such activities as management of procurements necessary for rehabilitation and repairing works, indicators of depreciation and renewal of assets, staffing (in the number and skill), sufficiency of financial resources, required training, etc,;
- Indicators of scientific and technological advances: an adequacy of existing technical facilities of O&M organizations to the world standards (computerization, SCADA systems, communications etc.);
- Environmental indicators reflecting an adequacy of the actual water quality compared to standards; providing ecological flows; the status of glaciers and erosion-affected zones; indicators of bio-productivity – an existence of representative animal units etc.

A proper governance system (described in Chapter 2) is needed to cover all components of the water management process as shown in Table 3.1.

**Management quality indicators are of special importance.**

In the IWRM-Fergana Project, as was described in Section 1.8, the information management system (IMS) that includes the model of water allocation planning, software and database (DB) and allows calculating, in particular, indicators of water services quality (water delivery and distribution) [17] was developed. In particular, the following indicators:

$$\text{Water supply factor (WSF)} = \frac{\text{Actual water supply}}{\text{Planned water supply}} \qquad (3.1)$$

The situation is considered optimal (from the biological point of view) when a water supply factor equal to 1. In practice, a water supply factor not always reflects the extent of water sufficiency for crops. Depending on purpose of the analysis, a water supply factor[5] is calculated for different levels of water management hierarchy top-down, including the end users.

A diurnal stability factor (DSF) can be estimated for each off-take as follows:

**DSF = a standard deviation of diurnal flow rates from an average daily flow rate / an average daily flow rate** **(3.2)**

A maximum value of the diurnal stability factor equals to 1.

A ten-day stability factor (TDSF) is calculated in the same manner for each intake structure (water diversion into an irrigation canal)

$$\text{TDSF} = 1 - \frac{\text{A standard deviation of an average daily flow rates from an average ten-day period flow rate}}{\text{an average ten-day period flow rate}} \qquad (3.3)$$

**Water supply uniformity factor (WSUF)** for one off-take or a group of off-takes (a farm, WUA, district, province etc.) is calculated as follows:

$$\text{WSUF} = 1 - \frac{\text{An absolute value of the difference between a WSF of an off-take (or a group of off-takes) and a WSF of an irrigation canal}}{\text{WSF of an irrigation canal}} \qquad (3.4)$$

At present, a fundamental principle of water allocation coming from the principle of social equity is a proportionality principle. A criterion of assessing social equity of actual water allocation among water users is a

[5] All factors are unitless, and to express them in percents (%) it is necessary to multiply their values by 100.

water supply uniformity factor. A maximum value of water supply uniformity factor equals to 1. The higher the value of water supply uniformity factor the more equitable water allocation process.

**A coefficient of water supply uniformity from a canal = an arithmetical mean value of coefficients of water supply uniformity to water users in the canal's command area** **(3.5)**

**A "from head to tail" uniformity factor**

In the practice of water allocation, as a rule, there is so-called "from head to tail" problem, when upstream water users are supplied by irrigation water better than downstream water users. A "from head to tail" uniformity factor reflects the equity of water distribution along all length of an irrigation canal.

**A "from head to tail" uniformity factor = 1 – (An absolute value of the difference between a WSF of 25% of downstream water users and 25% of upstream water users) /(a WSF of 25% of downstream water users)** **(3.6)**

**Technical efficiency factor (TEF)**

$$\mathbf{TEF} = \frac{\textbf{Water supply + transit flow + outflow}}{\textbf{Head water diversion + side inflow}} \qquad \mathbf{(3.7)}$$

In principle, a maximum value of the TEF cannot be more than 1. However, sometimes there are cases in the practice of water distribution, when the TEF is more than 1 due to the fact that it is very difficult to estimate dispersed water inflow into the irrigation canal.

Indicators of water allocation should be used for the assessment of the quality of water management. In the IWRM-Fergana Project, such an assessment is conducted on a regular basis. A fragment of such an assessment is given below. This assessment is done by comparing key indicators over the period of 2003 to 2007 (Table 3.2).

**Table 3.2 Water distribution indicators for pilot canals (IWRM-Fergana Project)**

| Pilot canal | Year | Actual water supply | WSF | WSUF | DSF | TEF | Specific water supply |
|---|---|---|---|---|---|---|---|
| | | mln. $m^3$ | % | % | % | % | 000' $m^3$/ha |
| South Fergana Canal | 2003 | 1053 | 112 | 60 | 85 | 81 | 12.6 |
| | 2004 | 925 | 93 | 89 | 87 | 88 | 11.0 |
| | 2005 | 871 | 85 | 94 | 85 | 87 | 10.3 |

| Pilot canal | Year | Actual water supply | WSF | WSUF | DSF | TEF | Specific water supply |
|---|---|---|---|---|---|---|---|
| | | mln. $m^3$ | % | % | % | % | 000' $m^3$/ha |
| | 2006 | 816 | 77 | 94 | 84 | 89 | 9.2 |
| | 2007 | 643 | 68 | 92 | 84 | 86 | 7.2 |
| Aravan-Akbura Canal | 2003 | 83 | 74 | 45 | 70 | 54 | 13.1 |
| | 2004 | 66 | 88 | 63 | 91 | 53 | 9.8 |
| | 2005 | 57 | 77 | 69 | 84 | 54 | 8.5 |
| | 2006 | 54 | 75 | 74 | 81 | 59 | 8.0 |
| | 2007 | 64 | 83 | 82 | 90 | 59 | 8.3 |
| Khodja-Bakirgan Canal | 2003 | 116 | 82 | 36 | 41 | 80 | 14.4 |
| | 2004 | 113 | 85 | 82 | 58 | 78 | 15.8 |
| | 2005 | 115 | 86 | 73 | 64 | 78 | 16.5 |
| | 2006 | 90 | 69 | 80 | 54 | 80 | 12.1 |
| | 2007 | 88 | 67 | 77 | 62 | 81 | 11.8 |

A similar assessment was made for the level of water users associations, too.

**Table 3.3. Project Impact Assessment in Pilot WUAs**

| WUA | Year | Actual water supply, 000' $m^3$ | WSF, % | WSUF, % | DSF, % | Specific water supply, 000' $m^3$/ha |
|---|---|---|---|---|---|---|
| Akbarabad | 2004 | 25.7 | 88 | 95 | 87 | 9.1 |
| | 2005 | 23.1 | 80 | 94 | 86 | 8.2 |
| | 2006 | 22.5 | 75 | 97 | 82 | 8.0 |
| | 2007 | 18.0 | 64 | 94 | 83 | 5.9 |
| Japalak | 2004 | 11.9 | 72 | 82 | 98 | 6.3 |
| | 2005 | 9.1 | 56 | 73 | 87 | 4.9 |
| | 2006 | 10.7 | 65 | 88 | 83 | 5.7 |

| WUA | Year | Actual water supply, 000' $m^3$ | WSF, % | WSUF, % | DSF, % | Specific water supply, 000' $m^3$/ha |
|---|---|---|---|---|---|---|
| | 2007 | 12.4 | 83 | 99 | 95 | 6.6 |
| Zarafshon | 2004 | 6.7 | 61 | 72 | 59 | 8.3 |
| | 2005 | 7.6 | 69 | 81 | 56 | 9.4 |
| | 2006 | 7.2 | 66 | 96 | 49 | 8.9 |
| | 2007 | 5.8 | 46 | 69 | 49 | 6.5 |

However, all these indicators reflect water management at the level of irrigation canal, WUA, and at the irrigation system level rather than the IWRM. It is necessary to carry out a comprehensive assessment of IWRM (its effectiveness, economic effects and impacts) on achieving MDGs.

An integrated assessment of the effectiveness may be made combining some indicators, for example, the ratio of actual water productivity and potential water productivity, taking into consideration the same cropping pattern; or a ratio of water volumes supplied at the head of irrigation system and crop water requirements. In the integrated water management system, this indicator can be calculated using the total water diversion and the technological need in water for all water consumers, including water for irrigation.

In the process of planning for the long-term improvements of an irrigation system, it is important to combine these indicators with the MDGs. Such an analysis and subsequent selection of options for developing the water management complex was made in the RIVERTWIN Project for the period of 25 years.

This project envisages the integrated hydro-ecological development of the Chirchik River basin, taking into consideration the requirements of hydropower, water supply, irrigation, and the environment. As a result of the analysis of existing situation and planned measures, which were reflected in modeling variants based on limited water resources, indicators of development were obtained for the period until 2030.

**Table 3.4. Indicators of Integrated Water Resources Development Resulting from the Introduction of IWRM in the Chirchik Basin**

| No | Indicator | Units | Actual, 2003 | Estimated values for 2030 | | |
|---|---|---|---|---|---|---|
| | | | | Without project | Optimistic | Realistic |
| 1. | Mean annual resources | $km^3$ | 8.390 | 8.677 | 8.973 | |
| 1.1 | Surface runoff | $km^3$ | 7.890 | 8.107 | 8.403 | |
| | including: | | | | | |
| | • Chirchik | $km^3$ | 7.000 | 7.088 | 7.363 | |
| | • Akhangaran | $km^3$ | 0.720 | 0.729 | 0.747 | |

| No | Indicator | Units | Actual, 2003 | Estimated values for 2030 | | |
|---|---|---|---|---|---|---|
| | | | | Without project | Optimistic | Realistic |
| | • Keles | $km^3$ | 0.070 | 0.176 | 0.176 | |
| 1.2. | Ground water | $km^3$ | 0.500 | 0.570 | 0.570 | |
| 2. | Population | ths. | 4,930 | 6 468 | 6 293 | |
| 3. | Gross product | mln. $ | 2112.88 | 2398.48 | 3989.99 | 2839.24 |
| | ▪ industry | mln. $ | 797.40 | 676.41 | 2048.96 | 898.21 |
| | ▪ agro-industry | mln. $ | 322.14 | 352.23 | 352.23 | 352.23 |
| | ▪ agriculture | mln. $ | 468.35 | 489.74 | 1016.69 | 1016.69 |
| | ▪ service sector | mln. $ | 524.99 | 880.10 | 572.11 | 572.11 |
| 4. | GDP | mln. $ | 1026.47 | 1280.87 | 1734.38 | 1492.73 |
| 4.1 | GDP per capita | $/person | 422.4 | 377.8 | 536.79 | 462.03 |
| 5. | Agricultural gross product | 000' tons | 468.58 | 489.74 | 1016.69 | |
| | • grains | | 450.03 | 305.02 | 627.01 | 570.5 |
| | • cotton | | 189.19 | 142.20 | 333.49 | 246.9 |
| | • vegetables | | 827.50 | 602.54 | 1067.37 | 1584.0 |
| | • fruits | | 215.19 | 304.68 | 993.12 | 530.0 |
| | • potato | | 375.39 | 341.50 | 464.13 | 758.0 |
| | • meat | | 72.10 | 94.66 | 197.43 | 160.0 |
| | • milk | | 356.17 | 465.95 | 972.00 | 1200.0 |
| 6. | Overall crop area | 000' ha | 380.28 | 416.1 | 421.7 | |
| 7. | Crop yield | centner/ha | | | | |
| | ▪ cotton | | 2.01 | 1.39 | 3.21 | 4.0 |
| | ▪ grains | | 4.16 | 2.43 | 5.11 | 6.3 |
| | ▪ potato | | 21.18 | 11.51 | 24.78 | 30.0 |
| | ▪ vegetables | | 22.49 | 13.08 | 26.02 | 29.0 |
| | ▪ fruits | | 3.21 | 3.03 | 14.09 | 11.0 |

| No | Indicator | Units | Actual, 2003 | Estimated values for 2030 | | |
|---|---|---|---|---|---|---|
| | | | | Without project | Optimistic | Realistic |
| | ▪ vineyards | | 2.38 | 4.21 | 17 | 12.0 |
| | ▪ rice | | 3.96 | 2.36 | 5.19 | 5.5 |
| 8. | Total water abstraction | mln. $m^3$ | 4110 | 5509 | 5977 | |
| | • for irrigation, Uzbekistan | | 2347 | 3691 | 3882 | |
| | • for irrigation, Kazakhstan | | 489 | 483 | 761 | |
| | • public utilities | | 798 | 876 | 876 | |
| | • others (including industry) | | 476 | 459 | 461 | |
| | Transit through HPS | | 1730 | 1500 | 1500 | |
| 9. | Return water | mln. $m^3$ | 2917 | 2476 | 2492 | |
| 10. | Food supply factor | % | | | | |
| | • bread | | 52 | 27 | 56 | |
| | • vegetables | | 145 | 80 | 146 | |
| | • fruits | | 112 | 121 | 405 | |
| | • meat | | 49 | 49 | 105 | |
| | • milk | | 39 | 39 | 83 | |
| 11. | Hydropower generation | M kWh | 3892 | 3566 | 3987 | |
| 11.1 | including Pskent HPS | M kWh | 0 | 0 | 344 | 1200 |
| 12. | Capital investments to irrigation | mln. $ | | 237 | 791.6 | |

Summarizing our approach concerning IWRM indicators, it is possible to state that they are mainly aimed at improving and developing water governance in line with key IWRM principles, as well as improving the effectiveness of IWRM implementation and outcomes.

In this respect, the major distinction of our approach, from those which were presented in foreign papers related to the use of IWRM indicators, is based on an understanding of the IWRM not as a management system (our principal idea is development!) but as a process of improving a management practice that is not described with clear outcomes and indicators (see our previous publication, devoting IWRM issues). B. Hooper [54], who suggests 115 performance indicators for river basin organizations, which are grouped into ten categories, is a quite interesting summary:

- Coordinated decision-making
- Responsible decision-making;
- Objectives and their achieving, shift in objectives;
- Financial sustainability;
- Organizational framework;
- Legislative base;
- Training and capacity building;
- Information and researches;
- Monitoring and record keeping; and
- Private and public roles;

These indicators are not calculated but provide a qualitative assessment based on scores from 1 to 5, gives a notion about the advance made by water organizations towards IWRM. They evaluate not the effectiveness of achieving certain management principles, but subjective planned forms, within which this process is developing. Their value no doubt, is especially in the making and developing the IWRM system, if they were be clearly specified in terms of quantity. Nevertheless, from the point of view of analysis of the effectiveness, they give nothing [3]. Therefore, it is not accidental that a half of the categories suggested by B. Hooper (financial sustainability, organizational framework, capacity building, and information and monitoring) [54] is represented in our components, but as numerical and auxiliary indicators. A set of indicators suggested by us that correspond to the necessary structure of information and database given in Section 1.8 allows tracking actual outcomes and analyzing measures necessary for achieving planned levels over all stages of introduction and development of IWRM.

# CHAPTER IV
# LESSONS LEARNED FROM IWRM IMPLEMENTATION IN CENTRAL ASIA

## 4.1 Pilot Projects on IWRM Implementation

**(V.A Dukhovny, V.I Sokolov, M.G. Khorst)**

Putting some of IWRM principles into practice in the water sector has been started even prior to the independence of Central Asian countries. Over a long time, this process was being implemented without the general strategy of adapting this approach to local conditions, spontaneously putting some IWRM elements and principles into practice at the regional level of water resources management.

One of the first steps was the establishment of two basin organizations as provided by the Resolution No 1088 of the Cabinet of Ministers of the USSR issued in 1987, as well as executing a number of other measures envisaged by this document. Establishing BWO "Amu Darya" and BWO "Syr Darya" was essentially the transition towards basin management (within hydro-geographical boundaries) at the inter-republican level (subsequently at the inter-state level); and organizational efforts of the former Ministry of Water Resources of the USSR have practically created the basis for such management and coordinating the sectoral interests of different republics (countries), as well as for developing mechanisms of water allocation and operational activity taking into consideration provisions of "the Schemes (Master-plans) for integrated water resources use" in both river basins.

Subsequently, after independence, specific steps were undertaken in the frame of other projects [9] under an umbrella of the ASBP-1 (the Aral Sea Basin Program). In particular, the EC WARMAP project has, in a large measure, contributed to first actions of preparing the IMS, measures for water saving at all levels of ware management hierarchy, and developing the legal base for IWRM at the top level of basin management. The GEF WEAMP project has resulted in the Regional Water Strategy that has specified the strategic grounds for introducing IWRM in the region; and its Component A-2 has clearly demonstrated the opportunities for water saving (taking into account findings of the EC WARMAP project) [13]. Approaches to rehabilitating the ecological profiles in deltas of two major rivers in the region were developed in the frame of Component "Sudoche Lake Rehabilitation" and the WB projects for rehabilitating the lower reaches of the Syr Darya River.

The CIDA project implemented jointly by the McGill University and SIC ICWC, which allowed training more than 3000 water professionals in the frame of the advance course "Integrated Water Resources Management" held at the ICWC Training Center, has played a considerable role in the popularization of IWRM principles and adoption of their backgrounds by many decision-makers in the region.

The most significant step towards IWRM was made in the frame of the regional project "IWRM-Fergana" implemented by specialists representing the Departments of Water Resources of Kyrgyzstan, Tajikistan, and Uzbekistan under overall co-ordination of the SIC ICWC and IWMI and financial support of the Swiss Development Cooperation (SDC) [41]. This project is aimed at improving the effectiveness of water resources management by means of introducing the IWRM principles in the Fergana Valley. An overall project objective is *"to contribute to more secure livelihoods, increased environmental sustainability, and greater social harmony, and to support rural restructuring in Central Asian countries through the improved effectiveness of water resources management on example of the Fergana Valley"*

Selecting of the Fergana Valley as a pilot area for introducing IWRM methods is based on socio-economic conditions in this dense populated region where more than 11 million people 60% of which are rural population reside on the territory about two million hectares. It is possible to affirm with confidence that livelihood and living standard of the population depend on the use effectiveness of water resources which, in a large extent, are transboundary waters, as well as the system of water management over the irrigated area of 1.2 million hectares.

From the beginning, the project was aimed at maximum participation of water users and water authorities in developing the conception of IWRM adaptation to regional conditions and in selecting the pilot areas. For this purpose, the preparatory project phase was established, during which teams from three countries and all provinces representing this region took participation in selecting pilot areas using the fundamentals and requirements prepared by the regional group. The principles mentioned in Chapter 1 were proposed as fundamentals and have been carefully reviewed, discussed, approved by participants of workshops for their use in project activity. Subsequently, representatives of all provinces have received the special forms in concordance with which they had to prepare data for two pilot areas in each province. At the same time, each pilot area essentially represents a chain consisting of three levels of an irrigation system including a main irrigation canal, the network of former inter-farm and on-farm canals, on the base of which WUAs can be organized, and the end users – farms.

Based on the analysis of proposed pilot areas, project participants have selected three pilot canals: the Aravan-Akbura Canal in Osh Province in Kyrgyzstan, Khodja-Bakirgan Canal in Soghd Province in Tajikistan, and South-Fergana Canal that crosses Andijan and Fergana provinces in Uzbekistan.

After five-year project activities the following practical outcomes can be noted:

The IWRM conceptual base taking into consideration hydro-geographical boundaries, participatory approach and democratic principles of water management were developed and submitted to national water authorities. The IWRM conception was coordinated and approved by all water authorities in Uzbekistan, Kyrgyzstan, and Tajikistan in May 2003 [41].

A comprehensive approach for social mobilization (awareness of IWRM principles) was developed [18]. A training program for social mobilization and capacity building at the levels of WUA and irrigation canal was prepared. Regular training seminars and sociological surveys established by the project provide new opportunities for involving all stakeholders in reforming the water sector in the Fergana Valley. Thanks to project efforts, new water users associations (the WUA "Akbarabad" in the command area of the South Fergana Canal in Uzbekistan, WUA "Kerme-Too-Akbursay" in the command area of the Aravan-Akbura Canal in Kyrgyzstan, and WUA "Obi-Zerafshan" in the command area of the Khodja-Bakirgan Canal in Tajikistan) were established. Earlier established WUA "Japalak" was also included as base WUA into the project sphere. Newly established WUAs were registered in compliance with national legislations; and in the beginning of 2003, WUAs' boards have signed the agreements on joint management with relevant privileges. In addition, at the instance of the MAWR of Uzbekistan and Tajikistan, the project has organized some unplanned training seminars on the topic "How to establish WUAs through social mobilization" for district-level specialists. Based on the experience learnt from these WUAs during first three years, dissemination of the proved IWRM principles and regulations over all WUAs in the command areas of pilot canals through the network of training centers and on-job training, which was conducted by specially trained project facilitators (trainers) in each province, was started [26].

Apart from the training activity in the Central ICWC Training Center, the project has established the branch of head training center in Osh City. Personnel of the Osh Training Center were trained, and then were independently carrying out the training programs related to dissemination of the project experience. Subsequently, similar branches were established under the Provincial Basin Organizations in Andijan, Fergana, and Khodjent to extend coverage of WUAs personnel and farmers in these provinces. Since July 2002, planned (according to the project program) and unplanned training seminars for personnel of water management organizations, water users and NGOs representatives from Fergana Valley were being monthly conducted. At these training courses, the great attention was paid to dissemination of the IWRM ideology. The communication network that was based on e-mail system and linked all key project participants (the SIC ICWC – national departments – provincial water management organizations – pilot canal administration - WUAs) was developed. The project has established the Information Management System (consisting of a database, a set of mathematical models, and GIS), operating in the on-line regime, which is a powerful tool for planning, operational analysis, and improving the water allocation process and actual water distribution.

Alternative organizational structures for water management at the level of WUA and main irrigation canals were specified, discussed and coordinated by project partners and other stakeholders. Based on agreements achieved, water authorities of Uzbekistan, Tajikistan, and Kyrgyzstan created new departments – Canal Administrations. In December 2003, activity on involving water users into the decision-making process related to water governance was initiated. As a result of these works, the Pilot Canal Water Users Unions were established and officially registered on all pilot canals; and the joint governance principle was put in practice: the agreements related to joint water governance were signed, and the Canal Water Committees consisting of representatives of superior state water management organization (WMO) and water users (CWUU) were created. An effectual factor of transition towards IWRM is participation of representatives of civil society in the governance process that is also legally fixed.

In the course of following works related to institutional reforms, the need in functioning intermediate agencies – a framework of basin water authorities and provincial water authorities should be specified yet. The first steps towards establishing procedures of water resources planning, record-keeping, reporting and monitoring at each level of new water management hierarchy were made. It is expected that activity will be implemented at all levels of the water hierarchy by means of establishing the Canal Water Committees.

Many technical aspects also depend on the public. It is not easy task to provide guaranteed and equitable water distribution over the irrigation system as a whole. When water is delivered in line with planned amounts and of necessary quality increase in productivity of water and land resources may be expected. Water users themselves should participate in more precise specifying of command areas for each irrigation canal, assessment their water demands, and accounting additional available water sources (ground water, return water). Adjusting water supply, rotation and use depending on weather and economic conditions, as well as improving hydraulic measurements and record-keeping at all levels of the water management system are also their functions. To tackle arising issues it is necessary to establish extension services that assist water users in the introduction of new technologies, advanced practice of planning and production, and solving water distribution problems. The project has developed and transferred for use “Model Regulations on Canal Water Committees”, as well as recommendations for their adaptation on each pilot canal [18].

Objectively realizing that the existing national legislations in the region are not perfect and cannot be the platform for supporting necessary reforms in the water sector, the project has prepared the recommendations on the package of changes required and transferred them to all national water authorities in the region. Just laws have to specify a role and duties of governments and water management organizations in regard to water resources use, protection and development. The need to specify clearly social, economic and ecological values of water, as well as a role of water users associations and regulations for coordinating water-consuming sectors is obvious. For example, there is the need to regulate relations of water authorities with conservancies, agricultural and local authorities. Financial mechanisms should also have the clear legal regulation in the water sector. The project has paid enormous attention to aspects of disputes settling at the level of WUAs and irrigation canal administrations – sociological surveys were conducted and recommendations, for presentation of which the project organized some on-site seminars, were developed.

The project has rendered the technical assistance in inspections and extra equipping of flow-measuring structures on pilot irrigation canals (an enormous work was implemented to establish the water-metering systems within pilot WUAs). This activity allowed setting the proper water record-keeping on the pilot canals and within WUAs resulting in the more transparent process of water distribution. Water meters were mainly manufactured and certified in the Regional Meteorological Center of the ICWC in Bishkek with participation of SANIIRI. The project has started real-time management of the water delivery process on pilot irrigation canals and within pilot WUAs in the form of monitoring and updating the planned water supply schedule based on water users’ applications with taking into account weather conditions during a growing season. This is the first step towards equitable and rightful water distribution and, at the same time, an attempt to reduce unproductive water losses [21].

Preparing the passports of demonstrative fields within pilot farms allowed creating an instrument for analyzing farmers’ production reserves and potential with the purpose of improving productivity of land and water resources. Testing the instrument for forecasting water consumption in line with weather conditions is conducted in the real-time regime, and its introduction in wide scale during the next phase of the project is planned. Our analysis shows that on 9 of 10 pilot plots the land and water productivity was perceptibly improved. On one pilot plot located on the SFC, where farmer did not follow the project recommendations, productivity has reduced.

Many women were involved in discussions related to management of the land and water productivity and of other water resources management problems in the Fergana Valley. For example, about 60 women actively participated only in one project seminar that was devoted to water productivity issues and was held on September 15, 2003 in the WUA "Akbarabad." Based on outcomes of these activities, the enabling environment was created for the wide introduction of extension services for farmers in the Fergana Valley.

Partners, under regular co-ordination of SDC, implement sufficiently effective governance and monitoring of project activity. Since 2003, the co-ordination meetings of project managers and SDC experts were being organized practically monthly. Problem-oriented matters of activity were being discussed at these meetings to come to an understanding and consensus in methods and approaches to implementing those or other IWRM aspects. The project has paid much attention to regular publishing of technical papers and disseminating of information related to the project activity through mass media. The project can enter as its asset the fact that as a result of intense popularization and information on the IWRM concept, the Government of Uzbekistan has decided to reform water governance in line with the hydrological principles (the Resolution No 320 of the Cabinet of Ministers "On Improving the Water Sector Governance" issued on July 21, 2003).

**Major project objectives at the third phase (since May 2005 until April 2008) were the following:**

- Strengthening proposed reforms at all levels of water management hierarchy and co-operation of all water-consuming sectors and completing a set of all necessary regulations for their wide dissemination;
- More wide and intense disseminating institutional, managerial, and technical information and appropriate recommendations among existing and newly established water management organizations, including agencies that co-operate with international donors.

**By the end of project activity in 2010, the following is expected:**

- IWRM principles will be adequately used in the practice of pilot canal management;
- WUAs, in their service area and under supporting by the project, will distribute and deliver water to their members on the equitable and sustainable basis, using IWRM guidelines;
- Advanced water management technologies will be introduced at the level of water users;
- Project recommendations will be transformed into certain political reforms at the national level; and
- Project outcomes will be positively assessed by the Swiss Develop Cooperation and national authorities.

A mission of the Swiss Develop Cooperation has already highly appreciated project outcomes and activities in the frame of its components one year before their completion.

**Conclusion of this mission is the following:**

"The project has developed the unique IWRM approach (reorganizing the governance and management frameworks) for which none ready model existed. Thanks to this new role, social mobilization (rising of public awareness, clarification of new conceptions, and persuasion) has become the important project component."

A token of success is the direct participation of water sector officials in governance of activities at pilot sites and in establishing national working groups consisting of representatives from water-related sectors, as well as a broad interest and support of above principles by water authorities of other regions and provinces that was expressed at the get-to-know seminars conducted by project personnel together with appropriate national ministries and departments.

Along with activities described in detail in other chapters of this book, the project (IWRM-Fergana Project) has implemented and proceeds with implementing sub-projects aimed at putting basic IWRM principles into practice in Central Asia and Kazakhstan. These subprojects are focused on different aspects of regional activity, but one general purpose unite them – the introduction of IWRM principles into multi-sectoral water economy in the region and involving the communities into the governance process by means of establishing the system of social mobilization (of water users and other stakeholders) aimed at introducing IWRM.

### The project: Transition towards IWRM in Lower Reaches and Deltas of Amu Darya and Syr Darya Rivers. The Pre-Feasibility Study

A methodology of the above project [10] (see Box 4.1.1) is based on the concept and principles adopted in the IWRM-Fergana Project, however, there are some differences resulting from the peculiarities of Amu Darya and Syr Darya lower reaches.

The project was aimed at developing the Pre-Feasibility Study (PFS) for the introduction of IWRM principles under the specific conditions in lower reaches that are the most depressive region from the socio-economic point of view in Central Asia subjected to recurrent catastrophic drops in water availability (for example, in 2000 and 2001) and environmental degradation. It was assumed that based on the PFS, international donors will receive the opportunity to assist the region in adaptation of IWRM methods to these conditions and to cover, selected with stakeholders' participation, pilot irrigation systems in Kyzyl-Orda Province in Kazakhstan, in Dashhowus Province in Turkmenistan, and in Khorezm Province in Uzbekistan, by analogy with the IWRM-Fergana Project. In spite of the fact that an appeal to the many international donors was not crowned with success, some project outcomes were reached:

- The IWRM conception was adapted to the conditions in lower reaches (considering the environmental requirements);
- Transboundary aspects of IWRM were specified.

Special consideration was given to land reclamation issues in the course of implementing IWRM. Peculiarities of Amu Darya and Syr Darya lower reaches show up, first of all, in the form of social and environmental tensions, and in some losing of *water resources controllability*, which emerges in extremely dry years (2000 and 2001).

By present time, specific socio-economic and environmental conditions conditioned by *inefficient water resources management during last 5…10 years* have been formed in different areas of lower reaches.

What kinds of activities are envisaged in "IWRM in lower reaches" for implementing measures planned in the preliminary FS?

**At the national level,** in contrast to "IWRM in Fergana Valley", consideration of local peculiarities is needed for each specific area in lower reaches:

- A situation in Khorezm Province is similar to the situation in Fergana Province (limited land resources and high population density), but differs by the specific character of land reclamation conditions resulting from stratified soils of deltaic layered- lacustrine sediments.
- A situation in Kyzyl-Orda and Dashhowus provinces and in Karakalpakstan a little bit different: abundant land resources; unsustainable water supply, insufficient natural and man-made drainage; salt-affected soils, and excessive carrying capacity of irrigation and drainage canals;

Tackling these specific matters requires different managerial, technical and land reclamation approaches for developing IWRM, but should follow the same key directions and mechanisms that are fine-tuned within the framework of IWRM-Fergana Project.

**At the inter-state level:**

- Strengthening the interstate co-operation in allocating a runoff of the Amudarya and Syr Darya rivers based on IWRM principles and by means of improving the institutional frameworks of existing organizations established for managing transboundary waters – the BWO "Amu Darya" and BWO "Syr Darya":

- Establishing the Public Boards (Councils) of the BWOs with inclusion to them of the representatives from all countries, provinces located in each river basin, large-scale water users such as hydropower schemes, as well as representatives of Hydro-Meteorological Services, administrations of large main canals, and the Hydro-Ecological Councils for Deltas Management that represent the interests of deltaic complexes;
- Setting up special subdivisions in each BWOs for monitoring and controlling river water quality that will be responsible for developing their proposals to the ICWC and national governments regarding measures necessary for improving natural streams and for integrated using of surface, return, and ground waters.

- Receiving national governments' endorsement of fundamental documents related to managing transboundary river flows such as:

- The Statute of Basin Water Councils and procedures for their participation in planning and governing the water economy in Amu Darya and Syr Darya river basins;
- Estimated values of environmental water requirements of natural complexes, rivers, and especially their deltas;
- Forecast of available water resources of rivers in years with the different runoff probability;
- Rules for regulating and allocating water resources in years with the different runoff probability, taking into consideration the specificity of flow regimes;
- Instructions to BWOs regarding water management under emergency events (extreme droughts or floods);
- Scheme of reservoirs system operation, including the regimes of water releases and filling;
- Procedures for financial relations between countries participating in control and regulation of river flows; and
- Regulations concerning the responsibility of countries and large-scale water users related to maintaining of established operational regimes.

- Developing a set of models for water resources management in each river basin (for annual and long-term operation) taking into account the interacting of rivers and areas under economical activity (water diversions, formation of return water, productivity of water use). The set of developed models should become the base for:

- Developing the national and sectoral strategies for regulating their economic activity related to water use and assessing impacts of their economic activity on downstream areas and riparian countries; and
- Specifying the possible consequences of management decisions and ways for achieving the consensus in the process of decision making.

The Pre-Feasibility Study approved by the ICWC was submitted to potential donors to provide financial support to the IWRM-Lower Reaches Project.

| **Box 4.1.1** |
|---|
| **Project name:**<br>Transition towards IWRM in Lower Reaches and Deltas of Amu Darya and Syr Darya Rivers. The Pre-Feasibility Study (FY 2003 OESI Water Project, the Regional Environment Office of US Department of State) [10] |
| **Donor:**<br>US Department of State |
| **Project period:**<br>2004 to 2005 |
| **Executors:**<br>The Regional Environment Office of US Department of State, national experts from Kazakhstan, Turkmenistan, and Uzbekistan |
| **Project objective:**<br>Developing the detailed plan of supporting and establishing the IWRM system and creating the water partnership at the national and inter-state level in Amu Darya River lower reaches (Khorezm Province and the Republic of Karakalpakstan in Uzbekistan and Dashhowus Province in Turkmenistan) and in Syr Darya River lower reaches (Kyzyl-Orda Province in Kazakhstan). A priority of this objective is conditioned by extremely keen ecological and socio-economic problems in above regions due to Aral Sea crisis and the low level of water resources control. |
| **Key project outputs:**<br>• Review of the current trends and issues that need to be tackled;<br>• Analysis of the political, legal and institutional frameworks necessary for functioning IWRM elements;<br>• Review of the national and international projects related to water resources management issues in Amu Darya and Syr Darya lower reaches;<br>• IWRM activity planned in lower reaches; and<br>• Regional and national action plans. |
| **Implementation aspects:**<br>The pilot sites for fine-tuning of IWRM principles taking into consideration the specific character of lower reaches were selected under consultations with decision makers, WUAs' representatives and the public, and cover three levels of water hierarchy: hydro-ameliorative / irrigation system – water users association - farms.<br>Selection criteria have included:<br>• Readiness and firm determination of all participants of the water sector for reforming the water resources management system;<br>• Representative character of pilot sites for each of three levels of water management hierarchy according to key indicators for above regions; |

Taking into consideration the dependence of lower reaches from the quality of transboundary water resources management, the additional component (level) was included: “Amu Darya and Syr Darya transboundary water resources management.”

The plan of introducing IWRM principles at pilot sites and all three levels of water management hierarchy and for implementing the additional component (level): “Transboundary water resources management” was elaborated in details.

Key tasks and principles for each level and phase of activity, as well as expected outcomes and implementation indicators were specified.

Necessary funds for implementing project activity over the three-year period were estimated: US$ 35,255,000 including US$ 907,000 of counterpart funds provided by Kazakhstan, Turkmenistan, and Uzbekistan.

The Pre-Feasibility Study was approved by members of the ICWC (Interstate Coordination Water Commission for Central Asia).

### The Project: Developing the Kazakhstan National Integrated Water Resources Management (IWRM) and Water Efficiency Plan

Under current socio-economic conditions in our region, Kazakhstan is a more advanced country having sufficient financial resources and appropriate legislative base for purposeful activity related to putting the IWRM principles into practice in the national water sector. Part of IWRM provisions was included in the new Water Code (passed in 2003).

The project “Developing the Kazakhstan National IWRM & Water Efficiency Plan” [14] (Box 4.1.2) is a considerable step towards awareness of the IWRM principles and substantially facilitates follow-up introducing this method into the practice of national water sector.

The plan (its first draft) outlines the actions needed to reduce wastes a significant proportion of national water resources through both inefficient use of water and through pollution; it also focuses on the problem of managing water resources use and water quality. As top-priority measures, the plan envisages strengthening a role of the State Water Resources Committee and Basin Water Organizations (BWOs), establishing the National Information Center, preparing the Basin IWRM and Water Efficiency Plans and providing sufficient funding the water resources management system. **The strategy for achieving the MDGs in the field of water supply and sanitation** has to be developed as well.

In 2007, the following activities were planned and implemented in the frame of this project:

- Submitting the National IWRM & Water Efficiency Plan for endorsement by the ministries and departments of the Government of the Republic of Kazakhstan;
- Supporting the formal meetings of Basin Councils of the Republic of Kazakhstan;
- Preparing the proposals concerning address some modifications in the Water Code of the Republic of Kazakhstan to strengthen a role of the Basin Councils in decision making;
- Specifying possible financial mechanisms for achieving the MDGs; in the field of water supply and sanitation in the Republic of Kazakhstan;
- Developing the program for achieving the MDGs; and
- Informing the general public (public awareness) and stakeholders regarding the MDGs and the importance of their achieving.

The project is quite important for the top level of IWRM introduction, because as a result of this project, not only IWRM has received the legal acknowledgement in the first one of countries in Central Asia and the water management organizations based on the hydro-geographical principle were officially established, but also the National IWRM & Water Efficiency Plan was approved. This plan outlines the time constraints and financing sources for some IWRM components, including establishing the training network, national and basin information systems, Basin Councils etc.

However, the IWRM introduction mechanism is insufficiently outlined in the plan, since the National IWRM & Water Efficiency Plan was confined exclusively to the national and basin level of water management without coverage of all water management hierarchy, especially of the most crucial "bottom" level - WUAs and farms. Just on that level, a considerable scope of works related to social mobilization of water users, including public awareness regarding putting IWRM principles into practice in the irrigated farming sector, need to be implemented. All measures for improving the efficiency of water use by direct consumers have been ignored. Public involvement was confined to the advisory functions and powers, but decision making remains the prerogative of water authorities. Thus, functions of water governance and management remain only in the hands of water professionals even at the top level of governance resulting in the possible strengthening the professional hydroegoism.

| **Box 4.1.2** |
|---|
| **Project name:**<br>Developing the Kazakhstan National Integrated Water Resources Management (IWRM) and Water Efficiency Plan (under assistance of the UNDP) |
| **Donor:**<br>The Government of Norway and the UK Department for International Development |
| **Project period:**<br>June 2004 to June 2007 |
| Executors:<br>Basin Water Organizations (BWOs), Ministry of Agriculture and Ministry of Economy and Budget Planning of the Republic of Kazakhstan, the UK Department for International Development (DFID), Global Water Partnership (GWP) |
| **Project objective:**<br>Assistance to the State Water Resources Committee and Ministry of Agriculture of the Republic of Kazakhstan in developing the National Integrated Water Resources Management (IWRM) and Water Efficiency Plan, as well as Basin IWRM and Water Efficiency Plans for eight river basins in the Republic of Kazakhstan (Aral-Syrdarya, Balkhash-Alakol, Irtysh, Ishim, Jayik-Caspian, Nura-Sarisuy, Tobol-Torgay, and Chu-Talas)<br>Establishing the Basin Councils in all eight river basins in the Republic of Kazakhstan.<br>Developing the strategy for achieving the MDGs in the field of water supply and sanitation, reducing by half a share of the population without access to safe drinking water by 2015. |
| **Key project outputs:**<br>• The conceptual note for the National IWRM and Water Efficiency Plan (March 2005);<br>• The Cross-sectoral Working Group for IWRM (ISWG) (May 2005);<br>• Draft IWRM plan sections (July 2005);<br>• The First National IWRM Forum (July 2005);<br>• The first draft of National IWRM and Water Efficiency Plan (November 2005);<br>• The second meeting of the ISWG (January 2006);<br>• The Second National IWRM Forum (March 2006);<br>• The Substantiation Report for including the National IWRM and Water Efficiency Plan into the National Medium-Term Socio-Economic Development Plan;<br>• The Resolution No 978 of the Government of the RoK issued on October 11, 2006;<br>• The second draft of National IWRM and Water Efficiency Plan (November 2006);<br>• The third meeting of the ISWG (December 2006);<br>• The Congress of Basin Councils of the Republic of Kazakhstan (April 2007) *where expected* |

*project outcomes by 2008 have been reviewed;*
- The National and Basin IWRM and Water Efficiency Plans for Kazakhstan; and
- The Strategy for Achieving the MDGs in the Field of Water Supply and Sanitation.

**Implementation aspects:**

Seven Basin Councils were established and are operable:
Balkhash-Alakol (09.09.05), Nura-Sarisuy (21.12.05), Chu-Talas (24.05.06), Aral-Syrdarya (29.07.06), Tobol-Torgay (17.10.06), Ishim (02.11.06), and Irtish (01.12.06).
The BWO "Nura-Sarisuy" has prepared and signed two multilateral agreements (the first one for the Samar Reservoir water area and adjacent water protection zones; the second one for water protection zones adjacent to the Nura River).
The BWO "Aral-Syrdarya" has prepared and signed inter-provincial agreements on water protection zones, strips, and protection ground water and surface water of the Syr Darya River.

The BWO "Chu-Talas" has prepared and signed four basin agreements on water protection zones and strips along rivers Chu, Asa, Talas, as well as Lake around Bibikol.

### The UNEP and UCC-Water Sub-Regional Program for Central Asia: "Speedup of IWRM-2005 Goals Implementation in Central Asia"

A key output foreseen for three countries: Kyrgyz Republic, Tajikistan and Uzbekistan in the frame of the UNEP and UCC-Water Sub-Regional Program for Central Asia: "Speedup of IWRM-2005 Goals Implementation in Central Asia" is the road maps / work plans for implementation of the IWRM target [15] (Box 4.1.3).

This "road map" describes objectives and the process of phased transition towards IWRM-2005 MDGs achievement (for short-term, medium-term, and long-term periods). To the point, the road map is the working sketch of the detailed IWRM plan, which should be prepared by each country-participant of the project in compliance with the proposals of the World Summit on Sustainable Development (Johannesburg, 2002).

The process of developing the national "road maps" within the framework of the UNEP and UCC-Water Sub-Regional Program for Central Asia was initiated at the first national workshops held in April 2006. There was proposed to national experts from three countries and members of the National Groups for Coordination and Support to IWRM to assess the following:

- At which stage of the IWRM planning cycle does a country stand?
- What factors are restraining the process of planning?
- What actions should be undertaken for implementing the IWRM plan?
- What is required for realization of these actions?

On the basis of the specificity of IWRM processes in each country, a composition of measures, dates scheduled for their implementation and funds required for the short-term period could be different, but were grouped in similar clusters:

- Capacity building in water management organizations;
- Establishing the enabling environment for IWRM (legal and political); and
- Technical and technological measures.

In the process of developing "the road maps", along with specific tasks conditioned by peculiarities of the water policy in different countries, purposeful activity for phased solving of the following key problems existing at different levels of water management hierarchy was envisaged:

1. Practical providing the jurisdiction of water organizations within hydro-geographical boundaries that meets to IWRM principles and allows making water management decisions in timely manner and to render water services without interference of administrative-territorial authorities.
2. Integrated water resources management taking into consideration all types of water use within the hydro-geographical boundaries, and based on the analysis of real-time hydro-meteorological information including data on the dynamics of water supply and multi-sectoral water resources use. This information should be in a format suitable for all water users.
3. Strategic planning of water use and consumption taking into consideration the needs of agriculture, municipal and rural water supply, industry and nature, as well as other water-consuming sectors.
4. Practical decentralization of water governance with transferring of the administrative functions towards an acceptably low level (WUAs and their federations, Canal Councils) based on the national legislation and under assistance of the Government in establishing and developing WUAs and their federations.
5. Gradual transition from direct state governance of water supply to regulation of water sector's activity and its relations with other economic sectors.
6. Step by step transition towards governing WUAs' activity (and later the water management organizations' activity) by Public Councils that will be authorized by relevant powers in the frame of national legislation in order to pursue a water policy, to establish procedures and rules necessary for their water management systems.
7. Based on the introduction of the measures for improving land and water productivity, to provide the conditions, which enable farmers to cover completely all expenditures related to O&M, as well as small repairing works and improving all irrigation and drainage systems within WUAs.
8. Assurance of the practical participation of Canal Councils, WUAs and their federations in developing a water policy and establishing rules for water resources management.

The draft national "road maps" were reviewed and discussed at the first regional seminar (Bishkek, July 27-28, 2006). During discussions, participants of the seminar made the constructive comments and proposals on the presented draft national "road maps" (the need to stress the improvement of water use productivity, prepare rational of the essential activities, social mobilization of stakeholders, and training in IWRM principles etc.).

The draft "road maps" and rational improved in accordance with these comments were discussed during the second phase of national seminars and then submitted to the key ministries and institutions of Kyrgyzstan, Tajikistan, and Uzbekistan. The national "road maps" and rational for the short-term period coordinated with key national ministries and institutions were presented at the final regional seminar (Tashkent, November 29-30, 2006). In the course of this seminar, it was proposed to national experts to submit "road maps" to the national governments officially to make decision on their practical implementation, and to the GWP CACENA (with assistance of the UNEP Collaboration Center for Water and Environment) to submit the project findings to potential donors / international organizations with purpose of seeking the financial support to the follow-up developing of the national IWRM plans based on "road maps." [15].

The UNDP support to the Ministry of Agriculture and Water Resources of Uzbekistan in developing the national IWRM plan was the important follow-up step of promoting the project findings. After consultations with stakeholders and representatives of governmental and donor organizations, the decision was made to implement the pilot project "Zerafshan River Basin IWRM Plan" as the first phase of developing the national IWRM plan on the ground that the Basin Water Organization is the most advanced for introducing IWRM: i) water management is implemented within hydro-geographical boundaries; ii) there is the database on water diversions and water delivery to users; iii) considerable donors' assistance in rebuilding WUAs and water authorities' capacity. A preparatory phase (September 2007 to January 2008) covers clarification and coordination of project objectives, as well as preparation of project rational for its submitting to the Cabinet of Ministers of Uzbekistan.

**Box 4.1.3**

**Project name:**

The UNEP and UCC-Water Sub-Regional Program for Central Asia: "Speedup of IWRM-2005 Goals Implementation in Central Asia

**Donor:**

Danish International Development Agency (DANIDA)

**Project period:**

November 2005 to November 2006

**Executors:**

UNEP Collaboration Center for Water and Environment - GWP CACENA and national experts from the Republic of Kirgizstan, the Republic of Tajikistan and the Republic of Uzbekistan

**Project objectives:**

***Long-term objective*** is: «*Speedup of IWRM-2005 Objectives Implementation in Central Asia*».

***Short-term objectives:***

- Assistance to development of the IWRM plans in those countries which are ready to start this process;
- Promotion of the IWRM in dialog about water policy through initiatives for awareness improvement with involvement of the ministers of water resources;
- Capacity building in the area of the IWRM plans development; and
- Analysis of the IWRM problems at the national level.

**Project outputs:**

- The sub-regional and national reports on progress with implementation of the IWRM 2005 MDGs and the IWRM planning in three countries in Central Asia: the Kyrgyz Republic, the Republic of Tajikistan, and the Republic of Uzbekistan;
- The accomplished national road maps/working plans for implementation of the IWRM objectives;
- Capacity needs assessment for support to implementation of the IWRM reforms, as identified in the "road maps" and working plans;
- The managerial capacity building in the IWRM planning for the key water managers and decision makers.

**Implementation aspects:**

The "road maps" developed by national working groups describe in detail the process of phased transition from national visions towards IWRM plans.

"Road maps" consist of three key sections:

- Capacity building in water management organizations;
- Establishing the enabling environment for IWRM (legal and political); and
- Technical and technological measures.

These sections specified objectives, scope of works, project periods (short-term – 2007 to 2009; medium-term – 2007 to 2012, and long-term – 2007 to 2025) executors, and potential sources of funds.
The rational of implementation methods and necessary inputs was prepared for short-term actions.

Approvals of "road maps" were obtained from key ministers and institutions. The "road maps" were submitted to the national governments officially (through the Department of Water resources in the Kyrgyz Republic, Ministry of Water Resources in Tajikistan, and Ministry of Agriculture and Water Resources in the Republic of Uzbekistan) to make decision on their practical implementation.

The RIWERTWIN Project (**www.cawater-info.net/rivertwin**) was initiated by the SIC ICWC together with the Hohenheim University (Germany) and is the only project in our region covering long-term planning of improvements in the water and water-related sectors based on IWRM principles that is implemented in the Chirchik sub-basin (Syr Darya River's tributaries: Chirchik, Akhangaran, and Keless).

Available water resources in the sub-basin, the efficiency of water use in irrigation, hydropower, water supply and other sectors were assessed by the project with special emphasis on the environmental needs. Based on former national elaborations and methods developed by European partners, the models for selecting long-term development scenarios have been developed. Alternative options for implementing the selected scenarios were assessed with participation of beneficiaries. Institutional approaches for transition towards the highest form of IWRM - hydro-environmental management, under which the needs of nature are considered as the top priority, were also developed (the Nature Managers Association represents the interests of nature management in the Basin Council).

At present, the Regional UNDP Office for Eastern Europe, Caucasus and Central Asia in Bratislava together with UNDP Offices in Tashkent, Dushanbe, and Bishkek prepare the proposal on developing the national IWRM plans in Kyrgyzstan, Tajikistan, and Uzbekistan. National Coordination and Support Groups, established in the frame of the IWRM-Fergana Project will participate in this activity based on national "road maps" prepared under the UCC-Water & Environment Project. The summary of IWRM projects' outputs and progress according to developed indicators is given in Table 4.1. As shown, the actual introduction of almost all IWRM principles takes place only in the IWRM-Fergana Project, and only the RIWERTWIN Project provides for joint consideration of all IWRM principles.

**Table 4.1. Planning and the Introduction of IWRM Principles in Various Projects in Central Asia**

| Project Name | WARMAP | WEAMP | WB project in lower reaches of Syr Darya | IWRM-Fergana | National IWRM plan in Kazakhstan | Canadian Training Project | UCC WATER | IWRM in lower reaches | RIVERTWIN |
|---|---|---|---|---|---|---|---|---|---|
| 1. WM according to hydrological principles: | | | | | | | | | |
| - at the inter-state level | | □ | | | | | | | |
| - at the national or basin level | | | | | + | | □ | □ | □ |
| - WMS as a whole | | | | + | | | | | |
| 2. Accounting all kinds of waters: | | | | | | | | | |
| - at the inter-state level | □ | | | | | | | | |
| - at the national and all sub-national levels | | | | + | □ | | | | □ |
| 3. Coordination of all water uses: | | | | | | | | | |
| - at the inter-state level | □ | □ | | | | | | | |
| - At all sub-national levels. | | | | + | | | | | □ |
| 4. Public participation | | | | + | partially | | | □ | □ |
| 5. Priority of environmental needs | | + | + | + | partially | | | □ | □ |
| 6. Water saving and preservation | | + | | + | | | | □ | □ |
| 7. Information exchange | + | | | + | □ | | □ | □ | + |
| 8. Economic and financial sustainability | | | | partially | | | | | |

LEGEND:
□ - planning & designing,
+ - put in place

## 4.2. Aspects of Transboundary Water Resources Management

**(V.A Dukhovny, A.G. Sorokin)**

Existing realities of inter-state relations in Central Asia are conditioned by the global political processes that are in progress during last two decades. These processes have started in the mid 1980s, and from the beginning of the 1990s, the geopolitics has drastically changed – the international relations system become more unsustainable. A new situation stipulates liberty to choose own way of further development by new players on the world political arena and exclusive complexity of this choice. However, finishing of “the Cold War” allowed us to look differently at the world and a role of a human being on Earth. One of benefits inherent in a new system of international relations is the recognizing by most of states of the fact that overall security depends on joint efforts related to elaborating the ways of sustainable development. The above directly refers to new independent states in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) that face new tasks of protecting their national interests, foreign-policy aspects of which are closely interrelated with problems of regional and global security. In April 2007, the 15-year anniversary of activities on governing transboundary waters in the Aral Sea basin that is jointly implemented by five riparian countries was celebrated in Almaty. In our opinion, the President of the World Water Council Mr. Loic Fauchon, in his welcome address to participants of the Central Asian International Scientific-Practical Conference dedicated to the 15th Anniversary of the ICWC, has delivered the most valuable assessment:

*“There are more than 260 transboundary basins in the world. But very few examples where five states are working together, hand-in-hand. Five States that are not only dealing with planning and negotiation but also with day-to-day management and functioning of two weighty rivers: the Amudarya and the Syrdarya. My congratulations”*

It is necessary to give credit for strategic wisdom of the political leaders of Central Asian countries who, already in September 1991 one month after disintegration of the USSR, have initiated the meeting of national ministers of water resources (at that time, of the republics in this region). In Almaty, on February 18, 1992, after discussing the issues related to establishing the ICWC and preparation of the agreement between the Republic of Kazakhstan, the Republic of Kyrgyzstan, the Republic of Uzbekistan, the Republic of Tajikistan, and Turkmenistan on collaboration in the area of joint management, use and conservation of inter-state water resources, they have signed this agreement. Approval of the agreement by Heads of five states on March 23, 1993 at their summit in Kyzyl-Orda has demonstrated to the whole world their political will to collaboration. In January 1994, Heads of the States have approved the Aral Sea Basin Program (ASBP-1), which envisages the major directions of works for strengthening collaboration in the region, and the concept to tackle basin socio-economic and environmental challenges. Both documents created the platform for activity not only the ICWC but also for other regional organizations that were established in the frame of IFAS (International Fund for Saving the Aral Sea): the Executive Committee National Branch Offices, ISDC, and Regional Hydro-Meteorological Centre. Declarations adopted in Nukus, Dashhowus, and Dushanbe and follow-up inter-state agreements (1997, 1999, and 2002) allowed developing the inter-state collaboration in the area of transboundary water resources management. The agreement on water-energetic resources management in the Syr Darya River basin, signed by Kazakhstan, Uzbekistan, and Kyrgyzstan in 1998, plays a central role in developing the cooperation of water management and hydropower organizations.

International financial institutions and agencies for international development of many countries such as the World Bank, Asian Development Bank, UNDP, UNECE, GEF, ESCAP, OSCE, USAID, CIDA, Swiss International Development, GTZ (Germany) and many others, as well as many target projects financed by the EC (TACIS, EuroAid, Regional Programs), NATO, INTAS made a valuable contribution to strengthening the co-operation of our countries. It should be also noted the active participation of international non-governmental organizations such as the World Water Council, Global Water Partnership, International Network of Basin Organizations and many others in strengthening the regional collaboration and relations.

A major achievement of ICWC activity over last years, under valuable support of other national and regional organizations, is the conflict-free water supply to riparian countries, in spite of all difficulties, different interests of riparian countries and their principle water users (irrigation and hydropower sectors), and alternating of extreme drought and flood periods.

As a result of joint institutional efforts, the ICWC structure was formed as a combination of regular sessions of leaders of national water resources departments and operational activity of executive bodies acting on the permanent base. The sessions chaired by a host country are held in all riparian countries in turns to specify the tasks of regional executive bodies and national departments for the periods between sessions. The executive bodies represented by the BWO "Amu Darya", BWO "Syr Darya", ICWC Scientific-Information Center, Secretariat, and Coordination Meteorological Center (CMC) implement all operational work, including:

- A joint planning of the regime of regulating river flows with adjusting the annual water sharing process for different periods (crop growing seasons and dormant seasons);
- Operative management of water releases, water delivery from inter-state sources to national consumers, monitoring of river flow rates (including monitoring of water quality at some gauging stations belonging to the BWO "Syr Darya");
- Capacity building of ICWC executive bodies by means of procuring machinery, computers and equipment, upgrading the communication system and training of personnel.
- Developing the regional information system, providing its openness and accessibility;
- Implementing joint regional projects based on common principles ; and
- Introducing and development IWRM both at regional and national level.

Joint activity of representatives of all riparian countries and regional organizations, covering last three directions, plays a central role in strengthening a mutual understanding, developing common approaches, overall awareness of local personnel, and establishing the system of co-operation. Consolidating the personnel in the process of assimilating new knowledge and joint adopting new technologies and technique, under technical assistance of international experts, is of great importance, since there is not more powerful uniting force as collective work, face to face.

Joint efforts of the ICWC, Canadian International Development Agency, Swiss Agency for Development and Cooperation, USAID and many other agencies in developing the training network and activity that allowed more than 2000 practitioners representing different levels of water management hierarchy to improve their professional skill should be also noted. The CAREWIB Project, which was jointly developed by the consortium consisting of SIC ICWC; GRID-Arendal and UNECE and funded by mainly the Swiss Agency for Development and Cooperation and partly by the United Nations, makes a valuable contribution to popularization of regional co-operation and has wide popularity in the region and abroad. Establishing the national information systems were initiated based on the unique Central Asia Regional Water Information Base with an integrated interface that enables developing the database and a set of models combined with the GIS. One of new outputs of this system is information-analytical reports that promote the improvement of current management quality of sharing water diverted from inter-state water sources.

Noting the positive tendencies in ICWC activity, the transboundary water resources management and use can not be evaluated as sufficiently sustainable due to some external and internal causes.

***External challenges*** **are predetermined by the following destabilizing factors:**

- *Population growth,* although its rates have reduced in comparing with the last quarter of 20$^{th}$ century, makes up not less than 1.5% per year resulting in annual population increase in the amount of half a million people, that even at a minimum water supply rate that equals to 1200 m$^3$/year/person require about 700 million m$^3$ of additional water resources annually;

- *Urban population growth* and expanding urbanized areas at the expense of irrigated lands causes the additional need in water resources and, at the same time, necessitates replacing them with new irrigated areas;
- *Changes in crop pattern* due to restructuring of large farms and tendency to receive second crop yields and produce high-valuable crops;
- *Raising environmental awareness* promotes fulfilling the requirements to maintain ecological flows through rivers into their deltaic areas;
- *Climate changes* that are exhibiting increasing crop water requirements and more often recurrence of extreme flood and drought events;
- *Progressing decrease in world prices on agricultural produce* against increase in prices on agricultural inputs makes the irrigated farming quite low cost-effective, but under the need of developing irrigation due to its high social significance in the region (about 60% of rural population).
- *Increase in use of hydropower potential* through construction of hydropower stations on upstream river reaches, strengthening the competition for water resources mainly due to shifting the water use regime towards the interests of maximum hydropower production, especially in winter time, for satisfying own consumption and export of electric power with the purpose of receiving extra revenues.
- *Possible increase in water withdrawals from the Amu Darya River by Afghanistan* after the stabilization of political situation in this country. Already now, there are some documents, which indicate that the Government of Afghanistan intends to raise a special demand regarding the Amu Darya water resources, considering that in the past the interests of this country have not been taken into account in the Basin Schemes of Integrated Water Resources Use.

In addition, permanent raising the world prices on electrical energy (according to the forecast, prices will increase two times up to 2025) makes other kinds of water resources utilization, including irrigated farming, are absolutely noncompetitive in comparing with hydropower production. Nevertheless, the socio-economic significance of irrigation in the region is not subjected to doubts and infringement of its interests can cause a social burst due to very low incomes in rural areas in all countries of the region.

A number of *internal challenges,* which characterize consumption factors and can be controllable, first of all, due to the introduction of IWRM in the region, should be added to the above:

- *Ignoring proper managing of water,* as extremely scarce resource, at the level of state governance;
- *Lowering an accuracy of flow rates measurement,* resulting in water losses in river channels, which have risen almost two times!!!
- *Aging and obsolescence of water infrastructure* at all levels of water management hierarchy leading to unproductive water losses and deteriorating the controllability;
- *Low level of capital investments to rehabilitating and upgrading water infrastructure;*
- *Increase in the amount of water users; and*
- *Insufficient financing O&M organizations resulting in loss of skilled personnel.*

As a result, unfortunate prospects in water supply can be met in 2030. Figure 4.1 shows what we can wait for regarding a specific water supply rates (the existing level is 2460 $m^3$/person/year):

- Optimistic scenario – 1870 $m^3$/person/year;
- Under current trends – 1560 $m^3$/person/year;
- Pessimistic Scenario – 1430 $m^3$/person/year;

It means that in dry years the mentioned values is decreasing by 20-25%, and, keeping in mind entropy of large hierarchical systems, it is expected that considerable part of end users will be provided with water at the level of 50% of their demands!!!

Such a prospect forces us, as a top-priority measure, to elaborate the strategy of surviving and sustainable development, without which conflicts and a growth of mutual distrust will spread over the whole region. In the water sector, own welfare shouldn't be built based on infringement of other users' interests, especially as multilateral links are inherent in the water system, and nobody can be absolutely independent from others. An every action causes a counteraction, and when any ambitions transcend reasonable limits of disagreement, the situation in other spheres of state relations (not related to water resources) is also worsened. This concerns both basin and inter-state levels of water management hierarchy, and all subsequent relations at the level of provinces, districts, WUAs and water users.

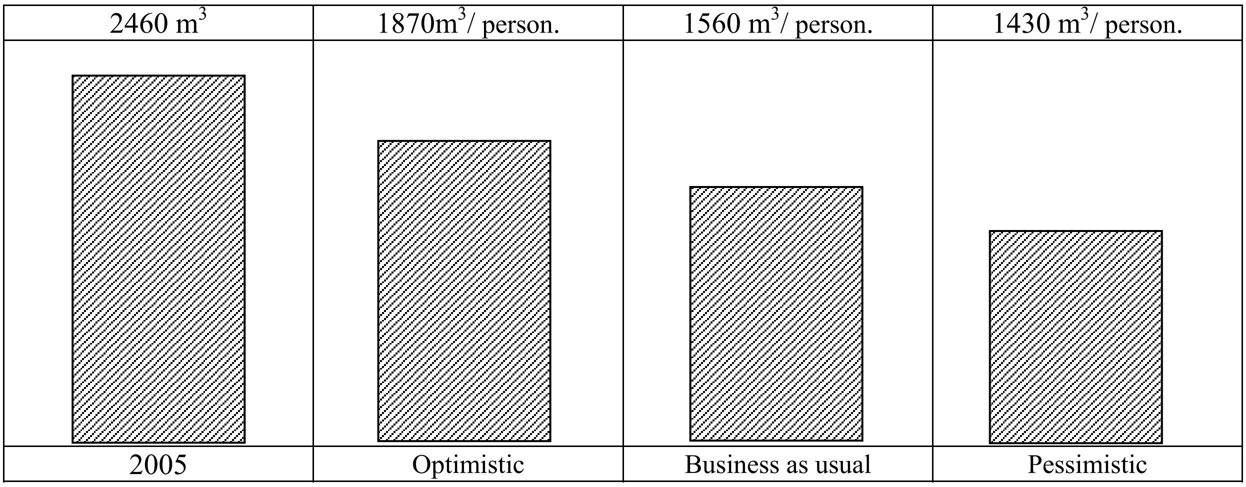



**Figure 4. 1 What Can Be Expected in 2030?**

Therefore, the integration strategy should be adopted as the base for all hierarchical levels – integration of all kinds of waters; integration among water users and with water management organizations; integration of all economic sectors and the natural complex. All types of integration have to be aimed at achieving potential water productivity, minimizing all unproductive losses, and ensuring the sustainability and uniformity of water allocation among all stakeholders.

Unfortunately, the basic provisions of the regional water strategy elaborated in 1995 in the frame of the ASBP funded by the World Bank [9] were not further developed in the WEAMP, where they had to be transformed into the well-proportioned strategy of regional and national development. However, three developed scenarios have a self-evident significance – they demonstrate the fact that challenges of the 21st century could be solved only under harmonization of co-operation and development parameters by neighboring countries. Thus, a new united regional strategy has to be created by joint efforts of all countries in the region, and for this purpose, institutional, legal, financial, technical and planning mechanisms have to be mobilized.

**A concept of this strategy should be based on the following provisions:**

- Sustainable and safe water supply to the economic sectors and natural complex in all riparian countries are impossible without guarantees of sustainable and reliable management of transboundary water resources including surface waters, groundwater, and return water;
- It is impossible to solve long-term tasks are without assessment of all abovementioned destabilizing factors. By the way, apart from expected climate changes affects, such factors as population increase, possible water diversion from the Amu Darya River by Afghanistan, as well as lowering of the controllability level of depreciated water infrastructure, especially of pumping equipment, will impact on prospective water availability in the region in a considerable extent. Therefore, the concept should take into consideration both maximum and minimum parameters of external challenges. Special attention should be paid changes of the river flows regime by the reservoirs in the runoff formation zones (Kambarata, Ragun, Dasht & Jun, Yavan, and other reservoirs); and
- The concept has to reflect those political and economical changes which take place in all basin countries and to take into account their conditional character, especially in governance and water consumption in the agricultural sector as a result of the progressive introduction of market mechanisms, as well as those tendencies in overcoming increasing a water deficit which take place in the world practice.

One of key goals of the concept is *the preparedness of water sectors in the riparian countries for transition towards IWRM*, which allows, without enormous investments, to provide considerable water resources savings and increasing of land and water productivity. Special goal of the concept is the provision of water to natural complexes in the Pre-Aral deltas, preservation of rivers, water bodies and wetlands, as well as maintaining of existing biodiversity based on rational water resources use.

It is obviously that major efforts related to water saving and rational water resources use should be aimed at reducing overall water withdrawal from all sources with achieving decrease in the total water withdrawal by all economic sectors, at least, by 25% up to 2025, that is a political goal for all countries.

The crrent *institutional framework for water resources governance* at the inter-state level suffers from some “bottlenecks” that were not yet removed. Although the ICWC and its executive bodies are directly responsible for water-sharing management and improving of water resources use, there are three parallel structures at the inter-state level, which are also involved, more or less, in water governance and in solving the problems of its perspective development and improving. The IFAS and its national branches, which are responsible for providing funds for implementing the ASBP-2 and preparing new agreements and other documents aimed at improving the water management (rules, procedures etc.), with few exceptions, are ineffective, but due to their overrated ambitions, they create tension situations and parallelism in work. The Regional Hydro-Meteorological Center that was established in the frame of IFAS and has to provide improving the reliability of flows metering and forecasts, unfortunately, does not operate in the regime promoting improvements in water management. At a distance from others the ISDC exists, which should be an initiator of monitoring and management of transboundary water quality, as well as of the regional measures to achieve the MDGs in the field of sustainable development. Although the representatives of national conservancy agencies participate in the national working groups established by the ISDC for improving management of water quality, but their participation is out of the ISDC program. The Regional Ecological Center with its national branches also acts on the same field (Figure 4.2).

Hydropower production, which is coordinated, in our opinion insufficiently, by the Central Asian Energy Council and UDC “Energy”, exerts great impacts on the river flows regime. Representatives of the National Ministries of Energy and United Dispatcher Center (UDC) are also involved in activity of ICWC working groups, but with a little progress.

In addition, the Eurasian Economic Community (EAEC), which established the special group for reviewing water and energy resources issues, intermittently, participates in discussions related to water resources management (these issues also discussed at the meetings of the Shanghai Cooperation Organization

(SCO)). Regional influencing on the system of water governance (the organizational aspect) creates a troublesome and instable situation in water supply from transboundary sources that is reflected in indicators of water availability, and sustainability and uniformity of water supply. This situation is clearly shown in Figure 4.3 and in Box 4.2 that contains a summary of assessing water sharing and water supply in the Syr Darya basin in 2007.

**Box 4.2.1**

In spite of the fact that actual inflow into the Togtogul Reservoir was higher than forecasted inflow (a divergence of 7%), the schedule of water releases from the reservoir was upset; and actual water releases were less than planned ones on 1.08 km$^3$ (a divergence of 15%). At the end of the growing season, a water volume accumulated in the Togtogul Reservoir was on 1.8 km$^3$ more than a planned volume. Drawdown of the Togtogul Reservoir was uneven: in the beginning of June and July, discharges were less than planned ones on 161 m$^3$/sec (29%) and 209 m$^3$/sec respectively, but in the beginning of September, they exceeded the planned values on 63 m$^3$/sec (21%).

This situation could not be improved at the expense of water releases from the Andijan Reservoir, due to insufficient inflow to this reservoir (actual inflow was on 27% less than forecasted inflow) they were less than the planned water releases on 0.7 km$^3$ (a divergence of 27%). An actual filling of the Andijan Reservoir was close to the planned one at the end of the growing season.

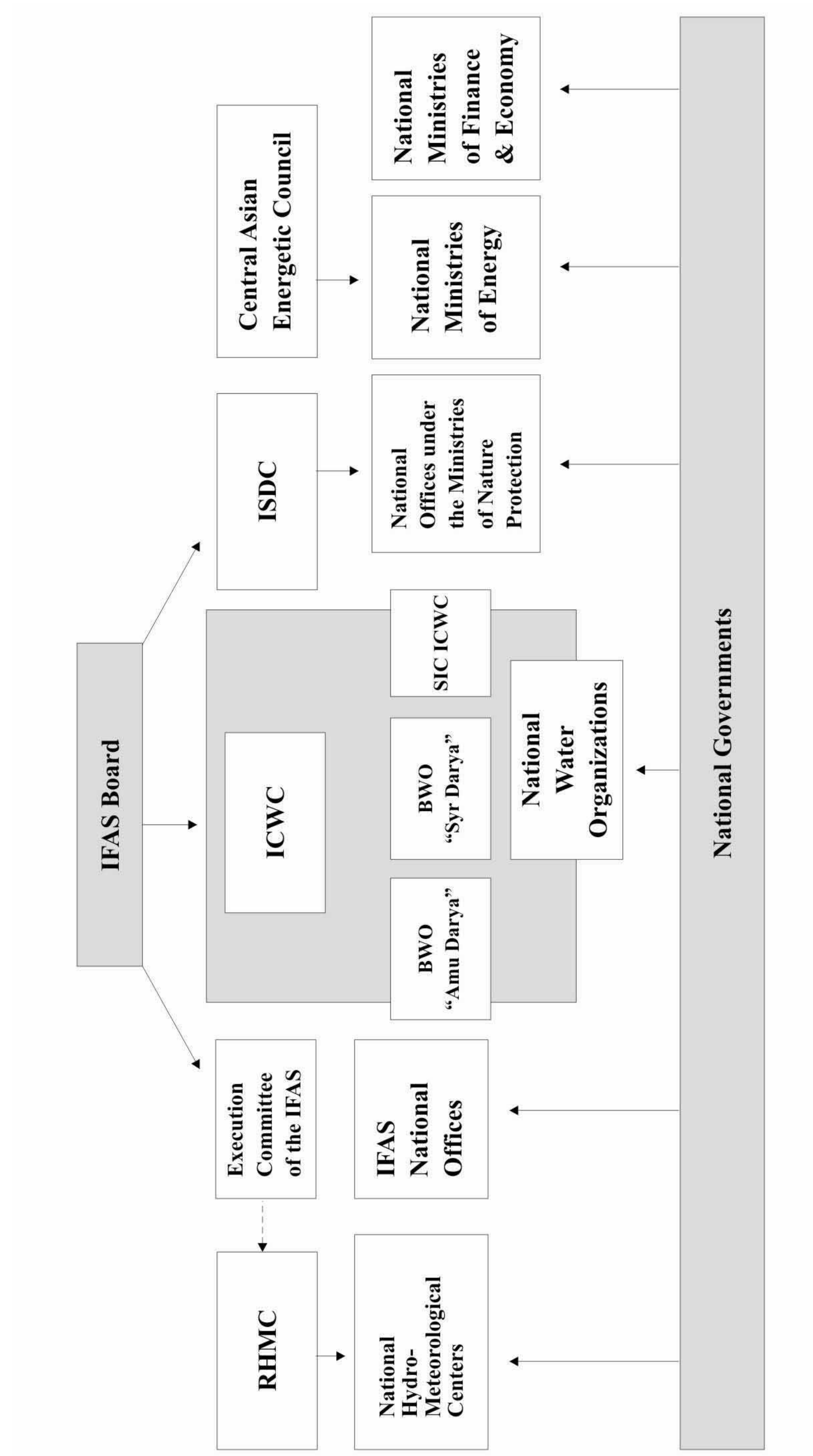



Figure 4.2 Existing Institutional Structure

It is necessary to establish the regional organizational framework with clear distributing the rights and duties, which could provide the sustainability in operation and, first of all, in financial aspects, as well as good co-ordination with national authorities related to the water sector, based on mutual trust and openness in its activity.

The following organizational structure for inter-state water governance that will allow avoiding an overlapping in operation and specifying clear rights and duties of its entities is proposed as one of options. The organizational structure of the Mekong River Commission was taken as a prototype but with taking into consideration the peculiarities of existing organizations in our region (Figure 4.3)

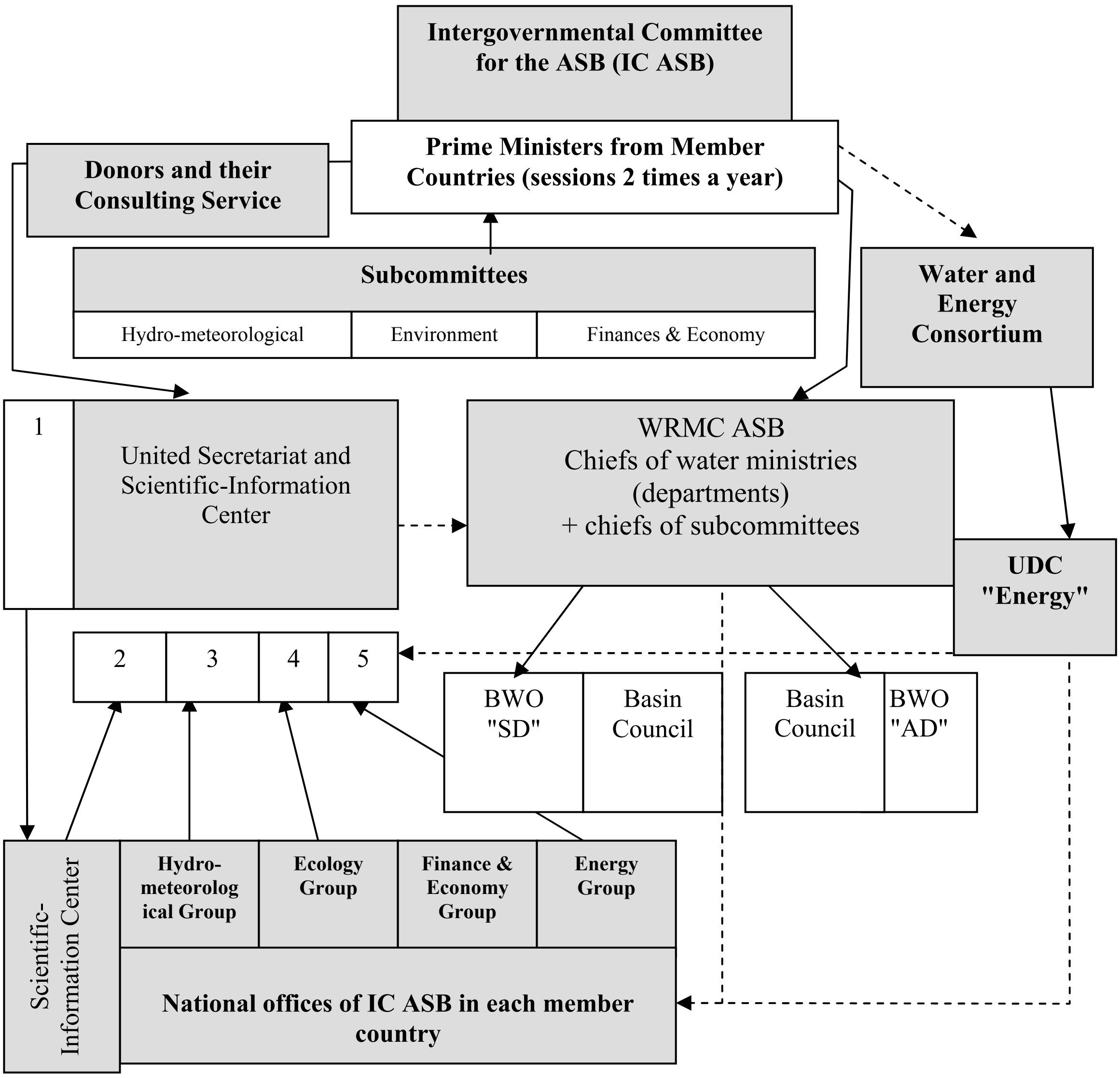



**Figure 4.3. The Proposed Regional Organizational Structure for Water Governance in the Aral Sea Basin**

*The Intergovernmental Committee for the Aral Sea Basin* (IC ASB) headed by Prime Ministers of all basin countries (in consideration of the significance of water factor) who will be, by turn, in charge of ICASB sessions that will be held strictly two times a year, prior to and after the growing season. The Committee consists of Ministers (or heads of relevant national Departments) of water resources, hydro-meteorological services, conservancy, energy, economy, as well as of Deputy Ministers of Foreign Affairs. Committee's sessions should be held strictly on that day which was specified in the regulations without preliminary co-ordination (the experience of the ICWC shows that the process of gathering all plenipotentiaries became the procedure of long-term co-ordination according to the following path: a host country → all members of the

ICWC → national governments → cross-sectoral coordination → repeated co-ordination to reach a consensus regarding a date). Over last 5 years, there were four occasions when the ICWC members did not attend the sessions, and they have signed adopted documents after the events. The proposed Committee has to replace the IFAS Board, which today lowered its status (from the representation only by Vice Prime Ministers to the combined representation by Vice Prime Ministers and Deputy Ministers)

The ICASB has to establish national offices in each riparian country, which have to replace the national branches of IFAS. ISDC, SIC ICWC, and REC. The Water Resources Management Commission for the Aral Sea Basin (WRMC ASB) becomes an executive body consisting of managers of water management departments from member countries, the Regional Hydro-Meteorological Center, subcommittee on water resources protection (former ISDC) and other subcommittees (finance and investments, energy), and UDC “Energy” (or a representative of the Central-Asian Energy Union). All chiefs of subcommittees take turns each half a year (according to the alphabetical order).

National offices include specialized subdivisions acting on behalf of appropriate ministries and departments and aimed at executing the measures adopted at the ICASB sessions for improving transboundary water resources governance and management. At the same time, a co-ordination of specialized subdivisions is implemented by relevant subcommittees in the course of their semiannual (or quarterly) meetings through personnel of appropriate national ministries and departments. Such an approach will provide their permanent participation in activity related to regional problems including transboundary waters issues, and reasonable continuity of policy, since because of frequent replacing of the sectoral representatives in the working groups and, as a result, shifts in personal attitude, hinders often the preparation of principle decisions, agreements, and operational procedures.

The United Secretariat with Scientific-Information Center in its structure will be established as a single executive body for planning, co-ordination, financing and managing water resources. This executive body will perform those functions, which, at present, are implemented with inherent fragmentariness (or have to be implemented) by the SIC ICWC (Box 1), Regional Hydro-Meteorological Center (Box 2), SIC ISDC (Box 3), Executive Committee of the IFAS (Box 4); as well as the Energy Group, which will represent the UDC “Energy” (1 or 2 persons) will be additionally established in the framework of the United Secretariat. According to the experience of activity of the Mekong River Commission, the United Secretariat should be headed by a non-resident of this region, but its personnel have to be composed by citizens of the member countries. Taking into consideration that the President of Kazakhstan Mr. N. Nazarbaev and the President of Uzbekistan Mr. I. Karimov have suggested, many times, to put the Aral See Basin Commission under the UN aegis, it would be rational if a UN representative will head the United Secretariat, with providing the diplomatic status to the United Secretariat and the WRMC ASB. In this case, the United Secretariat will work in close co-ordination with the Donors’ Consulting Service, being established also under the UN aegis.

**The proposed organizational structure will allow the following:**

- To concentrate all governance of basin water and hydropower resources at the level of Prime Ministers, including developing key aspects of annual and long-term planning, faster developing the united legislative platform for inter-state relations, decision-making on principle issues of financing, expenditures distribution and cross-sectoral co-operation, removing any sectoral barriers and interference;
- To preserve the well-functioned management system at the national level in water-related sectors, controlling and coordinating this system with regional rules, limitations, and requirements through the United Secretariat and IWRMC;
- To involve the representatives of other economic sectors and departments, apart from water and agricultural sectors, such as hydropower specialists, hydrologists, economists, ecologists and others into the decision-making process, as well as to provide an additional status of the United Secretariat by involving the representatives of National Ministries of Foreign Affairs in its activity (therefore, reorganization of the ICWC into the IWRMC does mean not only the change of its name);

- To obviate responsibilities' overlapping, latent competition and dissipation financial resources allocated by donors and national governments, by directing them for implementing the measures clearly specified at the level of the Basin Committee;
- To establish the Water & Energy Consortium as the mechanism for coordinating interests of the energy sector with irrigation practice; and
- To involve hydro-meteorological and conservancy agencies into the united system of water management and in activity of the IWRMC in order to provide more reliable water monitoring and forecasts; to raise their responsibility for data reliability; to improve their operability in data collection and developing clear regulations for water quality control; as well as to provide their participation in monitoring and control of waste discharges for environment improvements.

Transition towards the IWRM principles at the basin level will have a great significance for improving the institutional structure. It means that activity of the BWOs should be supported by establishing the Basin Councils in each river basin with inclusion in their composition the representatives of provinces, large water users (HPS), deltaic associations and other stakeholders. Similar to the Public Canal Committees (or Water Users Unions), established in the frame of IWRM-Fergana Project on the pilot canals in the Fergana Valley, these public organizations will participate in coordinating plans and operation schedules, monitoring their implementation, assistance to the BWOs in obtaining funds for improving O&M and upgrading water infrastructure.

Along with these institutional principles, it is rational to establish the Basin Committees or Councils in the basins of small transboundary rivers. Apart from two big rivers in the region there are more than 20 basins of rivers that in the past were tributaries of the Amu Darya and Syr Darya, but currently they have lost their links with big rivers. By analogy with creating of the BWO "Chu-Talas", which is a now active, similar water management system should be established in the basins of Zarafshan, Kafirnigan and other rivers located mainly in the Syr Darya basin. At present, in the frame of IWRM-Fergana Project, such activity is initiated in river basins of Shakhimardan (Kyrgyzstan and Uzbekistan) and of Khoji-Bakirgan (Kyrgyzstan and Tajikistan). It would be rational to cover all other transboundary river basins with similar activity.

### *Improving legal base for inter-state collaboration*

At present, there are a few principle inter-state agreements related to water resources management in Central Asian countries: two framework agreements – the first agreement adopted on February 18, 1992 and the second agreement linked to the Syr Darya River (1998), as well as earlier mentioned agreements and declarations concerning the IFAS.

An intention to support the framework agreements with more detailed legal documents was already mentioned in the Basic Provisions of Regional Water Strategy. A preliminary assessment has shown that under the general correct orientation of interstate agreements and regulations and their compliance with the international water law, their improvement, development and clarification (some aspects) are quite necessary.

***It is supposed that legal and juridical provision of the water strategy will be created in the form of some fundamentals and agreements that will regulate clearly its development and implementation, including those rules and norms, which can cover various situations in regional relations and must provide sustainable conflict-free development.***

**Such documents, in the first approximation, have to cover the following matters:**

- Inclusion of all transboundary waters, including ground water and return water, into the ICWC sphere of influence;

- Specifying the BWO's functions and its organizational structure considering the strategy being developed with the purpose of possibly full coverage of each river trunk using the BWO's capacity;
- Rules for joint use of all types of waters;
- Legislation and standards for monitoring water quality and limitations for waste discharges and disposal of some harmful ingredients into rivers and other water sinks;
- Procedures for preparing and making decisions by the inter-state water organizations;
- Arbitrage and procedures for disputes resolution;
- Liability due to infringements of water quotas, water supply schedules, operational rules, water pollution, as well as due to derangement of water supply to the Aral Sea;
- Safeguarding infrastructure and watercourses of international importance;
- Responsibility for establishing and maintaining an overall database;
- Procedures for joint activity on transboundary rivers, lakes, and streams;
- Specifying damages and procedures for their compensation, including compensations for flooding and waterlogging of lands, deteriorating of water quality etc. In addition, the further studying of these aspects and clear reflecting of studies' findings in appropriate inter-state documents are necessary;
- Public awareness and providing equal rights in water use;
- Criterion of use efficiency for transboundary waters; and
- Providing the priority of overall interests over national interests in the basin, and limitations of this priority.

At the same time, the following additional matters have to be included in some constituent documents of the inter-state organizations:

- A structure of organization;
- Official powers and duties;
- Procedures for the decision-making process; and
- Financing the inter-state activity;

Their development was started in the framework of the WARMAP Project funded by the EC, and was continued by the ICWC with participation of the EC IFAS and support of the RETA 6163 Project funded by the Asian Development Bank. At present, the ICWC has approved a text of agreement on information exchange; as well as the drafts of ICWC statute and agreement on improving the ICWC organizational structure were prepared for discussion. At the same time, under discussing a new text of this agreement on using water and energy resources in the Syr Darya basin, the existing disagreements are smoothed away by the working groups.

A considerable part of the ASBP-2 approved by Heads of the States is devoted to the need of developing a legal base for inter-state relations, in which not only the agreements developed in the frame of ADB RETA 6163 Project, but also specific procedures and rules of O&M as an attachment to these agreements were included. Thanks to the Asian Development Bank, this activity was initiated and now is in progress, though with some delay. A draft of Statute of the Water & Energy Consortium (WEC) (with different conceptions responding viewpoints of different countries) is among other problematic documents. Some experts suggest establishing the WEC as the complement body to the existing organizational structures, but other experts - as their replacement. The reasons of difficulties in forming the legal base for inter-state collaboration, first of all, consist in absence of the continuing expert group, which would tackle this problem, and in a very complicated system of co-ordination. Drafts of abovementioned documents are developed by national and regional working groups (NWG and RWG) in the frame of ICWC. Different countries have different approaches to forming and approving the National Working Groups. The Government of Tajikistan, by its decree, has approved the composition of NWG; however, in other countries the governments only coordinate the composition of experts from different ministries. Hereinafter, the procedure of elaboration and co-ordination of documents is moving forward as follows: the NWGs submit their proposals regarding the text of different documents (drafts of agreements, regulations etc.) to the RWG, and then the text is agreed at the meeting of RWG with participation of 2-3 representatives of NWGs and returned back to NWGs. As a result of coordinating with the Government and other institutions, the text coordinated with the RWG can be considerably modified. This procedure can be repeated many times. For example, the text of some agreements on the Syr Darya River went through this iteration process 11 times, but some positions remain uncoordinated. Changes in the composition of NWGs, replacements of heads of national ministries and, sometimes, lack of powers from the Government affect the coordination process.

In case of adaptation of the organizational structure proposed above (Fig, 4.3), all the coordination process will be established in the frame of the Inter-State Committee and its regional and national structures, which will have sufficient powers due to a high rank of their members. Participation of Prime Ministers and representatives of the Ministries of Foreign Affairs should provide higher status of legal documents and streamline their adoption.

At present, FINANCIAL INSTRUMENTS of the inter-state co-operation consist of proportional financing of inter-state organizations, and implementation of necessary works on the transboundary water objects within the national territory or, under co-ordination (or on request) with another country, on objects located in another country based on contractual obligations with payment for use of its territory. In the framework of the RETA 6163 Project funded by the ADB, the ICWC working groups collected data on expenditures of different countries for O&M of infrastructure on transboundary watercourses and for covering operational costs of regional organizations. In spite of some disagreements regarding the methodology employed, an assessment was made and described in the report that was submitted to ICWC members (key findings are presented in Table 4.2).

**Table 4.2.**
**Summary of Works Implemented by Riparian Countries for Supporting of Joint Management of Amu Darya and Syr Darya Water Resources, as of 2006**

| | **Activity/Expenditures** | ***Kazakhstan 000' USD*** | ***Kyrgyzstan 000' USD*** | ***Tajikistan 000' USD*** | ***Turkmenistan 000' USD*** | ***Uzbekistan 000' USD*** | ***Total*** | *%* |
|---|---|---|---|---|---|---|---|---|
| 1. | River training works and flood control measures | 14,298.3 | 536.4 | 2750.0 | 4897.2 | 3433.9 | 25,915.8 | 42.6 |
| 2. | O&M works on inter-state water infrastructure, including works related to safety of waterworks | 3300.0 | 1906.8 | 3230.0 | 2179.1 | 15,195.1 | 25,811.0 | 42.4 |
| 3 | Running costs of inter-state water management organizations | 307.0 | 32.2 | 347.3 | 3543.0 | 2859.7 | 7089.2 | 11.6 |
| 4 | Hydro-meteorological services and forecasting | 1074.5 | 165.8 | 10.0 | 78.8 | 663.6 | 1992.7 | 3.3 |
| 5 | Other interventions | | | | 44.2 | | 44.2 | 0.1 |
| | **GRAND TOTAL:** | 18,979.8 | 2641.1 | 6337.3 | 10,742.3 | 22,152.3 | 60,852.9 | 100.0 |
| | ***Total in %*** | 31.2 | 4.3 | 10.4 | 17.7 | 36.4 | 100.0 | |
| | | ***Kazakhstan*** | ***Kyrgyzstan*** | ***Tajikistan*** | ***Turkmenistan*** | ***Uzbekistan*** | ***Total:*** | |
| | Share of total water withdrawal, including internal sources, % | 11.2 | 4.3 | 10.2 | 22.9 | 51.4 | 100.0 | |
| | Water withdrawal, including internal sources, km3 (2003) | 11.6 | 4.4 | 10.5 | 23.7 | 53.1 | 103.4 | |
| | Total expenditures for maintaining joint water management in the basin (according to audit results), USD | 18,979.8 | 2641.1 | 6337.3 | 10,742.3 | 22,152.3 | 60,852.9 | |
| | Costs per1 m3 of water withdrawal, USD/m3 | 0.164 | 0.060 | 0.060 | 0.045 | 0.042 | 0.059 | |

Under considering expenditures for 1 m3 of water diversion from rivers, it becomes obvious that riparian countries incur different costs.

Continuing this activity, the working group has made up a list of services and costs that should be considered under specifying running costs for 2006. However, issues of distributing profit and compensation for damage, which in opinion of some countries they did not receive from their neighbors were out of consideration. In particular, this concerns damages due to incomplete use of the hydropower potential in winter time by countries located in upper watersheds and less production of electric energy. A lack of clear recommendations of the international law regarding similar precedents does not allow definitely answering what mechanism should be used for similar estimates. However, combining principles of "equitable and rational use" and "do not harm, and pay for caused damage" allows developing a certain approach, which was proposed by the specialists of the SIC ICWC (V. Dukhovny, A. Sorokin) in the process of evaluating impacts of operation of the Vakhsh Hydropower Cascade, including the Ragun HPS, on downstream users in the Amu Darya basin.

Comparing of impacts under different operational regimes of this cascade on socio-economic indicators of irrigated farming in middle and lower reaches of the river in Turkmenistan and Uzbekistan up to 2055 is given in Table 4.3. It is assumed that prices on hydropower and agricultural output are kept at the current level under a certain increase in cost of one kilowatt-hour in winter time against its cost in summer time (USD 0.02 and 0.015 respectively). Five combinations of three operational regimes (hydropower, irrigation, and combined) and two options for dam crest levels (DCL) of the Ragun Hydro-Scheme (1240 and 1290 m) were considered in comparing with the existing operational regime of the Vakhsh Hydropower Cascade.

**Table 4.3.**
**Comparing Impacts of Different Operational Regimes and Ragun Hydro-Scheme Parameters on Socio-Economic Indicators over the Period of 2005 to 2055 (million USD/year)**

| Options | Losses of irrigated farming and related sectors output during the year | Reducing (-) or increase (+) of planned output against current output, including power production | Power production at Ragun HPS in money terms | Total profit against the revenues under current operational regime of the Nurek HPS |
|---|---|---|---|---|
| Keeping the current operational regime of Nurek HPS | 94.71 | - | - | - |
| Power regime with dam level at 1240 m | 211.3 | 116.59 | 162.35 | 45.76 |
| Power regime a with dam level at 1290 m | 174.6 | 79.89 | 194.71 | 114.82 |
| Irrigation regime with dam level at 1240 m | 59.2 | -35.5 | 159.39 | 194.89 |
| Irrigation regime with dam level at 1290 m | 37.85 | -56.86 | 188.41 | 245.27 |
| Combined regime with dam level at 1240 m | 76.18 | -18.53 | 194.84 | 176.31 |

If to follow the "do not harm" principle, a total effect from constructing the Ragun Hydro-Scheme should differ by the amount of output losses in middle and lower reaches of the river due to affects of construction activity. In this case, both options of the power regime are less effective than three other options. At the same time, advantages of the combined regime option (irrigation and hydropower) become more obvious, because under increase in power production almost up to the level of power regime option it reduces losses in irrigation farming output in comparing with the option of current operational regime of Nurek HPS on USD 18.5 million a year, on average.

A foreign practice, for example, the experience of the USA and Canada, provides some possible solutions based on separating the functions of irrigation water management and water releases for energy production when hydropower stations should pay for water passing through turbines and, respectively, the irrigated farming sector has to pay for irrigation water supply on the commercial competitive base. Some elements of similar approaches may be used under establishing the Water and Energy Consortium (W&EC), a concept of which was proposed at the top level, but unfortunately did not get an overall understanding and supporting from all countries in the region. Some officials and experts propose to use it as a financial mechanism for implementing the water releases schedule agreed by the ICWC, but others suggest establishing a super-uniting body for governing all water and energy resources in the region. More weighted and correct solution was proposed by the Eurasian Economical Community (E. Vinokurov: Financing the Water & Hydropower Resources Complex in Central Asia, 2007) suggesting establishing the W&EC as "a permanent inter-state body with functions of a coordinator of investments and a dispatcher of the water and hydropower resources complex." This position also envisages that in the prospect the W&EC will coordinate developing the hydropower potential in the region, unutilized resources of which are estimated in the amount of 15,000 MW, for covering the winter deficit of electric power (in combination with some thermal power plants). This point of view is close to the concept developed by the SIC ICWC for the W&EC, which, first of all, is considered as the financial mechanism for regulating the necessary regimes of water releases, and then for regulating the matters related to investments into long-term development. In our opinion, the Water and Energy Consortium should be established as:

- A body, which, by means of regulating fuel and energy resources of Central Asian countries and financial flows, will organize the regular exchange of these resources with the purpose of strict coordination of the plans of water allocation and delivery to countries and their water management systems, as well as water releases from reservoirs that must be established by the ICWC taking into account social and environmental needs of riparian countries;
- An energy and fuel flows operator that provides to regional countries guaranteed supplies of fuel resources and electric energy necessary for optimal life support and functioning national economy; and
- A financial structure for seeking funds for implementing various projects with purpose of developing new hydropower capacities based on parameters of water management and water releases from the reservoirs agreed by all countries.

Activity of the regional bodies of W&EC can promote the improvement of the PLANNING MECHANISM of water allocation and the regimes of water releases from the multipurpose reservoirs with hydropower plants. At present, the ICWC is approving only water supply regimes and recommends the regimes of water releases for their coordination with the hydropower production organizations and owners of the Hydropower stations. As a result, the process of coordination with participating of the administration of national hydropower ministries, based on the mechanism of compensations for procurement of fuel resources or electric energy, is sometimes delayed until June, slowing the procedure of normal planning (prior to the beginning of a growing season (1$^{st}$ April) or a hydrological year that starts since 1$^{st}$ October).

Among other measures for improving the planning system, enhancing an accuracy of forecasts regarding natural inflow into reservoirs in the upper watersheds and lateral inflow into rivers, including return water, should be noted. Analytical documents that were placed on CAREWIB portal are showing that if a mean annual accuracy of forecasts for a growing season varies over the range of 17 to 35%, accuracy of forecasting inflow into some reservoirs (from April to June) within 50% resulting in quite unstable operation of inter-state water organizations at the beginning of the growing season. At present, BWOs have mastered the computerized technique of planning and adjusting their plans depending on updating forecasts and current water situation. However, to improve the effectiveness of this planning process it is necessary to implement some measures for enhancing the coordination of five national hydro-meteorological services, their capacity, and collaboration with national and regional water administrations, in particular:

- To put into operation the united system of record keeping and monitoring of river flows, including transboundary and ground waters;

- Specifying and permanent control of river flow losses, in their channels, that increased two times during last years;
- Preparing the reliable climatic and hydrological forecasts with special emphasis on monthly forecasts in dry and wet years;

Unfortunately, efforts of different donors an, first of all, the Swiss Development Cooperation (SDC) to assist in establishing the Regional Hydro-Meteorological Center face the ambitions and commercial egoism of some national services. On the way towards the proposed organizational structure of water co-operation under the direct leadership of five national governments, these adverse tendencies can be overcome if to proceed from the vital need to strengthen the collaboration of countries in managing transboundary water resources in the interests of all riparian countries in order to survive under the conditions of the growing water deficit.

The above system of STRATEGIC PLANNING that may create the platform for future water welfare in the region under a great complexity of coordinating the national interests and keeping in mind regional limitations has to become the cornerstone of the planning system. Undoubtedly, funds are necessary, but also other principles of joint activity – not only inviting the foreign consultants who can submit the non-committal report but also joint alternative planning of possible prospects by national institutions of strategic researches with the participation of regional water organizations based on the inevitability of seeking the joint solutions. Creating this document will be under permanent monitoring of the Inter-State Committee and former ICWC transformed into the IWRMC, which, through the United Secretariat (with the Scientific-Information Center) will seek the regional consensus in developing the strategy and its preparation for approval by the Governments of all riparian countries.

INSTITUTIONAL MECHANISMS of the co-operation suggest, first of all, establishing the transparent and accessible regional information system including sub-systems for each river basin. It has to be coordinated with national information systems based on the principle of "information screen" and an integrated morphological structure of regional, basin, and national systems. Such a system was developed in the framework of the CAREWIB Project for top levels of water management hierarchy (the region, basin, and country) and even covers, partially, a sub-national level in the form of so-called "planning zones" that coincide with boundaries of provinces, or are their parts. Using the GIS, the planning zones are aggregated with sub-basins and then subdivided into irrigation and drainage systems. The morphological layout of the Syr Darya basin with subdivision into planning zones (PZ) is given in Figure 4.4, and the principle of their coordination with the irrigation systems, is demonstrated in Figure 4.5.


**Figure 4.4 Morphological Layout of the Syr Darya Basin by Planning Zones**

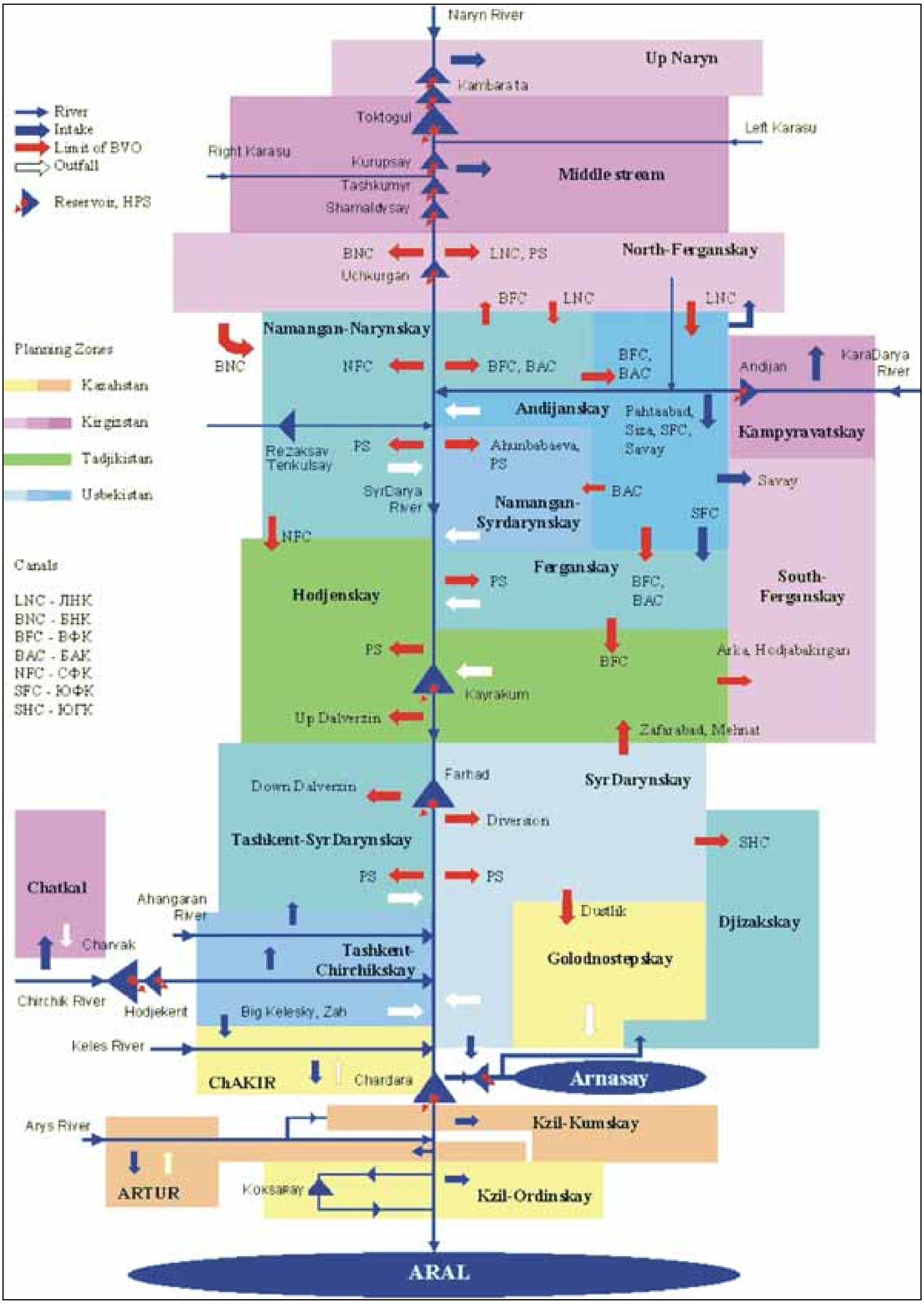



**Figure4.5. The Syr Darya Basin.Interrelations of Planning Zone with Irrigation Shemes.**

The Management Information System includes database, GIS, and a set of subsidiary models links of which are given in Figures 4.6 and 4.7., and which allow solving operational management problems and supporting long-term planning.

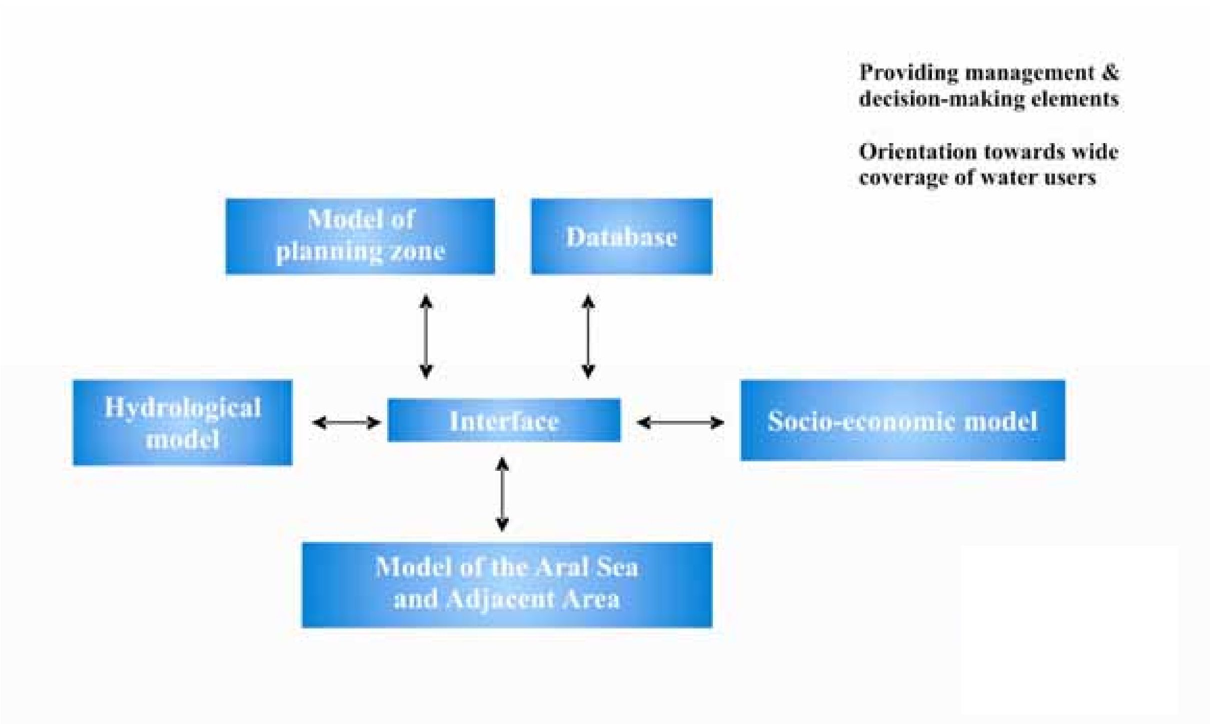



**Figure 4.6 Hydrological Model (HM) of the Syr Darya Basin in a Set of ASB-MM**

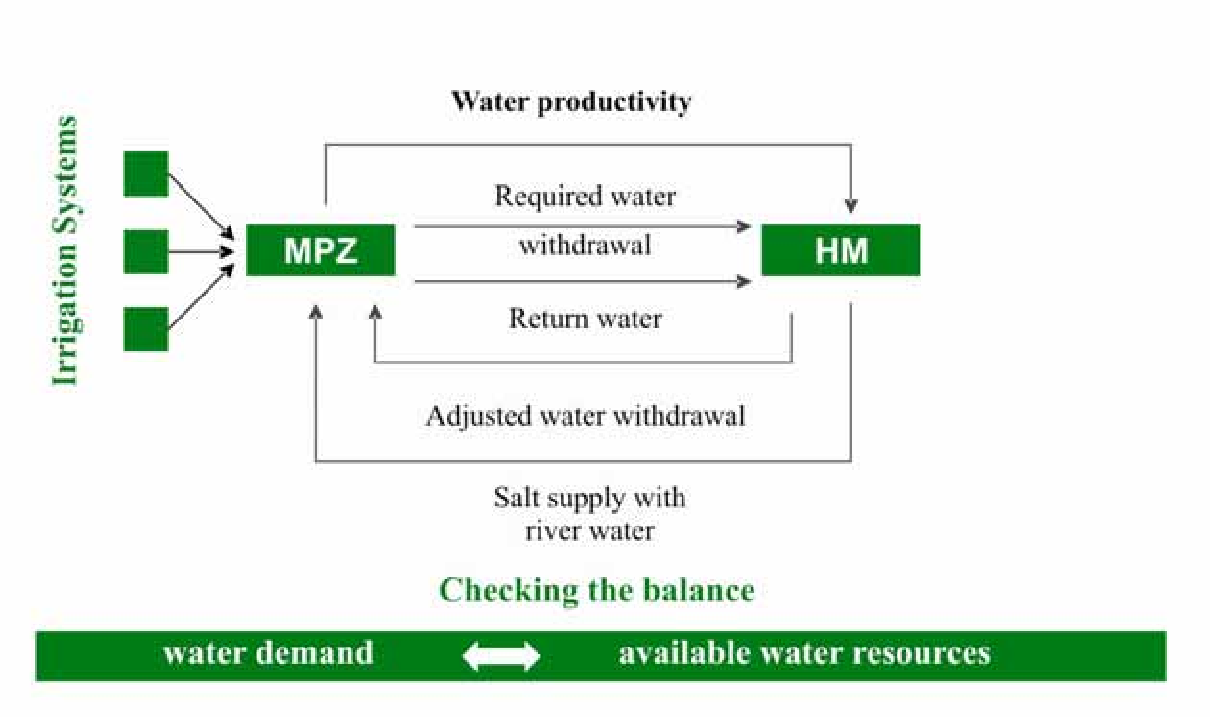



**Figure 4.7 Links between the Hydrological Model (HM) and the Planning Zone Model (MPZ)**

A set of models proposed for planning and evaluation of management results enables to adjust water allocation continually in order to maximize implementing the planned water use limits in each zone, country, water district, and planning zone. At the same time, socio-economic blocks allows estimating an effect of one or another principle of water allocation and its impacts on productivity of agriculture and development of secondary services so that "initiators of actions" may understand and evaluate effects of their actions

Another important tool is the involvement of all stakeholders into the water management process. Introducing of IWRM on the South Fergana Canal (a command area of about 100,000 hectares) allowed to reduce water supply through this canal on 39% in comparing with water supply in 2003 (Fig. 4.8) only owing to use of participatory and hydrological approaches with minimum costs for improving the hydrometric practice.

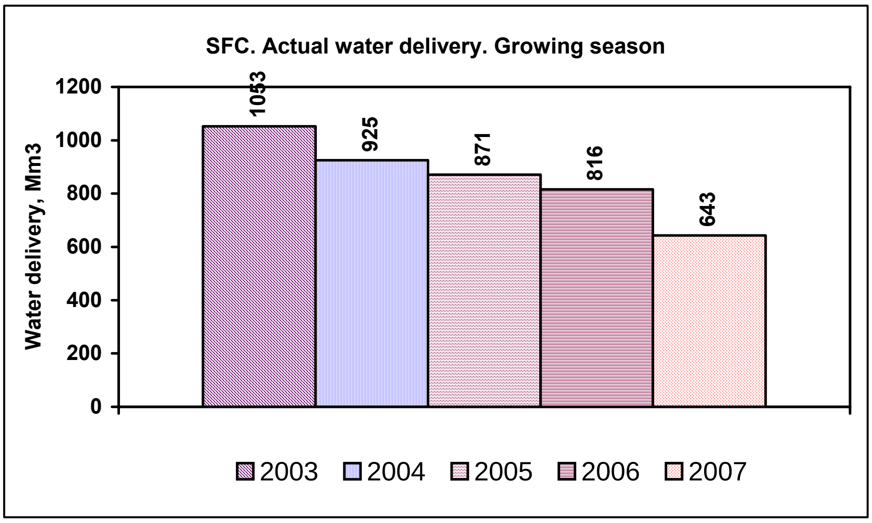



**Fig.4.8. Dynamics of water delivery from the South Fergana Canal**

Similar involving of water users, under establishing the Basin Councils under the BWOs “Amu Darya” and “Syr Darya”, enables to enhance coordinating of different water organizations’ activity and, at the same time, to assist BWOs to introduce proper order in water allocation. An experience of pilot projects shows that monthly meetings of Canal Water Council’s members allow involving communities in the water management process not only as supervisors but also as parity participants responsible for maintaining planned regimes and water diversions at each river section. It is rational to subdivide the Basin Councils into separate units representing each balance site on the river, firstly, in order to monitor these parameters of water management within own site, and, secondly, to defend the interests of own site at regular meetings of the Basin Council.

It is very significant to involve the representatives of lower river reaches, especially, of deltaic water administrations, with their interests that are often infringed upon, in particular, in dry years. The Basin Councils, with their site entities, can assist clearly to specify the environmental requirements of both deltas and some basin sites for preserving the rivers as natural objects. For this purpose, water users and representatives of provincial water administrations, owners of reservoirs and hydropower stations, as well as representatives of the fishery sector, public utilities, and conservancy agencies should be members of the Basin Councils.

One more important element of water management is the training and professional development of personnel of water management organizations engaged in O&M of waterworks on the river, BWOs, national water management organizations, and water users. In 2001, the ICWC Training Center was established based on financial and technical assistance of the Canadian International Development Agency (CIDA), Swiss Development Cooperation and other donors. More than two thousands of water professionals were trained at advanced training courses covering IWRM principles, advanced technologies, international water law and a number of other areas of water management under relatively low financing by donors (about USD 130,000 annually). On the same base, affiliates of the ICWC Training Center were established in Osh, Fergana, Andijan, Urgench for covering water professionals of the intermediate and “grass roots” level, as well as water users. However, after cessation of CIDA financing, since 2006 we are forced to seek funds for training activity continually since even support of trainees (accommodation, travel expenses, daily allowances, learning aids etc.) requires the availability of currency allocations, which the ICWC does not practically have.

The Asian Development Bank renders some support, using which, in 2005 and 2006, 11 advanced training courses covering topics related to water management and water law were held for personnel of national ministries and basin organizations; and this training activity allowed promoting some improvements in operation of ICWC organizations and adopting the inter-state agreements.

It is also necessary to note two target programs funded by the ADB and OSCE. These are: the program “Water & Gender Policy”, based on which the Central Asian Network of Global Water Alliance was established with broad involving of women and opening of liaison offices in all regional countries; as well as the program “Water & Education,” with help of which the topics covering special knowledge on water resources will be included in a curricula of secondary schools.

Developing of gender movement in the water sector has already provided some results, namely the emergence of women among chiefs of WUAs and even CWUCs. As an example, the great organizational activity of Mrs. Maysura Sayfutdinova, the chairwoman of the Water Users Council of the South Fergana Canal, can be mentioned. Often, women-managers are more “go-getter” than men, especially, keeping in mind the local mentality. Therefore, the special training programs should be aimed at training of women-farmers and women - water users in order to strengthen a role of women in WUAs.

An interactive training method, employed in the ICWC Training Center, under which all trainees can exchange their practical experience, is exceptionally useful for creating the atmosphere of collaboration and an understanding of peculiarities and approaches of other countries, as well as for reaching the consensus in the overall view on the future of water resources use. In our opinion, development of training activity is the most profitable and effective investments into raising knowledge and capacity of water professionals, into strengthening the co-operation and creating the atmosphere of “team spirit” in riparian countries, sub-basins and provinces.

Technical assistance and enhancing of training activity at the regional level is one of top-priority objectives of the EC strategy for strengthening the co-operation between Central Asian countries. Proposals for developing training activity were jointly prepared by the SIC ICWC and UNESCO IHE and submitted to the embassies of EC countries; we hope that the international institutions, in the first place, the EC will provide the financial support to the central training center and its affiliates.

Technical mechanisms for improving water resources management at the regional level, first of all, include the system of monitoring, record keeping, and information exchange. Some progress was reached in this direction. In particular, in 1996, activity related to the introduction of the SCADA (Supervisory Control and Data Acquisition System) on the Dustlik Canal’s headworks funded by the CIDA was initiated; and later on the technical and financial assistance of the SDC allowed automating operation of the first dozen of hydraulic structures in the Syr Darya basin. The SCADA, in spite of all fluctuations of water levels and flow rates near a head hydraulic structure, ensures sustainable water delivery into secondary irrigation canals in accordance with planned parameters and, simultaneously, implementation of the monitoring and control of water levels and flow rates within the irrigation system. Earlier, all changes in flow rates near the Uchkurgan Hydro-Scheme (sometimes, up to 100 m3/sec) immediately affected irrigation water supply over the whole Fergana Valley (through headworks of North Fergana Canal, Big Fergana Canal and other main irrigation canals). At present, in spite of the same flow rate fluctuations, deviations in flow rates passing through the headworks do not exceed ± 2 %.

International experts who monitor the introduction of the SCADA on irrigation canals have highly assessed the reached progress and prepared the special presentation for the ICID[6] session in Sacramento.

It is necessary to note that the participation of local personnel and use of engineering tools that earlier were employed only at USSR enterprises with restricted access (“SIGMA”) allowed reducing the cost of these works 5 to 6 times in comparing with foreign prototypes, ensuring the same quality of operation. The introduction of SCADA is the cheapest way of water losses control. The SIC ICWC together with BWOs developed the proposal on completing these works in the Syr Darya basin and their full developing in the Amu Darya basin that is estimated in the amount of USD 16 million; however, unproductive water losses in the region will be reduced minimum by 7-8%.

We hope that donors and financial institutions in Central Asian countries will find the funds for completing these works in two major river basins within the next 2-3 years.

The introduction of SCADA provides two technical innovations – regular control of water levels and flow rates passing through headworks of inter-state importance and permanent monitoring of water quality. Such a continual monitoring with simultaneous transferring of data to the control units of territorial and central BWO offices allowed avoiding considerable fluctuations in flow rates that took place earlier when flow rate measurements were performed only four times a day. In addition, this system creates the trust and openness in water management in the basin. Including the network of hydrological monitoring on rivers and in upper watersheds that maintained by the National Hydro-Meteorological Services into this system is the next topical task. These works are quite significant for improving an accuracy of water records and forecasts.

DEVELOPING THE NATIONAL PROGRAMS FOR EFFECTIVE WATER RESOURCES USE is no less important instrument than strengthening the collaboration at the regional level. It is very important that,

[6] International Commission on Irrigation and Drainage

within the above framework of jointly developed strategy, all riparian countries will provide the progress in achieving those indicators of rational water consumption and improving water productivity, which were put into the joint plans.

It is also very important to return former governmental attention and support to water sector in Central Asian countries. First of all, it should be expressed in establishing the united state bodies for governing water resources at the top level as it was done in Tajikistan and Turkmenistan. At the same time, the National Water Councils under the leadership of Prime Ministers should be created in all riparian countries to provide the broad public participation in the decision-making and to coordinate other ministries in respect of rational water resources utilization.

Of course, the proposed program is not complete. This is only some considerations aimed at assisting in developing appropriate plans and measures that can be a cornerstone of the holistic survival program of Central Asian countries under conditions of a future water resources deficit.

## 4.3. Water Resources Governance and Management at the Level of Irrigation Systems

**(N.N Mirzaev, R. Saidov)**

As was mentioned in Chapter 1, establishing of water management structures within administrative boundaries, which do not coincide with hydrological boundaries, entails loss of the controllability of some elements of the water cycle affecting sustainability and uniformity of water allocation i.e. of major water management objective. The above is correct for both the whole river basin and some irrigation systems.

Instability and unevenness of water delivery through irrigation canals are caused by both the technical reasons and the organizational ones. Under conditions of administrative-territorial organizational upbuilding of water resources management, it is very difficult to maintain proper water distribution due to the fact that there are many "owners" of the irrigation system: district and provincial water administrations, and local authorities. Owing to such an approach, the well-known problem "head-to-tail" arise when, under a water resources deficit (but sometimes without a deficit), downstream water users have the "impaired rights" in comparing with upstream users. It was typical for the pilot canals at the initial project stage in 2003 (Table 4.4).

**Table 4.4.**
**Uniformity of Irrigation Water Supply from the Pilot Canals Prior To and After the Introduction of IWRM**

| Pilot Canal | SFC | | AAC | | KBC | |
|---|---|---|---|---|---|---|
| Year | 2003 | 2007 | 2003 | 2007 | 2003 | 2007 |
| Uniformity, % | 60 | 92 | 45 | 82 | 36 | 77 |

At present, it becomes more obvious that the problem of improving water resources management is an institutional (organizational) problem rather than a technical one.

One of key directions of institutional improvement of water resources management is the introduction of hydro-geographical principle or, correctly saying, the coming back to the hydro-geographical principle, since earlier, as known, water management organizations were formed based on the hydro-geographical principle.

Subsequently, under pressure of local authorities (District or Provincial Committees of the Communist Party) there took place the reorganization of the Irrigation System Administrations (ISA) into District and Provincial Water Authorities, which established their jurisdiction over a part of the irrigation system or canal within their administrative boundaries. This situation made the process of water distribution more complicated and enabled the local authorities to actively interfere into the process of allocating water resources; and this interference has not always met the requirements of equity, sustainability, uniformity, and efficiency.

At present, the process of transition towards the hydro-geographical principles of water resources management and refuse from the administrative-territorial principle of upbuilding of water management organizations (WMOs) was initiated in Central Asian region.

**A historical aspect of reforming water organizations in Uzbekistan:**

*1. **Hydro-geographical approach** (up to the 1960s):*

*- Irrigation System Administrations.*

*2. **Administrative-territorial approach** (with some elements of the hydro-geographical approach - Zerdolvodkhoz, UPRADIC, ADUOS) (until 2003):*

*- Rayvodkhozs (District Irrigation Administrations);*

*- Oblvodkhozs (Provincial Irrigation Administrations).*

*3. **Hydro-geographical approach** (after 2003):*

*- Irrigation System Administrations (ISAs);*

*- Basin Irrigation System Administrations (BISAs); and*

*- Main Irrigation Canal Administration.*

Prior to reforming the institutional structure within the framework of the IWRM-Fergana Project, the pilot canals were under jurisdiction of the following organizations:

- The Big Fergana Canal Administration (BFCA), Andijan and Fergana Provincial Irrigation Administrations (Uzbekistan);
- Aravan and Karasu District Irrigation Administrations (Kyrgyzstan); and
- Gafurov and Rasulov District Irrigation Administrations (Tajikistan).

At present, three Irrigation Canal Administrations: SFCA (South Fergana Canal), AACA (Aravan-Akbura Canal), and KBCA (Khodja-Bakirgan Canal) are active in the project area.

Earlier, prior to the transition towards the hydro-geographical principle, a path of co-ordinations in case of a conflict was the following (the Aravan-Akbura Canal Case Study): the Aravan District Irrigation Administration – Aravan District Authorities – Provincial Authorities – Karasu District Authorities – Karasu District Irrigation Administration. Now, after establishing the AACA, the decision-making process became more simple and effective. At the same time, this facilitates the operation of local authorities, which earlier was forced to solve continually water issues. According to representatives of the local authorities: "there are not now concerns related to water."

The decision-making process regarding operation of the KBC was also facilitated. As known, depending on seasonal water availability, a decision on "introduction" or "cancellation" of the inter-district water rotation on the KBC had to be made. Like the practice of the AAC, prior to establishing the AACA, it was impossible to make a decision regarding the water rotation in a *timely manner*.

Water resources management based on the hydro-geographical principle was completely put in practice on the KBC and AAC.

*In Uzbekistan, transition towards water resources management according to the hydro-geographical principle took place in the scale of all the republic (the Resolution of the CM No 320 of July 21, 2003).There is a reason to consider that the IWRM-Fergana Project contributed into issuing this Resolution. However, it is necessary to note that the process of transition towards water resources management based on the hydro-geographical principle in Uzbekistan was not yet completed, since there* *is an intermediate link between the Main Canal Administration and water users that is represented by the Basin (essentially, Provincial)Irrigation Administration i.e. "a body was united but wings were cut." Nevertheless, a very important step on the way of improving water governance was done. In the frame of the IWRM-Fergana Project, activity related to completing this process on the SFC is in progress.*

*In particular, in 2006, on the SFC the following was made: almost 40 km of the Shakhrikansay Canal and two remaining hydro-operational sites of the SFC ("Margilan" and "Fayziobad"), which were under the jurisdiction of the Sokh-Syrdarya Basin Irrigation System Administration (BISA)were transferred under the authority of the SFC Administration. In addition, there is the permission enabling five WUAs in Fergana Province to sign the contracts on irrigation water supply directly with the SFC Administration, by-passing the Irrigation System Administration "Isfayram-Shakhimardan." Activity related to transition towards water resources management based on the hydro-geographical principle on the SFC will be continued.*

In those regions where the necessity of transition towards water resources management based on the hydro-geographical principle cannot be put off, water professionals, water users and other stakeholders should initiate this process, not living to see when this problem will be solved at governmental level.

We would like to stress that the necessity of transition towards water resources management based on the hydro-geographical principle at the level of inter-farm canals and, especially, of main canals is out of doubts. At the same time, the practice of establishing WUAs in Central Asia within former collective farms shouldn't be ignored. An adherence of many practitioners to this approach is evidence of the fact that at the level of WUAs, it is necessary to take into consideration not only the belonging of private farms to single hydro-geographic network but also certain social aspects and economic links established last decades. In particular, a role of the hydro-geographical approach at the level of WUAs is not so obvious when the irrigation system has a "fishbone layout" rather than a "nodal layout" [22].

***Bottle-necks and ways for reforming the institutional structure of water resources management (the SFC: Case Study)***

*The experience of introducing a new version "IMS-Fergana" (Uzbekistan, 2007) has shown that under establishing the M&E system on the SFC, some problems arise due to the existing boundaries of WUAs, which can be settled by reorganization of the WUA based on the principle of matching to hydro-geographic boundaries.*

*Problems related to establishing the affiliates of Canal Water Users Council at the so-called hydro-operational sites arise because some WUAs simultaneously cover two hydro-operational sites*[7]*.*

*In 2007, an operational experience of the SFC Administration has shown that in the tail part of SFC (hydro-operational site "Fayziobad"), also on other big secondary canals, it is necessary to establish either the big WUA or the Union (Federation) of WUAs.*

*Principles of reforming the institutional structure of water resources governance (the SFC Case Study)are the following:*

- *A hydro-geographical approach is not an end in itself. It should facilitate the process of monitoring and evaluation of water distribution, which, in its turn, has to facilitate decision making and control of implementing the decisions*
- *A hydro-geographical approach is not a dogma. If under specific conditions, any other factors (technical, institutional etc.) facilitate improving the efficiency of water resources management in*

[7] A term "hydro-operational site" is of local origin and means a section of an irrigation canal or irrigation system, which is operated and maintained by a separate group (sub-division) of the Irrigation Canal Administration implementing such activities as monitoring, O&M works, record-keeping, and reporting.

*the larger extent, then a deviation from the hydro-geographical principle is possible.*

- *As a rule, the territorial principle of establishing WUAs in the SFC command area causes some troubles in water resources management.*
- *An issue of improving the water governance structure cannot be considered in isolation from land resources management.*
- *According to its formulation, IWRM requires not only an organizational separation of irrigated areas according to their belonging to irrigation water sources but also their integration if this measure facilitates a holistic settling of problems related to water and land resources management.*
- *Parameters of water management structures depend on sizes of the irrigation system.*

*It is desirable to adhere to the following principles under realization of the hydro-geographical approach:*

- *Irrigation water supply to a WUA only from one water source;*
- *A WUA has to be located within one hydro-operational site. If it is difficult to change WUA boundaries then the possibility of changing hydro-operational site's boundaries should be considered;*
- *WUAs have to be located within one administrative district (exception can be made only for WUAs located on inter-district canals);*
- *WUAs should cover land plots along both banks of the SFC;*
- *Other rural water consumers (villages, holiday villages; etc)have to enter into WUAs;*
- *WUA's area has to be within 1500 to 2000 ha;*
- *Realization of the hydro-geographical approach should be implemented based on the agreed and approved plan;*
- *A plan of realization of the hydro-geographical approach must be developed with the participation of water users and officials of the SFC Administration;*
- *A plan of realization of the hydro-geographical approach has to be discussed at meetings of the WUA Council and Boards of SFC;*
- *A plan of realization of the hydro-geographical approach has to be approved at the enlarged session of the Board of SFC WC with the participation of local authorities' representatives.*

*The Action Plan on reforming the water governance structure should include the following measures:*

- *If a WUA takes water directly from the SFC, a WUA has to sign the Contract on irrigation water supply with the SFC Administration;*
- *If a WUA takes water from different irrigation water sources (not only from the SFC), a WUA should be restructured in such a way in order to take water only from the SFC;*

*A number of WUAs divert water from the canals of different ranks in the SFC system.*

Recognizing the importance of transition towards water resources management based on the hydro-geographical principle, it is necessary to acknowledge that only the transition towards the hydro-geographical principle does not make the decisions of water professionals more equitable and effective. It creates opportunities (prerequisites) for making more equitable and effective decisions. Whether a water professional will take advantage of the opportunities (or not) to make water governance effective depends on some objective and subjective factors; and the participatory approach is a key factor among others. A problem of improving water governance based on the participatory approach is topical not only for the Central Asian region (CAR). A World Water Forum Declaration (The Hague, 2000) contains the following statement: "The water crisis is often a crisis of governance"; therefore, making water governance effective is one of topical priorities (GWP, 2000). A Ministerial Declaration on Water Security in the 21st Century reaffirms this standpoint and calls on: "Governing water wisely: to ensure good governance, so that the involvement of the public and the interests of all stakeholders are included in the management of water resources." [39].

Reforming the agricultural and water sectors in the CAR creates opportunities for encouraging equitable and effective water governance on the market base. Established institutional and market conditions, being major prerequisites, are not insufficient for appreciable improvement of water allocation governance. At present, a lack of the public participation in governing water and agricultural sector is one of the constraining factors that impede raising productivity of agricultural production and effectiveness of water governance in the region. Therefore, the democratization of water governance through involving the public in decision making and establishing new-type water organizations (Fig. 4.9) that will take into consideration the interests of common water users becomes topical. A problem is to find a reasonable level of unity of decentralization and governmental regulation. At a "grass roots" level of water distribution (a level of former collective farms), this dilemma can be solved by establishing water users associations (WUAs). At the same time, Canal Water Users Unions (CWUUs) have to be established at the level of main irrigation canals (or irrigation systems). From this point of view, morphology of irrigation network and governance on the Aravan-Akbura Canal, where the CWUUs are formed based on the involvement of WUAs and other water users that are not WUAs members and represent non-agricultural stakeholders can be considered as an ideal solution.

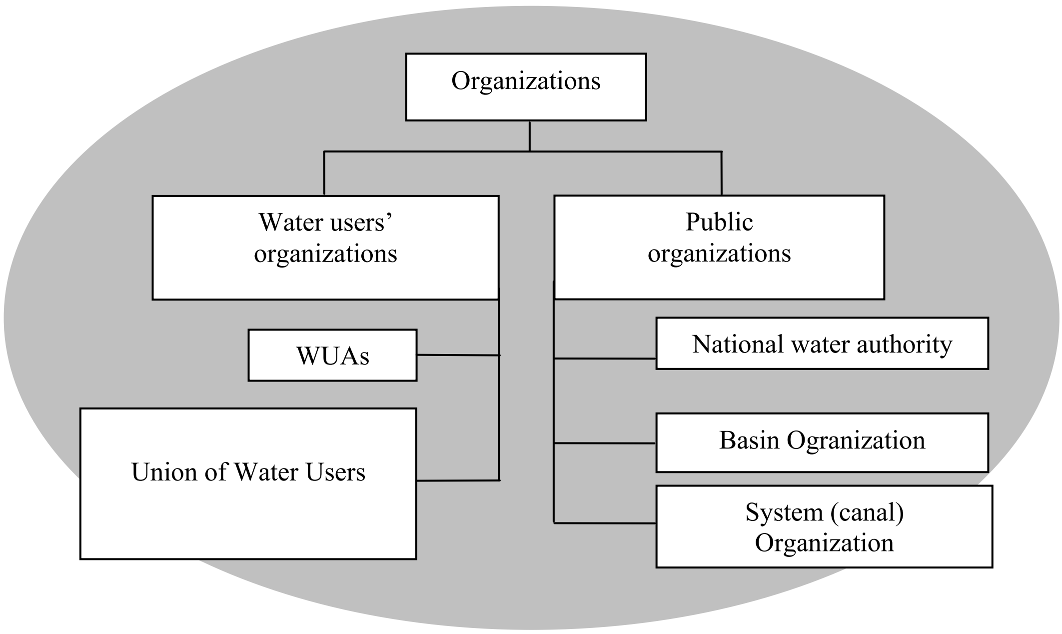



**Figure 4.9 Water Organizations in the Frame of National Water Governance**

***Why the public has to be involved in water governance?***

Due to different socio-economic approaches, there are the following methods of water allocation: centralized (governmental), decentralized, and combined.

**A Centralized Method:** A domestic and foreign experience shows that, at present, a purely centralized (governmental) approach does not already allow ensuring sufficiently equitable, effective, and ecologically sound water governance. Equitable water governance means that all available water resources are used in the manner meeting completely the needs of all social groups. It means that any decisions should meet the interests of all social groups, somehow or other, involved in water use, creating an enabling environment for their direct participation in decision making. Otherwise, a risk of unfair water governance is rather great, resulting in aggravating poverty, natural disasters, and social instability. The centralized method of water governance has prevailed in Central Asia. Governmental officials have to defend the democratic fundamentals of social progress according to their official duties, although their interests can differ from interests of the civil society. Therefore, public participation is necessary in order to create the atmosphere of transparency and openness when the likelihood of decisions making contradicting the public interests is reduced.

The higher level of public participation the less favorable conditions for corruption and ignoring the public interests. At the same time, it is necessary to understand clear that the decentralized method of water governance can be completely introduced only when the public management bodies reached full institutional and financial self-sufficiency to cover running and development costs (by analogy with the French system). Under conditions of prevailing irrigated farming, as a major water consumer, and of a low level of self-payback, putting all water governance and management on "shoulders" of water users and other stakeholders means for them non-sustainable existence.

Therefore, under our conditions it is more correct to move towards combined methods of water allocation. In this case, decentralization, or its combination with centralization depending on capabilities of stakeholders, is implemented through involving the public in the process of water allocating and transfer interested entities the right to make decisions regarding issues that can be solved more effective on-site. The more decentralized the decision making the broader the public participation. It is clear that public participation is a very complicated process because the resistance of some officials should be overcome.

*Here, it should be mentioned the following aspects related to assessment of a role of water professionals, water users, and local authorities. It does not mean that water professionals are "bad boys" and water users "good boys." "Bad guys" can be met both among water professionals and among water users. It means that "good boys" among water users should be united into the public associations to help "good boys" among water professionals to allocate water in an equitable and effective manner.*

*At the same time, the local authorities belong to stakeholders-water users or, in other words, interested legal entities. However, traditionally, local authorities manage water professionals. It does not mean that local authorities poorly govern – the practice shows that a leading role of local authorities can affect water management both positively and negatively. In particular, a moving towards the participatory approach is aimed at enhancing a positive impact and mitigating a negative impact of some representatives of the local authority by means of democratization of water governance.*

**The Second Method:** Water, depending on its target use, can be a social benefit. In this case, it can be used for ecological, social, recreational, sanitary, and other purposes. Such its value just strengthens the necessity of transition towards joint governance when authorized state bodies (national or local) represent the state interests in new-established management bodies, working together with representatives of water users.

**The Third Method:** Water users' water governance includes water resources management and water demand control. In developed countries, an emphasis is shifted to regulating of water demand, but in the CAR, an emphasis is traditionally made on water resources management; and under conditions of a water resources deficit, problems of water use cannot be solved only by engineering tools. A specific character of water demand management consists in focusing on people engaged in water use rather than technical norms and facilities.

There is one more important aspect requiring water users' participation – a budget deficit a long with the need of public control over necessary expenditures for operation and maintenance of water infrastructure. Under budgeting, a necessity of those or other expenditures is specified practically by the same economic players that, hereinafter, spend budgetary financial resources. As a result, there is the possibility for overstatement of planned and actual scope of works. Under conditions of joint water governance, when the sources of financing are combined – partly from a "pocket" of water users and partly from the state budget

– the mechanism of public control over specifying a necessary financing and expenditures is active.

Thus, taking into account above statements, the public participation is a significant tool for improving water governance, creating the enabling environment for realization of principles of openness, transparency, and fairness due to better awareness of water users, higher material incentives of operational services' personnel to meet the needs of those who are serviced by them and on whom they depend.

Whereas, a rising of water users' awareness is able to put an effective barrier for infringement of the principle of fairness by officials and employees of operational organizations, as well as for an illegal interference of local authorities' representatives, the concept of public participation is, not always, supported by them. They pay lip service to the public participation, but, de facto, either undervalue its role or resist to it [18, 41].

**Canal water users union (CWUU)**

*A concept of introducing IWRM, in line with which institutional improvement of water governance was planned through establishing Canal Water Users Committees (CWUCs), was developed in the beginning of the IWRM-Fergana Project [41].*

*In the course of its realization it became obvious that the idea of establishing the CWUC is correct, but our views on how to do this had to be adjusted. This became clearer when questions concerning a legitimacy of participating the CWUC in water governance and its sustainability in the post-project period have arisen under specifying the legal status and mandate of the CWUC.*

*At present, principal steps for the introduction of participatory approach are undertaken in the following sequence:*

*1. The Resolution on establishing the Canal Water Users Unions (CWUU) was adopted at the Constituent Assembly of agricultural water users; the following CWUU were established and officially registered: Water Users Union on the SFC (WUU SFC), Water Users Union on the AAC (WUU AAC), and Water Users Union on the KBC (WUU KBC);*

*2. Official registration of the CWUUs was approved by the Ministry of Justice;*

*3. The Agreements on the joint management of the canals were signed with water management organizations (WMOs) ranked higher than the Canal Administration (CA);*

*4. The CWUCs, as the joint water governance bodies, were established;*

*5. Non-agricultural water users and other stakeholders became the official members of the CWUUs (and members of the CWUCs as representatives of the CWUUs);*

*Our views on joint water governance also underwent some changes. At the beginning, we thought that joint water governance should be implemented by the CWUU and the CA. Now, we consider that joint water governance has to be implemented by the alliance of the CWUU and WMO rather than the alliance of CWUU and CA. When we speak about the WMO we keep in mind the organization, which directly governs the Canal Administration*

The CWUU executes its activity based on the Charter adopted at the Constituent Assembly of water users of the pilot irrigation canal.

It was decided that the water users' organization having a legal status should be firstly established. The Constituent Assemblies, at which water users approved the Charter of the CWUU, were anew held. Agricultural water users were the founders of the CWUUs on all pilot irrigation canals. In the course of consultations, jurists have clarified that other water users can become the members of the CWUU, after its official registration, submitting their applications. The Boards of CWUUs were set up when the CWUUs were officially registered.

Subsequently, a question how and who empowers the participation of CWUU in water governance was arisen.

A concept of joint water governance, in compliance with which the CWUU is authorized to participate in water governance through its representatives in the CWUC that was established based on the Agreement on Joint Water Governance, was developed and put in practice.

A joint governance body, in the form of the Board of CWUC including representatives of water organizations and agricultural water users, is established at the initial stage. The Council of CWUC including representatives of other water users and stakeholders, which are not direct water users (for example, representatives of local authorities, NGOs, sanitary services, conservancy agencies, and other organizations), is formed during the next stage.

**The Canal Water Users Union (CWUU) mandate and functions**

The CWUU is a noncommercial public organization, by means of which all individuals or legal entities interested in water services (local authorities, irrigated farms, conservancy agencies, public utilities, power sector, fishery farms etc.) have an opportunity, through their representatives in the Canal Water Users Committee, to participate in water governance on the equitable base. Thus, the CWUU, on behalf of its members, pursues a general technical and economic policy that provides equitable, sustainable, effective, and ecologically sound governance of water allocation over the irrigation canal's command area.

**For implementing these tasks, a newly-established CWUU, through its representatives in the CWUC, executes the following functions:**

- Participation in elaborating the strategy of developing irrigation and land reclamation services over the irrigation canal's command area;
- Coordinating the water allocation plans;
- Monitoring of the compliance of actual water allocation with the principles of fairness, sustainability, uniformity, and efficiency;
- Coordinating a plan of water infrastructure maintenance and repairing;
- Coordinating the Canal Administration's budget and participation in drafting business plans;
- Mobilization of additional funds for activity of the CWUU and Canal Administration;
- Extension services (in the outlook under the availability of funds) in the field of water management, establishing of WUAs, and co-ordination their activity and other water users. At this stage, the project, through its local specialists, facilitates beginnings of this system by means of activity on so-called "pilot polygons" under leadership of project trainers financed by jointly the BISA and the project; and
- Others.

Due to restructuring of shirkat (cooperative) farms and establishing of WUAs, the general meetings of representatives from hydro-operational sites (HSs) were again held on ten SFC HSs to renew the membership of the Councils of these units (HSs).

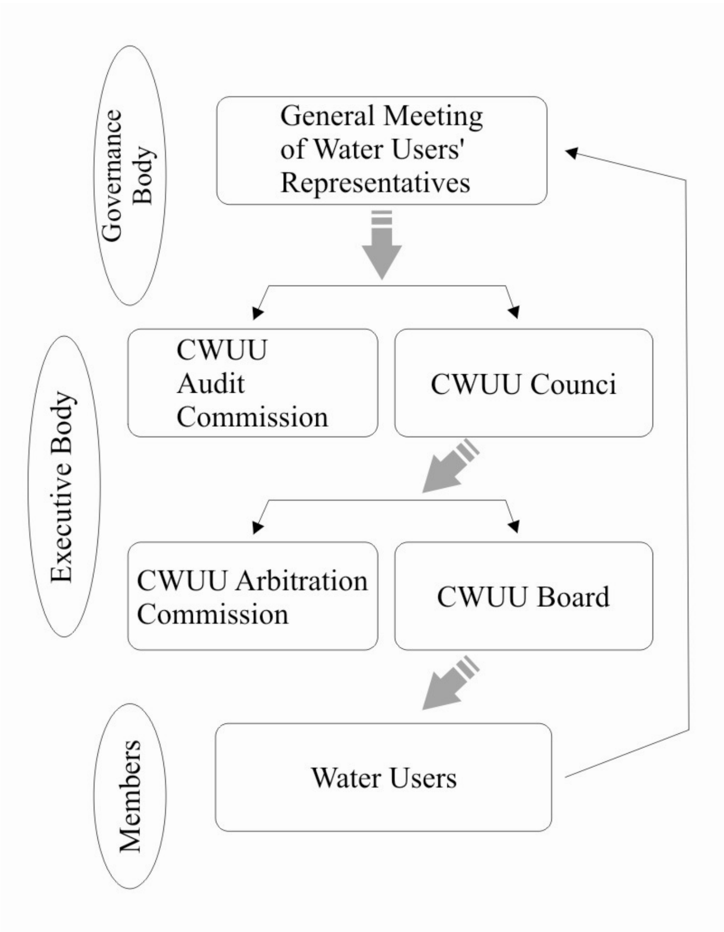



**Figure 4. 10. Sample Organizational Framework of the CWUU**

Subsequently, the general meeting of representatives from the SFC water users was held to renew the membership of the Water Users Union of SFC (SFC WUU). All these measures were aimed at promoting activity related to involving water users into water governance at the level of hydro-operational sites enabling to make activity of the SFC WUU more effective.

The SFC WUU consists of a head office and 10 its affiliates (according to the number of hydro-operational sites on the SFC), representing the Water Users Unions of Hydro-Operational Sites on the SFC (WUU HS SFC), see Figure 4.11. It is necessary to note that the organizational framework of WUU HS SFC is similar to the organizational framework of SFC WUU and consists of governing and executive bodies responsible for water governance and management within a hydro-operational site.

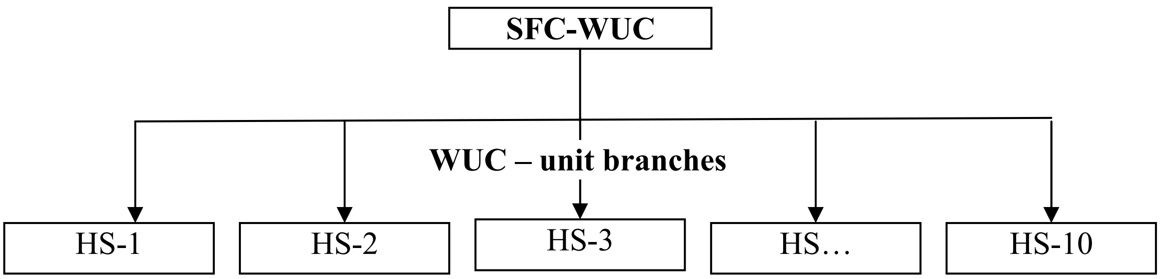



**Figure 4.11. Organizational Framework of the SFC Water Users Council**

### Financial Aspects of CWUU Activity

Stakeholders (water users and others) and international donors finance activity of the CWUU. The CWUU budget is drawn up by the Board of CWUU and approved by the general meeting of water users (or by the CWUU council, if the general meeting authorized it).

Within the project framework it was planned that financing of the CWUU activity will be implemented at the expense of special funds allocated in the CA budget, but the experience of CWUU activity has shown that it is impossible to rely on their financing.

It became obvious that for providing the financial sustainability, the CWUU Council should be financed directly by stakeholders and donors. Water users of all WUAs on the AAC, at their meetings and at the general meeting of water users, which was held in December 2004, made decision on financing the CWUU Council. All WUAs have agreed to contribute into the annual budget of the CWUU Council in the amount of Tajik Som 10 per ha (about USD 2500 annually). This amount was sufficient mainly for covering expenditures related to conducting the meetings of CWUU Council, hiring of auto-transport, wages of three members of the Board of CWUU etc.

unds for financing the CWUU Council of the AAC are provided for in budgets of WUAs but not paid in full. Therefore, the CWUU Council of the AAC faces a lack of funds. In 2006, part of these funds was used to prepare the project proposals to potential donors to equip two newly-established WUAs with minimum office equipment.

Taking into consideration the grave financial situation in the CWUU at the initial stages of its activity due to overall financial difficulties at most of water users, it is reasonable: i) to brisk up the work with donors and water users (collection of membership fees); and ii) to seek medium-term credits, with a low interest rate. For this purpose, at the meetings of CWUU Council and the general meetings of representatives of water users, it is necessary to obtain the support of water users, and then, together with specialist, to initiate preparing and discussion of the business plans for the CWUU and to follow the formal procedure.

In comparing with other CWUUs, the CWUU SFC is in the best conditions, since more than Uzbek Sum 100,000 was transferred to its bank account, and the SDC has granted USD 8,300 (this grant covers the annual budget of the CWUU SFC that equals to Uzbek Sum 10 million), as well as it won the US Embassy Grant in the amount of USD 4,000 for conducting workshops in the SFC command area in 2007 and 2008.

Cost items of the CWUU are given in the table below. Either only the governmental budget funds or, under conditions of water charging, combined funds of governmental budget and water users' fee are used for financing CA operation.

| No | Cost Items | Sources of Financing |
|---|---|---|
| | Wages of some members of the CWUU Board | 1. Fees of WUA members<br>2. Donors' grants<br>3. Income from commercial activity of the CWUU |
| | Expenditures that covers conducting the meetings of the CWUU Board and Council, and the general meeting of representatives of water users | |
| | Payment for renting the office | |
| | Payment (in the prospect) for consulting services (jurists, scientists, engineers etc.) | |
| | Travel expenses | |
| | Entertainment expenses | |
| | Other operating expenses | |

**Legal aspects of establishing and activity of the CWUU**

The CWUU is a nongovernmental noncommercial organization having the status of legal entity with own the bank account.

*In Kyrgyzstan, the CWUU was registered under a name: "the Union of Water Users Associations of the AAC", and in Tajikistan under a name: "the Union of Agricultural Producers-Water Users "Khodjabakirgansay"." Founders of the latter are agricultural co-operatives. Representatives of the Provincial Department of Justice consider that other stakeholders (including WUAs) can become a member of the CWUU KBC after its registration based on submission of an appropriate application.*

*The CWUU SFC was officially registered in the Ministry of Justice of the Republic of Uzbekistan.*

***Constituent Assembly***

A final phase of social mobilization at the level of main canal is the preparation and conducting of the meeting of representatives of water users (MRWU). The two-level system of conducting the MRWU (at the beginning at hydro-operational sites, and then for the whole canal) is recommended for big canals, like the SFC. Since only founders are attending the first meeting rather than all water users, it is called "the constituent assembly of representatives of water users."

***Agenda of the Constituent Assembly of representatives of water users*:**

1. Discussion, improvement, and adoption of the CWUU Charter;
2. Elections and approval of the CWUU Council members;
3. Elections of the CWUU chairperson (he/she is also a chairperson of the CWUU Board).

*The first (constituent) MRWUs on the pilot canals were held in December 2003. Subsequently, MRWUs are held annually. Their agendas include discussing of activity outcomes of the CWUU and CA during a reporting year and working plan for next year, as well as some organizational issues.*

*Since over 90% of water is consumed for irrigation, it is important in principle in order that agricultural water users can make up a majority in the CWUU and its Board, and it is also important in order that a representative of agricultural water users from the tail part of irrigation canal would be elected as the Chairperson of CWUU (CWUU Board). As a rule, chairpersons of the CWUU SFC and CWUU KBC represent agricultural water users of pilot canal downstream areas. As a result, irrigation water supply in downstream sites of pilot canals has improved.*

***The CWUU Council***

After the constituent assembly of water users, the meeting of CWUU Council is held to solve the following issues:

1. Elections of CWUU Board members;
2. Forming an arbitrage board and auditing committee;
3. Preparing the annual plan and schedule of CWUU activity (an assignment for members of the CWUU Board).

*At present, a WUA organizational structure, in which a governing body is represented by the CWUU Council headed by a Chairman, and an executive body is represented by a WUA Directorate headed by a Director, was adopted in Central Asian region. Since the position of WUA Council's Chairman is voluntary and a WUA Director manages all finances, the Director is a key personality and a role of the*

*WUA Council and its Chairman, as a rule, is negligible.*

*In Turkey, for example, another organizational structure was adopted, and a key personality is a WUA Chairman. It is necessary to note that the legislation of Kyrgyzstan envisages two options of WUA organizational structure, including the option adopted in Turkey. In addition, at the beginning, WUAs in Kyrgyzstan were established according to the Turkish organizational structure of WUAs. This structure can be considered as a WUA organizational structure for the transition period.*

### *The CWUU Board*

The CWUU Board, at its meetings, reviews a draft annual working plan and schedule of CWUU activity and submits them to the CWUU Council for its approval. After discussion and approval of annual working plan and schedule of CWUU activity at the CWUU Council meeting, all works are implemented in compliance with these documents.

In addition, the CWUU Board delegates its representatives to the CWUC for joint governance of the Canal Administration. The members of CWUU working in the CWUC Board participate in assessing water allocation over the last ten-day period and in decision making for a next ten-day period (based on indicators of water allocation that are calculated with help of the MIS), as well as in conflicts resolution. An example of water users' constructively participation in decision making is their participation in settling the conflict with Kyrgyz water users and also the conflict between the BISA "Naryn-Karadaya" and the Main Canal System Administration (Fergana Valley) in August-September 2007. The CWUU Board pays special attention to the tail hydro-operational site "Fayziobad" on the SFC; and therefore, indicators of water allocation at this HS have considerably improved in spite of dry year.

### *A CWUU Chairman*

A CWUU Chairman (he/she is also a chairperson of the CWUU Board of the Council) is elected at the general meeting of water users with the 3-year run of office. During the elections procedure, a preference should be given to a representative of agricultural water users located along a downstream stretch of the irrigation canal. A CWUU Chairman can be removed from his position based on the decision of CWUU Council, if the CWUU Council considers that a CWUU Chairman is not able or unworthy to execute his assigned functions, or based on his written request about resign. The CWUU Council has a right by secret ballot to elect another person as an acting chairman instead of a former one.

*CWUU Chairmen were elected by open vote at the constituent assemblies of water users. In 2004, chairmen of CWUUs of SFC and AAC were reelected at the meetings of the CWUU Councils. A reason was the following: CWUU chairmen have changed their places of basic employment and could not represent the interests of water users in the CWUU Council.*

*Chairmen of CWUU SFC and CWUU KBC represent the interests of water users located along tail parts of the pilot canals.*

### *An Arbitrage Commission*

The most important function of CWUU is to consider matters of argument and to settle conflicts between water users, as well as between water users and the Canal Administration. An arbitrage board (commission) is subordinated to the CWUU Council.

*Since 2004, conflicts related to water allocation between the Canal Administration and water users have practically ceased at the level of pilot canals. Specialists consider that this is mainly related to reforms conducted in the frame of the project. The reforms have provided good results in dry years, but now other types of conflicts are topical mainly due to external causes: in Kyrgyzstan –"tulip revolution"; in*

*Uzbekistan – sudden stop of water releases from the Andijan Reservoir; and in Tajikistan – peculiar price and tax policy regarding water services of the KBC Administration.*

*At the same time, in Tajikistan the conflict between the KBC Administration and "non-payers" intensifies. The KBC Administration, by approbation of the KBC CWUU Committee, has attempted to use extreme, but legal pressure: temporary cessation of irrigation water delivery to water users, which do not pay for water services, and has directed this matter to economic court. Nevertheless, in Tajik water users' opinion, without reforms it would impossible to deliver water to the farm "Samadov" in 2006 and 2007.*

*In 2007, there was the conflict on the SFC between the SFC Administration and Kyrgyz water professional and water users, which was provoked by sudden stop of water releases from the Andijan Reservoir. This conflict was discussed with representatives of Kyrgyzstan (of the Aravan District Irrigation Administration and frontier WUAs) in the course of seminar on planning of water allocation (Fergana, August 2007) and at the joint meeting of SFC Water Committee and the Water Committee of hydro-operational site "Karkidon Feeding Canal" (KFC).The following attendees were at the joint meeting: Chairman of the SFC WC, Chairman SFC CWUU, representatives of BISAs "Sokh-Darya" and "Naryn-Karadarya", and Director of SFC Administration. It was decided to strengthen and brisk up the work of SFC WC and to authorize it to settle conflict situations efficiently and promptly.*

***An Audit Committee***

To provide the transparency and openness of CWUU activity, an audit committee consisting of three members is elected at the general meeting of water users. The audit committee does not audit financial management of the CA, but has access to auditors' reports related to auditing its financial management. The audit committee audits only funds allocated for the CWUU Council operation.

*Audit Committees of the CWUU on the pilot irrigation canals was not yet formed due to absence of such a necessity, since there are not funds.*

*In the course of preparing and conducting the meetings of CWUU Board and Council, an awareness of water professionals and common water users is rising. In addition, issues, about which it was preferred to be silent (interference of local authorities in water allocation) or which were ignored (uncoordinated activity of power supply managers resulting in sudden shutdowns of pumping stations and unsustainable irrigation water delivery to secondary canals) are now tackled. In Tajikistan, undue gravel excavation from the Khodjibakirgansay channel causing riverbanks' erosion, washing out trees and reducing the safety of waterworks became the subject for consideration at the meeting of CWUU Council.*

*The SIC ICWC has streamlined the study of cross-sectoral interests and links in the pilot canal's command area. Analyzing collected data has shown that the following problems are the most topical for all three pilot canals:*

- Water protection zones (WPZs). Political, legal, and financial issues impede a clear definition of WPZ boundaries and owners along the pilot canals (PC). Effects of this situation are the following:
- *Contamination of the WPZs (garbage; washing cars; lavatories; pumps, garages,…);*
- *Unauthorized acquisition of WPZ lands;*
- *Water pollution (garbage, wastewater, spoils, disease carriers and pathogenic bacteria).*
- Water supply to the population (also for watering livestock) both during the growing season and, especially, in the dormant season. This problem is extremely topical due to severe deficit of potable water in the pilot canals' command areas;
- Land reclamation: rise of groundwater table on the downstream plots due to irrational water use on upstream plots; and

- Population safety. Sometimes people drown in the pilot canals (it is especially typical for the SFC); As a result, breakdowns of irrigation canal operation and decrease in the stability of water intake into the pilot canal and water diversions from the pilot canal take place.

*Information collected by project consultants over the period of 2005 to 2006 under studying the cross-sectoral interests and links in pilot canal command areas was synthesized; and the book: "The Research Record on Issues of the Environment, Potable Water Supply, Land Reclamation, Power Supply, Pumped Irrigation, and Sustainability of Water Availability" was written based on collected information. The first chapter of this book is devoted to the SFC, second chapter to the AAC, and third chapter to the KBC. The book was distributed among local water professionals. An electronic version of this book will be as the basic for the Knowledge Base, which is, in its turn, the integral part of pilot canal database (www.cawater-info.net/iwrm).*

Studying water management problems in co-ordination with problems of other sectors is not an end in itself. The goal is to develop appropriate action plans and streamline their implementation based on the studies of these problems. The WCUUs of pilot canals (SFC, AAC, and KBC) and the canal administrations are responsible for implementing these plans in the frame of the project.

Action Plan No1 that is covering the environmental issues, potable water supply, and land reclamation under water management on the pilot canalas was developed based on findings of studying the cross-sectoral relations and now is being implemented including the following actions:

- Measures for cleaning and planting of greenery in the WPZs with involving stakeholders in the form of "khoshars" (a voluntary participation in works of public importance);
- Formal notifications to the administrations of districts and cities located in the pilot canals command areas with the request to improve the situation related to pollution of the WPZs;
- Joint field inspections of CWUU members and representatives of conservancy agencies to inspect ecological and sanitary conditions in the WPZs and settlements adjoining the SFC;
- Meetings for improving an sanitary awareness of settlements' inhabitants to prevent pollution of irrigation canals and WPZs;
- Operational schedules of the PCs for the dormant periods to mitigate potable water deficit in the pilot canal command areas;
- The formal letters to potential donors with the request to assist in solving PC problems through initiating the water supply and sanitation projects in the PC command areas;
- Accounting return and ground water under planning water allocation and adjusting the plans of water allocations on the pilot canals;
- Other actions.

### Joint governance and management

From the hierarchical point of view, governance is implemented at the national level external regarding the overall system of governing the water sector and based on the national constitution and other regulative mechanisms executing international conventions and treaties, national laws concerning property rights, market relations, water charging, water rights, water rights market, investments, subsidies, and other national mechanisms. Its subordinated form is ***internal governance*** at the sectoral level, which, acting in the framework of directory regulations and financial restrictions, can establish its own sectoral regulations and rules including allocating funds, quotas, institutional structures, staff, norms, rules of information exchange, a reporting system, and many other procedures, which serve as guidelines in the management process.

From an institutional viewpoint, IWRM is characterized by transition from exclusively state governance towards the so-called joint governance when part of governmental powers are transferred to bodies formed together with public organizations.

***Under these circumstances, governance bodies are the following:***

1. State governance
2. External governance, which, in compliance with the Constitution, means activity of the President, Parliament, Government and local authorities;
3. Internal governance, which, on behalf of the Government, is executed by National Ministries and Committees responsible for water resources (Ministry of Public Utilities, Ministry of Agriculture and Water Resources, State Committee on Environment Protection, Ministry of Energy, Ministry of Geology) an their offices in provinces and administrative districts; and
4. Public governance represented by above CWUUs.

*The WMOs that directly execute internal governance of the Canal Administrations are the following: for the AAC – Osh BWMO; for the SFC – the Fergana Valley System Administration of Main Canals with United Dispatcher Center (FV MCSA & UDC); and for KBC – the Ministry of Land Reclamation and Water Resources of the Republic of Tajikistan.*

In respect of operational management that means the process of planning and implementation of technical, technological, financial, and organizational measures related to water allocation and O&M of water infrastructure, in this case we consider "management" as a synonym of "operation and maintenance."

***Functions of governance bodies are the following:***

1. Annual planning:
- Specifying and balancing water demands and available water resources;
- Water allocation within established water use limits;
- Managing of drainage systems and protection of water quality;

2. Implementing the plans of water use:
- Water distribution in due time;
- Drafting the regimes of water releases and filling reservoirs;
- Drafting the schedules of water delivery;
- Control of organizational water losses.

3. Monitoring of Implementation:
- Establishing a water gauging and record keeping system;
- Analyzing and adjustment of an operational mode;
- Evaluation of water saving.

4. O&M of water infrastructure:
- Reservoirs and headworks;
- The main and secondary irrigation networks and hydraulic structures;

- Drainage network;
- Gauging stations;

5. Establishing and maintaining the database.

## A theory and practice of transferring powers for water governance

In the world practice of restructuring the water and agricultural sectors, the transferring of powers for water governance means the full or partial transferring of responsibilities and powers related to water governance from the national government towards groups of water users themselves organized in the form of various consumers' or production co-operatives, partnerships, associations, unions, federations etc.

A world practice shows that due to local conditions and economic and technical capabilities of both those who hands over the powers and those who takes over governance functions, such a transfer may have different forms and scales. A key cause for transferring governance over operational organizations, as a rule, is the lowering of a water resources controllability level and deteriorating water infrastructure and services due to the following factors:

1. Jump in the number of water users and complexity of water supply and distribution under using former methods;
2. A lack of budgetary funds for further financing of water management organizations;
3. A low level of fee collection for irrigation water delivery and other water services; and
4. A low level of professional knowledge of officials and personnel of water management organizations and a lack of incentives for proper work under conditions that were changed in the process of reforms.

Therefore, the involvement of water users in direct governance of water management organizations is a call of the times and also one of the world widespread methods to tackle the crisis in the water sector.

After independence, tens of and even hundreds of small farms were created and continue being created instead of large collective farms in the agricultural sector in Central Asian countries. O&M services that earlier operated in collective farms and state farms went out of business. Instead of them in countries of the region, water users associations (WUAs) that are operating according to principles of forgotten bygone traditions of "*Adat*"[8] and "*Shariah*"[9], the cornerstone of which is the public participation, are being established. Foreign and local experience of WUAs shows that a direct participation of water users in water governance, as a rule, provides sustainable, equitable and effective water resources management.

At present, an experience of public participation in Central Asia is mainly limited by the WUA level, i.e. within the former on-farm irrigation and drainage network. At the same time, the world experience shows that a direct participation of water users in water governance at higher level, for example on the main irrigation canal, also can be effective solution:

1. To improve the controllability of irrigation systems and, based on this improvement, to raise a level of uniformity, effectiveness, and sustainability of irrigation water supply;
2. To create incentives to water users and personnel of operational services for reducing water consumption and O&M costs. At the same time, performance capabilities are considerably raising due to greater responsibility of water users and allows:

[8] A word "adat" literally means a habit, custom, or tradition. Rules and provisions of the Adat in the legal sense are regulations of the customary law

[9] The Shariah is the Muslim Legislation

- To improve financial and technical conditions of irrigation systems;
- To reduce the number of disputes due to unsustainable irrigation water supply;
- To increase a collection of fees for irrigation services;
- To raise crop yields and revenues owing to effective water distribution;
- To defend own interests (as a more consolidated group) in the process of developing governmental and legislative decisions;

Active participation of water users in governance of operational organizations due to the transfer of powers from governmental organizations to associations of water users allows achieving more qualitative water management, rise of productivity of water and land use, improvement of land reclamation conditions, and consolidation of separated groups of water users over the whole irrigation system.

In contrast to foreign developing countries that reforms their water sector where private farms initially existed as separate water users, and inter-farm irrigation network belonged to the state, the farms in Central Asia were, as a rule, collective units and, de jure, already had powers for water governance.

In the period of reforms after restructuring collective farms, the former on-farm irrigation network became ownerless, and the controllability of water distribution has lowered up to the level when negative effects for agricultural productivity were unavoidable. At that time, the governments were forced to initiate the process of establishing WUAs, to which the governments, naturally, started to hand over powers for governance and management of the former on-farm irrigation and drainage network. Thus, without considering the short period of ownerless on-farm systems, as a result of reforms the transfer of water governance powers from restructured or completely disintegrated former large water users towards water users associations of a new type took place.

In case of big main canals, here, in contrast to the WUA level, it is planned to transfer only part of governance powers, namely, to provide the transition towards joint governance of the state and public stakeholders. At the same time, part of powers should be transferred from the state to water users. It is necessary to keep in mind that often the state, represented by state officials, does not see the exigency of this transfer, although the exigency exists. Due to some reasons, such as lack of the experience of participatory governance at the level of main canals, reluctance to hand over powers etc. the process of transition towards joint governance of large irrigation schemes cannot be smooth, rapid and extensive like what happen at the WUA level. Therefore, a period of transition is needed here – the period of joint water governance.

### The key stages of institutional improving of water governance on the pilot canals

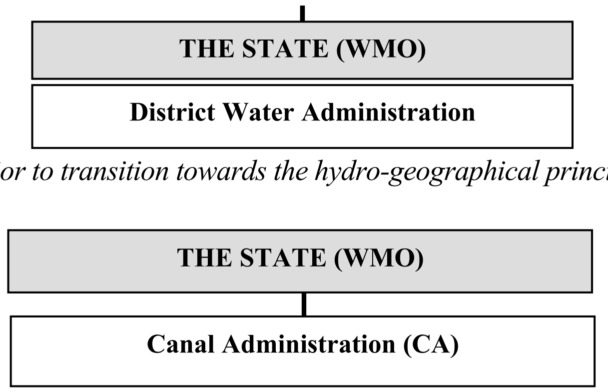
Figures 4.12 and 4.13 below show the stages of improving water governance, which were partly already passed through in the frame of the IWRM-Fergana Project and which should be passed through in the process of transition from exclusively state water governance towards joint water governance with involving stakeholders.

### Rational of transition towards the joint governance

At present, the CWUUs, under support of the project, participate together with governmental water management organizations in executing the following functions of water governance:

1. Approval and collection of water users' financial contribution and its redistribution among water users;
2. Specifying the procedures for water delivery, distribution, and use (water rotations, adjusting the irrigation schedule, monitoring, and reporting);

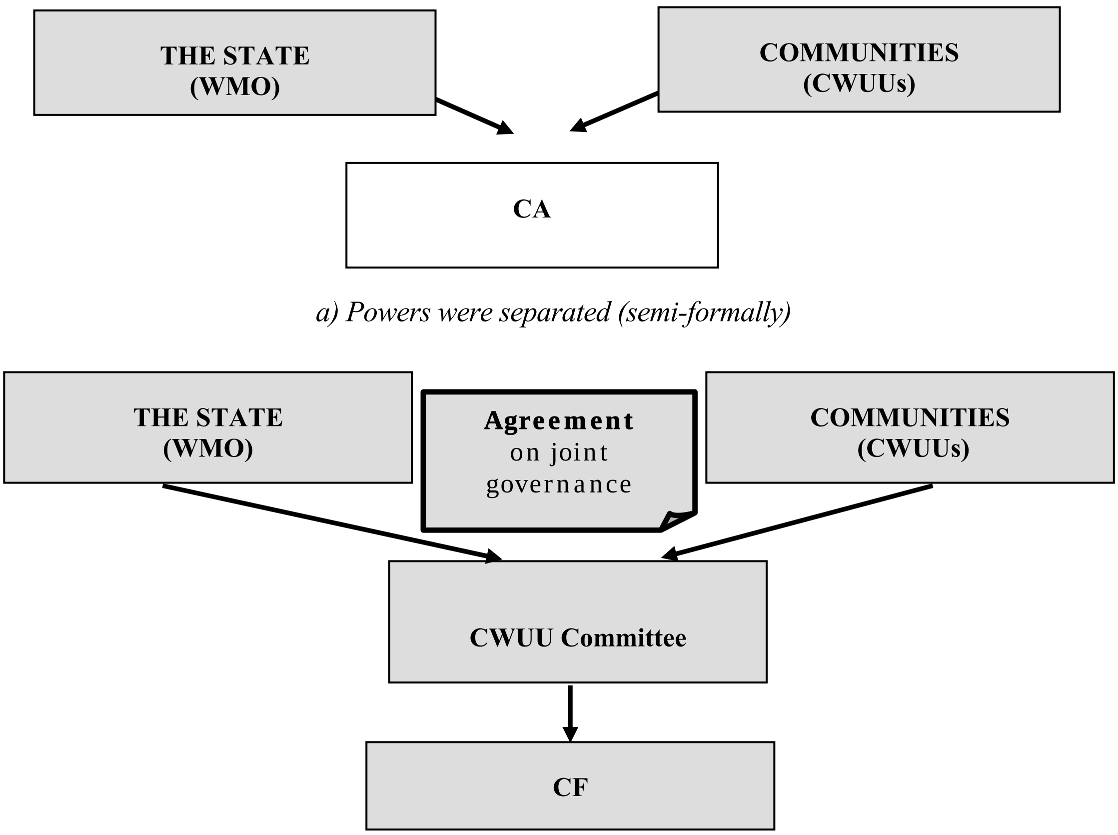
3. Arbitrage and settling disputes between water users and the CA;
4. Approval of the business plan based on the balance of allocated state budget, collected fees, funds accumulated due to different activities, as well as procedures for creating the emergency fund and its use etc.; and
5. Decision making regarding receiving the credit that will be repaid by water users;




*a) Prior to transition towards the hydro-geographical principles;*

*б) After transition towards the hydro-geographical principles.*

**Figure 4.12. Diagram of State Water Governance**




*a) Powers were separated (semi-formally)*

*б) Powers were separated (formally)*

**Figure 4.13 Diagram of Joint Water Governance**

It is necessary to note that powers of the CWUU still are not *legitimate* and, therefore cannot be sufficiently effective and sustainable. Undoubtedly, ideally, governmental water governance should be replaced by public water governance in the canal (system) command area, namely by the CWUU, in which sectoral bodies and local authorities should participate as stakeholders – members of the CWUU, at least, making their contribution. At the same time, the CA and CWUU should merge into a united organization, in which the General Meeting and CWUU will be its board (governing body), and the CA will be transformed in its executive body.

However it will be possible only in the future. At present, it is early to speak about this for a number of reasons. Firstly, an economic situation of water users is difficult, and they won't be able to cope with it without substantial state assistance; secondly, the time is needed to make significant progress in democratization of the national systems, as planned, in the Central Asian countries.

Today, artificial promoting the progress of events and attempts of jumping from state water governance to public water governance are wrongful. Under present conditions in Central Asia, such a revolutionary activity cannot facilitate putting the participatory approach into practice; and, moreover, the idea can be discredited. A transition period – the stage of joint water governance by two legal entities: the CWUU and WMO – is needed. In fact, duration of transition period will depend on the rate of democratization in Central Asian countries. It is necessary to continue institutional, preparedness and training activity in order to provide, on the one hand, *a real voluntary consent* of water users to undertake governance of pilot canals and, on the other hand, a consent of sectoral ministries to transfer powers to water users for governing the pilot canals. Transferring powers for governing the pilot canals has to be formalized in the form of the legal document: the agreement on transferring powers between the Ministry and CWUU.

At present, only step-by-step transition from state water governance towards joint governance, when the government participates in water governance on a par with water users is possible. Transition towards joint governance should be based on the agreement on joint water governance signed by the WMO, as a representative of the state, and the CWUU, as a representative of the community. It is suggested to make the CWUU that will be formed by representatives of state and public organizations as the governing body for the transition period of joint water governance. One of options of CWUU composition is the representation according to financial input into supporting operational activity of the CA.

The CWUC consists of 5-7 members. In the future, after transition to completely public water governance, the general meeting of water users, CWUU Council and Board will play a role of a governing body, and the canal operational administration (present CA) will execute a role of an executive body.

Water users' fees for water services of the CA are considered as water users' contribution into financing operational activity of the CA.

At the initial stage of transition period, only agricultural co-operatives within the command areas of pilot canals will be members-founders (the Union of Agricultural Producers-Water Users "Khodjabakirgansay", the Union of Water Users Associations of the AAC) i.e. other stakeholders (WUAs, conservancy agencies, public utilities etc.) are still not members of the CWUU. Therefore, at the beginning, the CWUU will consist of 5-7 members representing two Parties that sign the agreement. During the next stage of transition period, in the process of including representatives of other stakeholders into the CWUU, the composition of CWUC can be extended. A mechanism of transforming the CWUC from a "narrow" into "extended" structure of representation is envisaged in the status of CWUC. An extended structure of the CWUC is given in Figure 4.14 below.

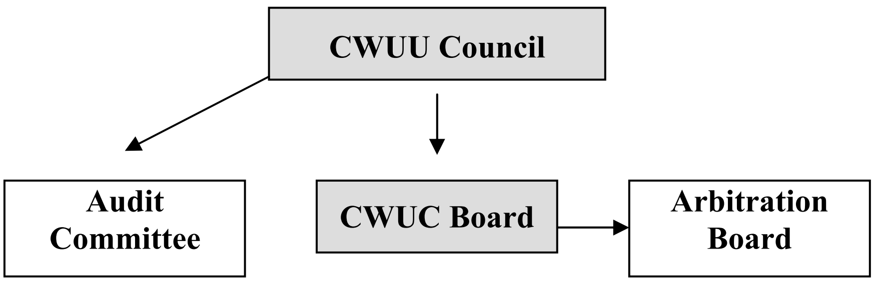



**Figure 4.14 Organizational Structure of the CWUC for the Transition Period (Joint Water Governance)**

Due to the fact that the CWUC is established based on the agreement on joint water governance signed by the WMO and CWUU, each party is budgeting funds necessary for participation of their representatives in activity of the new joint structure, if needed.

### State financing

A role of the state financial mechanism is very important under transition towards joint water governance. Most of governments do not have the appropriate legal base for allocating budget funds to non-state structures including local public organizations, NGOs or private companies. In this case, two options are possible:

1. Firstly, water users pay for irrigation water delivery to the state organization (CA) making an addition to the funds allocated by the state for covering O&M activity, running costs and development of this organization. In this case, the state bears chief responsibility for financial sustainability of the CA.
2. Secondly, joint proportional financing by water users and the state bodies provides the financial sustainability and self-financing of the CA based on a business plan. However, this business plan has to include measures ensuring frugal expense of funds allocated for O&M, strict control of water quality, seeking of cheaper water sources, holistic use of available funds and resources (including land resources that can be underused due to poor soil conditions), and saving measures based on optimization of pumped irrigation water supply.

It is clear that during the transition period, the state should keep financing the O&M organizations in an amount sufficient for supporting the due level of water management. Further state financing is exclusively a subject for negotiations between the state and a public organization, which in the future take over the water governance based on its share (equal or less than a shareholding) under keeping opportunities for state control. In this case, the following options are possible:

1. As before, the state continues to finance the CA in spite of changes in its status;
2. The state is gradually reducing financing in the period of joint water governance;
3. The state pays a certain amount into a lump sum, as an initial capital, and then is gradually reducing annual financing; and
4. Other possible options.

In any case, the project will facilitate the negotiations between parties participating in governance of the CA related to financial matters and use of other resources handed over to a new organization. Nevertheless, even if the state financing and other resources are available, it can be insufficient for achieving the full efficiency and profitability of the production process.

Therefore, for the purpose of seeking and mobilizing own funds and resources for covering running costs and development, such an organization has to be able draw up own business plans in a manner that allows to involve all possible reserves in the form of using the water protection zones, fishery etc. and simultaneously to make possible covering of credits.

The need of state participation in financing water management organizations naturally follows from impacts of irrigation and land reclamation activity on the environment and society; and social and environmental welfare depends mainly from the level of state support including financial aid. In addition, the world experience shows that, as a rule, the state finances rehabilitation of large-scale water infrastructure of irrigation and drainage systems.

## The process of transition towards joint water governance

First of all, it is envisaged to provide a necessary awareness of all stakeholders on planned reforms. In this case, we deal with three groups of stakeholders:

1. A group that participates in water governance on behalf of the community (CWUU);
2. A group that participates in water governance on behalf of the state (WMO); and
3. A group that will be governed by joint efforts of the state and community (the CA).

Water users groups should be informed: why and how reforms will be implemented and what swings and roundabouts of these reforms. These measures will be of an information-explanatory nature rather than a mobilization nature, since the decision related to transferring water governance was made earlier, and water users were informed in the course of previous campaign.

At the same time, the WMOs should be informed on objectives of reforms, procedures of implementing reforms, who and how will be involved, who and what will lose or acquire. It is also necessary to help them to make aware of possible problems, and what assistance and support they can provide to overcome them. These measures will also be of mobilization nature to prepare this group of people to some loss of their powers!

A group of people that will be governed by joint efforts of the state and community (the CA) has to be informed about their prospects, how joint governance affects their powers, rights and duties. They need also to be informed on difficulties and problems that can be faced, and how to provide the preparedness for their overcoming. Measures related to this group of people will be of an information-explanatory nature.

In the course of meeting and consultations with above groups of stakeholders, the project experts, as supervisors of this process, should collect and record all their concerns, doubts, requirements, and fears, as well as specify legal obstacles and the need in training. At the same time, it is necessary to make efforts for mitigating or neutralization of all problematic effects and, as far as possible, to include these matters into the Protocol of Intent for Transferring Governance Powers in order to attach due legal force to this process and to ensure the execution of appropriate commitments by Parties.

***The following project activity was carried out for transition towards joint governance [18]:***

*For each pilot irrigation canal the following documents were prepared:*

- *«The Concept of Joint Governance of Pilot Canal Administration's Activity»;*
- *«The Agreement on Joint Governance of Pilot Canal Administration's Activity».*
  - *The Concept and Agreement for each pilot irrigation canal were discussed at "round tables" in Bishkek, Khojent.*
  - *As a result of discussions at "round tables", the Protocols of Intent were signed by all members of the working group consisting of the representatives of Parties participating in the process of transition towards joint water governance.*
  - *The Protocols of Intent include the agreed plans and forms of transition towards joint water governance.*
  - *The CWUU (AAC, KBC, and SFC) are Party of the Agreement on behalf of the communities;*
  - *A Party of the Agreement on behalf of the state are the following organizations:*
- *In Kyrgyzstan – the BWMO,*
- *In Tajikistan - the MLR&WR of the Republic of Tajikistan,*

- *In Uzbekistan – FV MCSA.*

*- «Agreements…» were signed by Parties for all three pilot irrigation canals.*

*- The Boards of Pilot Canal Water Committees were established based on Agreements: WC AAC, WC KBC and WC SFC.*

*- The Board of AA Pilot Canal Water Committee consists of 7 members – 3 the BWMO, Director of AAC Administration and 3 representatives of the CWUU AAC.*

*- The Board of KB Pilot Canal Water Committee consists of 7 members – 1 representative of the MLR&WR, 2 representatives of SogWMO, Director of KBC Administration 3 representatives of the CWUU KBC.*

*- The Board of SF Pilot Canal Water Committee consists of 7 members – 1 representative of the FV MCSA, Director of SFC Administration, 1 representative of the BISA «Sokh-Syrdarya», representative of the BISA «Naryn-Karadarya» and 3 representatives of the CWUU SFC.*

## Challenges and Opportunities for Institutional improvements

The experience of putting the IWRM principles into practice in the frame of the IWRM-Fergana Project shows that the introduction of hydro-geographical principles and participatory approach is the very complicated process that faces many problems, but there is not another alternative if we want raising water productivity and ecological safety in the region.

Transition towards hydro-geographical principles in the frame of the IWRM-Fergana Project did not cause any objections even in Uzbekistan since this was profitable for water professionals. However, there is another situation with introducing the participatory approach. At the "grass roots" level, the public participation, as a rule, is profitable for water professionals in contrast to water officials, who are paying lip service to a leading role of water users represented by the CWUU and even making some modifications in the Charter of Canal Administration, de facto, are trying to turn the CWUU into a "pocket" obedient body. Denial in legal registration of the CWUU, as nongovernmental, self-sufficient and noncommercial body of water users with own official stamp and bank account, promotes transforming the CWUU into a body depending from the Canal Administration, but not vice-versa. In this case, denial in legal registration of the CWUU is advantageous for water officials but not for water users.

## Key challenges are following:

### *Psychological problems:*

1. Water users traditionally play a role of suppliant for water officials rather than a Client that creates agricultural output and, therefore, has the right to demand the qualitative services from water agencies. Therefore, along with strengthening a leading role of the CWUU Council and its chairperson, simultaneously the WUA representation functions in the CWUU should be also promoted;
2. According to the same causes, the WUA in the CWUU Council should be mainly represented by its chairperson; and
3. Since the Soviet period, a distrust of public organizations that took care of the needs of communities too little is kept.

***Legal problems:***

1. Here and there, an illegal practice of interference of local authorities in water allocation is being continued;
2. The law on WUAs (Uzbekistan) and the CWUU was not adopted; and
3. Procedures of formal registration of the CWUU are too complicated.

***Human resources problems***

1. Less and less of skilled water professionals are available in water management organizations, at the same time, many persons who before were never busy in irrigated farming arise among water users.

At present, the IWRM-Fergana Project's achievements have to be disseminated "geographically" and "institutionally". When we speak about disseminating the IWRM-Fergana Project's achievements "geographically", we keep in mind implementing of similar reforms on additional main irrigation canals (the North Fergana Canal and Right-Bank Canal). When we speak about disseminating the IWRM-Fergana Project's achievements "institutionally", we keep in mind introducing the IWRM principles at higher level – at the level of river basins (Akburasay, Khojabakirgansay and others), and now a new project component has started to study opportunities for introduction of IWRM in basins of small transboundary rivers.

## 4.4. Water Governance and Management at the Level of Water Users Associations

**(M.A. Pinhasov, A. Alimdjanov, H. Manthrithilake)**

In recent years, restructuring of large farms (former collective farms and state farms) has resulted in creating a whole army of small private and peasant farms, and institutional reforming of the on-farm system of water distribution becomes necessary.

In contrast to large collective farms that had own governance structure of on-farm irrigation and drainage network, under new conditions, small farms are facing problems of water distribution, repair and maintaining their irrigation and drainage systems, especially, of financing these activities.

Most of countries in the near and far abroad have faced the same problems in different time periods. To tackle these challenges the various institutional approaches were used for establishing proper on-farm water use: through the state structures; local administration, joint-stock companies and co-operative associations etc.

An institutional setup of on-farm water use in the form of water users association (WAU) is considered as the most viable of all listed institutional structures. In broad understanding, a WUA unites a group of water users and, using their financial and material resources and receiving the mandate from them, on behalf of these water users organizes O&M of their irrigation and drainage system.

Under current conditions in the irrigated farming sector in Central Asia, the following problems can be mentioned:

- Land is the state property in all countries in the region; and plots are allocated among the land users based on leasing agreements or in joint ownership. Sizes of plot and a leasing period are considerably vary over countries – from less than 0.5 ha in Kyrgyzstan up to a few hundreds of hectares in Kazakhstan;

- Legislative bases and an extent of state regulation under privatizing the agricultural sector are also quite different;
- Drastic increase in the number of water users, and a complex system of the multi-step irrigation network result in extremely unsustainable irrigation water supply, making water resources one of key factors ensuring crop yield;
- As a result, the need to improve water availability, stability of irrigation water supply and uniformity of water distribution among water users that are located at different distances from a water source;
- There is also the need to rehabilitate on-farm irrigation and drainage systems, which during last years were not properly maintained due to grave economic conditions of farms in the period of transition towards the market relations.

### Institutional problems

WUAs were established both according to the territorial approach – within the boundaries of former collective farms and state farms and according to the hydro-geographical approach i.e. establishing of WUAs within the command areas of secondary and tertiary irrigation canals (branches of a main irrigation canal). The first approach was widespread, since it allowed keeping the former system of water governance, only under a new name. Advantages of this approach are obvious: the possibilities for using common hydraulic structures, buildings, machinery in interests of a new formation without property repartition, for keeping skilled management staff, as well as good knowledge of local conditions etc. However, there is the former governance's legacy difficult for overcoming: lack of understanding the new economic conditions and inertia of administrative thinking, but the most important is the complexity of equitable and fair water delivery and distribution under strip holding of land and striped pattern of water users. The second approach enables a WUA to supply irrigation water from a single source and to use additionally internal water sources. Such an institutional set-up enables a WUA to manage available water resources in more effective manner.

The pilot WUAs established in the frame of the IWRM-Fergana Project in Uzbekistan, Tajikistan and Kyrgyzstan may be cited as examples of such an institutional set-up. For example, in Kuva District of Fergana Province in Uzbekistan, the WUA "Akbarabad" was established covering command areas of secondary irrigation canals RP-1, "Akbarabad-1," and "Akbarabad -2" that divert water from the South Fergana Canal. In this case, integrated water resources management spreads from the main canal (the SFC) through WUAs to irrigated fields inclusive.

At the same time, most of WUAs in Uzbekistan are being established according to the territorial-administrative principle i.e. based on the institutional set-up of former large collective farms. Therefore, the problems of WUAs established according to this principle are related to the need of their restructuring based on the hydro-geographical principle. The hydro-geographical principles of establishing WUAs should be stated in the Law on WUAs.

Applying appropriate procedures for transferring the secondary canals to a WUA, which prior to establishing a WUA have played a role of inter-farm irrigation canals and O&M of which were financed by the Ministry of Agriculture and Water Resources, is a quite important matter under establishing a WUA. Two options can be used for solving this issue.

***First option:*** For the five-year period after establishing a WUA i.e. for the initial period when water users strengthen their economic capacity (mainly based on water and land reclamation services that must be provided by a WUA), above water infrastructure (inter-farm irrigation canals) are handed over to a WUA on the contractual base for temporary use with annual payments for operation and maintenance of this water infrastructure.

The legislations of the Republic of Uzbekistan (Article 31 of the Law on Water and Water Use) and Tajikistan (Article 35 of the Water Code) state the possibility for transferring water infrastructure for temporary and continued operation.

***Second option:*** A state water management organization becomes one of WUA co-founders. Its contribution is water infrastructure transferred to a WUA. In addition, the WMO, as the co-founder, assumes a liability to finance operation and maintenance of water infrastructure transferred to a WUA within the normative requirements.

Selecting of any option is the prerogative of water users and key officials of the Ministries of Agriculture and Water Resources. The practice of establishing WUAs in the Fergana Valley shows that the WMO can be a co-founder, transfer water infrastructure (irrigation canals) registered in its book to WUAs, and respectively provide its maintenance.

As a result of this transferring both a WUA and the WMO are the gainers: a WUA, on the one hand, provides complete hydro-geographical coverage – the opportunity of effective water management from the secondary irrigation canals up to off-takes of water users – on the other hand, a WUA does not finance O&M of that inter-farm irrigation canal which is registered in the book of WUA. Under transferring water infrastructure to a WUA, the WMO also hands over all concerns for its maintaining and repairing to a WUA and only assists a WUA by providing special machinery in the period of large-scale operational works. A water management organization, as a co-founder, is represented by a certain number of votes at the Constituent Assembly and in the WUA Council.

**A WUA is in charge for the following**:

***I. To organize water use:***

- Drawing up a water use plan for the served area that covers farms - members of a WUA and its co-ordination with the state water management organization based on the Agreement on irrigation water supply;
- Uniform water distribution among all members of a WUA in amounts and in terms that are established in the water use plan;
- Monitoring the correctness of flow rate measurements at the gauging stations established on irrigation and drainage canals;
- Record keeping of irrigation water supply and drainage water disposal within the area served by the WUA.

***II. To organize repairing and maintenance works:***

- Drawing up a business plan;
- O&M of irrigation and drainage systems within the WUA service area; and
- Rehabilitating on-farm irrigation and drainage systems.

**III. Land reclamation services and drainage.**

**A WUA represents and defends the interests and rights of its members in mutual relations with state and public organizations, and provides economic and operational contacts with the water management organizations, on the one hand, and between water users – members and non-members of a WUA, on the other hand.**

***Certification of WUA activity*** is one of key pillars. Usually, it means receiving the authorization for executing economic, financial, legal, and production activity.

***Under establishing and operation, a WUA solves the following matters:***

- Overcoming the resistance of water users by means of conducting social mobilization and raising their awareness regarding the necessity of establishing and operation of the WUA;
- Receiving the authorization for establishing the WUA as noncommercial organization;
- Receiving the rights for crediting and taxation on preferential terms;
- Equipping the WUA's irrigation and drainage networks with water-gauging posts;
- Procedures for imposing sanctions on water management organizations, the WUA and WUA's members under infringing the rules of water use;
- Financial and moral incentives for WUA's personnel under achieving target indicators of irrigation water supply, O&M, and land reclamation practice resulting in the rise of crop productivity;
- Establishing and upgrading the material and technical basis of the WUA with assistance of water users, water management organizations, and the Government;
- Rehabilitating the hydrometric network and establishing the water record keeping in the WUA; and
- Establishing the system of differential fee for service of WUA's members those who use various waters (surface fresh water, drainage water, mixed water) and, due to this fact, who have different profitability, generated from to their agricultural activity.

**Social mobilization of water users** for WUA establishing and operation has to be organized by a group of initiators consisting of water users and representatives of water management organizations (WMOs), local authorities, environmental NGOs and, finally, mass media.

A group of initiators should disclose to water users the existing problems and opportunities for their successful solving using the capacities of WUA, as well as considerable benefits available to all stakeholders due to WUA establishing and operation.

A WUA is established as noncommercial organization exempted from taxation. As a rule, water users themselves, represented both by individual persons and legal entities, are founders of a WUA. However, the WMOs and other stakeholders also can be co-founders.

The status of WUAs as non-governmental noncommercial organizations should be stated in the Law on WUAs, and until it is absent it is necessary to include this provision into other normative and legal documents. This status allows a WUA:

- to execute its functions;
- to establish the procedures of relationships with WUA's members;
- to exclude the direct interference of governmental bodies into WUA operation activity;

WUA's relationships with water authorities are based on contractual relations. Field survey of irrigation and drainage networks conducted in the pilot WUAs under the IWRM-Fergana Project has shown that irrigation and drainage networks handed over from former owners to WUAs are insufficiently equipped with hydrometric means. This impedes equitable water allocation within WUAs, and creates opportunities for disputes and conflicts between WUAs and WMOs and between WUAs and water users.

Installation of gauging posts at off-takes into WUAs on the main irrigation canals has to be financed by the WMOs, and at off-takes into farms on secondary irrigation canals by WUAs.

**For improving WUA operation it is necessary to create incentives for its personnel, but at the beginning, find answers on the following questions**:

1. What indicators for assessing WUA personnel activity and what amounts of bonuses should be accepted for creating these incentives?
2. What financial sources can be used for creating these incentives?

***WUA personnel should be encouraged due to achievement of the following indicators:***

- Reducing unproductive water losses due to WUA personnel activity on the way from the WUA water intake to off-takes into farms of water users;
- Implementing all planned works including repairing and maintaining of irrigation and drainage network, and uniform and sustainable irrigation water delivery to WUA members both in the growing season and in the dormant season;
- Saving funds against the estimated finances under implementing the planned works;
- Improvement of soil and hydro-geological conditions within the service area, in comparing with their status in the previous period; and
- Raising productivity of major crops - cotton and grains.

***Financial sources for encouraging WUA personnel can be the following:***

- Funds of the WMOs under specific contractual relations, for example, if unproductive water losses were reduced providing water conservation;
- Funds of water users under implementing all planned measures by the WUA personnel resulting in improvement of soil and hydro-geological conditions and raising productivity of major crops - cotton and grains;

WUAs, as organizations that provide O&M of irrigation and drainage networks, should have appropriate machinery. Machinery and equipment are supplied to WUAs by different ways. In Uzbekistan, under restructuring the shirkat farms (large co-operative farms –former collective-farms) part of machinery were handed over to WUAs. **Short-term and long-term credits on preferential terms** with a “soft” interest rate (less than 5% a year) can be another source of funds for procuring machinery and equipment.

The Ministry of Agriculture and Water Resources, Ministry of Finance, National Bank, and Ministry of Justice of the Republic of Uzbekistan should elaborate the mechanism for granting such credits, specifying a guarantees and interest rates and developing the legal base (the Decree issued by the Government or another normative document).

There is one more way for procuring machinery and equipment – accumulation of funds in the emergency fund. Under conditions of sufficient accumulation of funds in this fund it is possible to procure machinery and equipment for WUAs.

WUAs can provide services of different quality to water users; for example, some water users receive surface fresh water for irrigation while others only brackish drainage water. Water users have different revenues from agricultural activity due to its specialization (some water users grow cotton while others - grains or fruits). In these cases, differentiated tariffs are used for WUA services that are agreed with WUA members. For example, the tariffs for servicing the cotton-growing or grain-growing farms amount to

Uzbek Soum 13,000 per hectare, while the tariff for servicing horticultural farms makes up Uzbek Soum 26,000 per hectare. A similar differentiation of tariffs for WUA services takes place under using surface water and drainage water.

Issues of water use are considered more or less in detail under discussing WUA's functions, and often another important function of WUAs (land reclamation services to water users) is lost sight. This activity is especially topical under conditions when, for example, in Uzbekistan, more than half of irrigated lands are salt-affected. This problem is also topical for other countries in Central Asia.

Drainage networks have different owners: farms and land reclamation agencies. At present, WUAs are servicing the on-farm drainage systems. An amount of O&M works on the on-farm drainage system, in the last analysis, depends on an area serviced and specifies a level of economic relations between WUAs and their members.

WUAs together with farmers, based on an assessment of land reclamation conditions of irrigated lands (water and salt balance of an irrigated area, groundwater table and salinity, soil salinization, water availability for irrigation and leaching operations, salts content in irrigation water, and drainage capacity) develop a set of measures related to improving irrigation practice, land reclamation operations, agricultural practice, and O&M activity, including the following:

- Drawing up the action plan of water use and allocation among water users;
- Adjusting the plan of water allocation among water users according to actual water use quotas;
- Planning works for cleaning and repairing irrigation and drainage networks;
- Scheduling winter-spring leaching operations and irrigations for replenishing soil moisture in the farms serviced by WUAs; and
- Coordinating the terms of agricultural operations and repairing works on the irrigation and drainage network.

Cleaning and repairing works on the irrigation and drainage network are planned based on the report of field inspection and surveys jointly drawn up by representatives of WUA and water users. They also together make decision on a scope of work and executors (WUA using own production capabilities or together with subcontractors etc.).

Implementing of all planned works is distributed between the WUA and water users and approved at the general meeting of the WUA. In the process of implementing the planned works, in case of some departures from the schedule, the WUA together with water users establish appropriate executors' guilt in slower execution or in an incomplete scope of works implemented. Based on results of an audit, an extent of WUA's or water users' guilt and also a size of damage are specified; and disciplinary actions are imposed.

To evaluate the serviceability of drainage system or its components and to plan necessary technical and soil-reclamation interventions, the WUA land reclamation service needs to have the following information:

- Meteorological data (rainfall, potential evaporation, moisture deficit, air temperature etc.)
- Data of field auditing of the technical state of drainage system;
- Drainage discharge and drainage water salinity;
- Amount of irrigation water supply and irrigation water salinity;
- Amount of drainage water reused for irrigation and soil leaching;
- Amount of seepage losses in irrigation canals;
- Data on soil salinization;
- Amount of irrigation water releases;

- Information on necessary land-leveling operations and retiring of agricultural land; and
- Data on crop yields.

Under establishing WUAs, different scenarios and model for restructuring the agricultural sector should be reviewed. For example, the Kyrgyz model of restructuring the agricultural sector resulted in breaking up into smaller units of large collective farms and creating numerous small private farms. As a result, there are 6 WUAs with thousands of private farms with an average size of irrigated area less than one hectare in the command area of Aravan-Akbura Canal. Under these conditions, not only water allocation but also any other services rendered to private farms, including land reclamation, inputs procurement, marketing etc, are difficult. In addition, mechanized cultivation of small plots, less than one hectare, is also quite difficult or even impossible.

In this case, it is possible to adopt the Japanese model of land use, which creates the opportunities for co-operation and keeping large-scale agricultural production under existing of many farms with small irrigated plots (less than one hectare). A core of this model is the establishing of the large cooperatives (2500 to 15,000 hectares in area) that take upon themselves all responsibilities related to O&M of agricultural infrastructure under support of the Government.

***In compliance with the contracts, the cooperatives provide to farmers:***

- Machinery and equipment necessary for all kinds of land treatment and ameliorative works (tillage, preparation of fields for basin check irrigation, installation of polyethylene baffles within basin checks, land leveling etc.);
- Extension services that provide recommendations on fertilizer application rates, use of herbicides and other agricultural chemicals, as well as information on know-how and introduction of the agricultural passports for fields and farms;
- Seeds of high quality and the most suitable for specific agricultural areas;
- Packaged fertilizers and agricultural chemicals in accordance with recommendations of extension services;
- Marketing of agricultural output: procurement, transportation and sale, including co-ordination of prices with farmers; and
- Irrigation water supply and allocation, waste water disposal, monitoring and O&M of irrigation and drainage network, since practically all the network is inter-farm network.

Farmers enter into an agreement on delivery of their output to cooperatives. Output delivered to a cooperative is evaluated according to internal prices approved by the Council of the cooperative in which the cooperative’s services are also taken into account besides a price of producer. Thus, the internal prices include both the process costs and profit of farmers, process costs and profit of the cooperative.

In its turn, the cooperative enters into contractual relations with the outside world (suppliers and customers) based on the business plan approved by the General Assembly of the cooperative and in coordination with the Council of Cooperatives, as well as takes credits from the government and private financial institutions and then repays credits. Thus, the Japanese model successfully combines personal interests of all farmers in improving of land productivity with advantages of large-scale agricultural production.

This approach seems can be successfully developed in Kyrgyzstan, under governmental support. At the same time, water users associations that were already established could be used as the basis for these cooperatives.

**What problems exist in new-established WUAs in Central Asian countries?**

Unfortunately, the legislative base for establishing and operation of WUAs exists not in all Central Asian countries. The Law on WUAs was not yet adopted in Uzbekistan and Turkmenistan. In other Central Asian countries, the Law on WUAs *makes no provisions for state support in establishing the material and technical basis of WUAs and in rehabilitating on-farm irrigation and drainage systems.*

Issues related to *granting short-term and long-term credits on the preferential terms to WUAs*, which could enable WUAs to procure necessary specialized machinery and equipment and to rehabilitate water infrastructure or to cover running costs, also were not solved.

*At present, the quite limited number of specialists having a degree is working in new-established WUAs.* For attracting such specialists to WUAs, it is necessary to provide sufficient incentives, for example, allow them to cultivate crops at plots within water protection zones along irrigation canals or develop lands earlier excluded from the irrigation schemes as unsuitable for irrigation, as well as it is possible to create a bonus fund for personnel of WUAs at the expense of deductions from farmers' incomes. In addition, it is necessary to develop the special curricula related to WUAs' activity in the educational institutions covering agricultural and water management topics, as well as to prepare the advanced course on various aspects of WUAs activity in the ICWC Provincial Training Centers.

*Not always, where there are land reclamation problems WUAs have a special ameliorative unit.* Well-organized and coordinated work of all stakeholders in the field of land reclamation (water users, Hydrogeological & Ameliorative Expedition[10], and Pumping Stations Administration[11]) depend on proper activity of this unit.

*Existing practice of water allocation at the inter-farm level does not envisage the participation of WUAs in this process, representing the interests of their members.* Provisions concerning participating WUAs in inter-farm water allocation should be entered into new legislative documents that regulate activity of water management organizations at the level of inter-farm irrigation canals (the Law "On Water and Water Use", regulations and charters of WMOs, CWUC etc.)

Most surprising is that laws "On Water" in the Kyrgyz Republic, "On Water and Water Use" in the Republic of Uzbekistan, and the Water Code in the Republic of Tajikistan do not state the liability of the WMO that inflicts losses to WUAs (WAU members) due to infringing the agreed schedules of irrigation water supply.

A WUA has to establish good relations with water management organizations regarding two aspects of its activity: i) with the Canal Administration (or the Irrigation System Administration) in the field of irrigation water delivery to farms serviced by the WUA; and ii) with Provincial Hydrogeological & Ameliorative Expedition (PHAE) in the field of rendering land reclamation services.

A plan of water use covering all necessary aspects: crop pattern, zoning of irrigated lands according to water requirements, and an efficiency factor of on-farm irrigation system should be the basis for signing the agreements between the Canal Administration (or the Irrigation System Administration) and WUAs. However, under acting the system of water use limits (quotas), amounts of water included into the plan of water use can be decreased according to a certain percent, which is stated under signing the agreement between the WUA and the WMO.

***As a rule, the Agreement between the WUA and the WMO contains the following provisions:***

- Rights and duties of contracting parties;
- Procedures for monitoring and record keeping of delivering irrigation water and services' quality;

[10] Hydrogeological & Ameliorative Expedition is the unit in the frame of the Ministry of Agriculture and Water Resources responsible mainly for monitoring irrigated land conditions, O&M of drainage systems, and leaching of salt-affected soils within the irrigated area.
[11] One of the responsibilities of this organization is O&M of drainage tubewells within the irrigated area.

- Procedures of payment for water services;
- Sanctions and penalties for infringement of agreement obligations for both parties;
- Procedures for settling conflicts and claims of contracting parties; and
- Procedures for termination or prolongation of contractual relations.

At present, there are not contractual relations between WUAs and the Hydrogeological & Ameliorative Expeditions. However, the specific character of maintaining both the inter-farm and on-farm drainage network requires their joint work in the field of drainage water disposal and land reclamation operation.

According to the agreement between WUAs and the PHAE on land reclamation services in the frame of the IWRM-Fergana Project, the following activities are recommended to implement:

***At the expense of budgetary funds, the PHAE is under an obligation to:***

- Monitor and maintain the inter-farm drainage network in operable condition, providing the design cross-sections and depths to ensure problem-free drainage water disposal beyond the irrigation area;
- Collect and analyze information on irrigated land condition and technical state of inter-farm drainage network, since this information is the basis for scheduling necessary interventions at the inter-farm and on-farm level.

In addition, the contractual relations based on specific types of services for a fee can be established between WUAs and the PHAE.

Contractual relations between WUAs and the PHAE related to land reclamation services should take into consideration:

- Rights and duties of the Client (WUAs)
- Rights and duties of the Contractor (the PHAE);
- An agreement value and procedures for mutual settlements;
- Execution of an agreement;
- Liability of Parties;
- Procedures for disputes resolution;
- An agreement period; and
- Final provisions of an agreement.

### Arrangement of water distribution among WUGs

Current reforms in the agricultural sector in Central Asia resulted in arising of new water users represented by private farms. As a result, an attitude of new water users towards issues of water distribution has considerably changed. The right to receive irrigation water in the amount specified in a plan of water use or by water use quotas (limits) is guaranteed for new water users by the state. In addition, all rights of water users and their requirements to WUAs are sustained by appropriate legislative documents, and if they will be infringed the criminal proceedings against WUAs can be instituted or administrative responsibility may be inflicted.

In point of delivering irrigation water to water users according to the irrigation schedule of crops, WUAs have to meet all normative requirements in the sustainable, equitable and well-timed manner. However, the execution of this key task is impossible without involving water users in planning and without implementation of agreed plans by water users by themselves. Moreover, undisciplined water users neither clean their irrigation network in proper time nor meet requirements of the irrigation schedule and nor manage properly water applications on their fields but, at the same time, they attempt to receive more water than envisaged in the agreed plan of water use. Additional field irrigators (mirabs) are necessary for arranging proper and effective water use in the WUGs that consist of tens and, sometimes, hundreds of water users. However, WUA personnel are limited; and WUAs are therefore unable to organize water delivery to an off-take of each water user within the GWU.

Nevertheless, WUA management has to develop, propose to water users and advocate the best options of water distribution that can be put in practice through establishing the WUGs. You can't take a laissez-faire attitude towards water distribution in the GUW, and, all the more, hope that water users themselves are able to organize water distribution within the GWU. Frequently, water users are not acquainted with a water management practice, and many of them even do not know how properly to organize a water application. In addition, stereotypes related to ill organization of water applications (protracted water applications, longer furrows etc.) and improper agricultural practice (ill-timed inter-irrigation soil treatment) are widespread among water users.

### Water users and planning water use

First of all, water users have to submit reliable information on planned crop pattern in the command area of their distribution canal for consideration of WUAs. Some water users conceal information on crops growing on row-spacing strips in orchards and about sown areas under secondary crops (after harvesting of cereal crops).

There are also some difficulties related to planning a crop pattern. As known, Uzbekistan employs the state orders on production of cotton and wheat, but some farms are engaged in horticulture or livestock farming; and owing to this situation, often an accuracy of information on a crop pattern makes up 70-80% early in the year.

Numerous armies of water users with irrigated plots over the range of 0.3 to 0.8 ha aggravate this problem in Tajikistan and Kyrgyzstan. It is necessary to keep in mind that the composition of water users is quite diverse – from teachers and physicians up to construction workers who were never busy in agricultural activity. Most of water users are the poor and cannot purchase stock seeds of different crops; and therefore in April, May, and June they sow those seeds which they were able to get.

A severe deficit of water takes place in the command area of the Khoja-Bakirgan Canal in Tajikistan in the period since March until July; and under planning a crop pattern, this important factor should be taken into consideration. However, as often happen in practice, water users, first, sow some kind of water-loving crop, and then wait for water that is not provided for in the plan of water use.

## 4.5. IWRM in Action through Establishing Effective Groups of Water Users

Land reforms in Central Asia resulted in fragmentation of agricultural lands. A great deal of new private farms arises instead of large collective farms i.e. many small water users arise on the place of one former large water user. Thus, real life demands a transition of current water governance towards more effective hydro-geographical or basin methods of economic management. In addition, the efficiency of water use under new conditions depends to a large extent on water users themselves, from the point of view of both governing water delivery and maintaining their irrigation and drainage systems (Pinkhasov et al., 2005).

Reforms in each Central Asian country have own specific character from the point of view of both their progress rates and concomitants. Nevertheless, it is possible to notice some similar problems in establishing WUAs over the whole region. First of all, WUAs were established and continue to be established mostly according to governmental directives i.e. according to a command "top-down." Therefore, water users think about WUAs not as about their own consumer association but as about a new body, which simply collects money independently of the fact that water was delivered or not. As a matter of fact, WUAs are and have to be the organizations of water users. Unfortunately, at present, because of objective and subjective reasons, a WUA, not always, can represent and defend the interests of its water users. In turn, water users, not always, understand for what a WUA is needed and its role. Therefore, there arises an institutional gap between water users and WUAs resulting in a number of problems under water distribution and distortion of IWRM principles. However, there is a solution of these problems. First of all, this is the creation of link in the form of water users groups that can effectively improve relations between water users and WUAs and facilitate the participation of water users in water distribution, WUA governance, and improving operating conditions of irrigation and drainage systems, and finally in water resources management at higher levels.

## Practical aspects of establishing water users groups (WUGs)

From time to time, water shortage arises in tail parts of the secondary and tertiary irrigation canals. In such cases, water users try to solve this problem according to the principle: "do-it-yourself". They attempt to receive water with the help of their friends-irrigators or to undertake other illegal actions. In fact, when such situations arise quite often, conflicts between water users are unavoidable; and they do not trust each other and don't understand that water is their common resource, and therefore such problems should be jointly settled. For example, the WUA "Japalak" (Osh Province, the Republic of Kyrgyzstan) unites about 5000 water users and covers a total irrigated area of 2010 ha. An average size of their plots amounts to 40 sotoks or 0.4 hectare. It is impossible to conceive what huge organizational costs will be incurred by the WUA "Japalak" if the agreement on irrigated water delivery will be signed with each water user. Moreover, equitable water distribution among all water users and effective water management become an unrealistic task for limited WUA personnel. Therefore, establishing of WUGs for effective water resources management and for facilitation of governing WUAs is proposed. Establishing of WUGs within a WUA provides the following advantages:

- Improving the water distribution process;
- On-farm irrigation canals (tertiary and lower level ) is maintain in the operational status;
- Decreasing, or eliminating at all, of conflicts between water users;
- Improving of activity of WUA, since water users themselves become responsible for the operational status of on-farm irrigation network;
- Water users control the process of water distribution;
- A confidence among water users is strengthened;
- Water users specify the rules for water distribution that are understandable and adapted to local conditions;
- Decisions are jointly and democratically made;
- A leader selected by a WUG can represent their interests in a WUA through its Council or General Meeting; and
- Issues of agricultural practice (pest control, tillage, land leveling, crop rotation etc.) can be collectively solved in a more effective manner.

Therefore, when there are many water users, both small and large, on tertiary and lower level canals, water distribution should be established in such a manner that can satisfy everybody. This is possible only following the principles of fairness and co-operation.

An establishment of water users groups (WUGs), which will directly participate in water management and distribution, is the best solution of water distribution problem. At the same time, WUGs can act on a voluntary basis as a community unit without a formal registration. It is necessary to note that there are problem-free canals regarding water distribution. There, water users have developed own rules and entrust water distribution to experienced irrigators (mirabs) and foremen respected by local inhabitants. On such sites, WUGs are not necessary because they can complicate, and even frustrate, existing procedures of water distribution.

## The process of establishing water users groups (WUGs)

A social mobilization is a series of measures that creates the public platform based on the mutual dialogue when each subsequent action depends on results of previous one. Achieved results are studied and taken into consideration under developing next actions in the form of appropriate adjustments [26]. First of all, a chief of WUA should be interested in establishing WUGs. To establish effective WUGs, this chief has to have leadership qualities because he/she should explain advantages of WUGs to people and persuade them to create water users groups. In other words, the chief of WUA will play a role of initiator and facilitator of this process. If the chief of WUA has not sufficient time for this activity he/she can hire employees who after appropriate instruction and training regarding the approaches of establishing WUGs based on hydro-geographical principles will be able to implement this mission. In particular, farmer, who has leadership qualities, a respected aksakal (elder) or person who knows local conditions and has ability for persuasion can become such a facilitator. There is not the need at all to attract water professionals for activity as social facilitators. Above all, such persons should have knowledge of agriculture and desire to work properly. Two or three persons are enough to form a mobile group that could implement the required information-preparatory works and create the enabling environment for initiatives of water users in establishing own WUG. Such an activity consists in a series of steps necessary for creating required conditions.

**The first step**: to specify problematic areas for establishing WUGs within the WUA territory. Activity should be started in those areas where water users conflict each other especially frequently in the course of water distribution. When a facilitator is not acquainted with local conditions a schematic map of the area serviced by the WUA for developing an action plan of establishing WUGs needs to be plotted with assistance of a chief or specialists of the WUA. Irrigation canals and off-takes where water shortage and conflicts between water users take place should be pointed on this map. As a rule, WUGs are established on tertiary canals.

**The second step:** field inspection of target canals and off-takes in the area selected for establishing WUGs. During the field inspection the following aspects should be carefully surveyed: i) the technical state of off-takes (as well as availability of a design water intake or "do-it-himself" structure, or absence of any structure), ii) a situation around off-takes including a layout of fields, crop pattern, and conditions of irrigation canal's channel (for example, erosion of side-slopes, overgrowing with aquatic and semi-aquatic plants, steep gradients etc.). It is preferable to conduct field inspections during water applications and critical periods for water distribution. In the course of field inspections, a facilitator will pass through those sites, where farmers, rural wage earners or tenants are working, meeting with local inhabitants to discuss relevant issues. As far as possible, he should represent himself and get to know local direct or indirect water users. This can be useful under discussing the matters of establishing WUGs with water users and for creating confidential relations.

**The third step**: initial meetings with water users and identification of active leaders. In the course of field inspections, a facilitator meets with water users and explains to them the objectives of establishing WUGs. He/she asks them about existing problems and their reasons (conflicts related to water distribution, water shortage, interference of water management organizations etc.). A facilitator should get to know water users' opinions about their WUA, the extent of their acquaintance with specialists of the WUA, and their proposals for how to settle existing problems. At the same time, it is necessary to ask them how neighbor water users solved similar problems. If a facilitator feels a lack of interest in this discussion he has to ask with whom else these issues can be discussed or who can be recommended as the most active and competent water user. People being interested in improving a water management practice or experienced farmers who rationally use their water resources and receive good crop yields can be always found among water users. Any water user can point out them. After a few meeting, a facilitator can decide who may be included into a so-called group of initiators. WUA specialists, community leaders (aksakals of local communities, chiefs of local administrations etc.) can be also included into this group. The group of initiators has to organize the meetings of water users united by one off-take.

**The fourth step:** the meeting with all water users. This meeting should be held on date and in place suitable for water users. A facilitator himself can hold this meeting, but it is advisable to attract additional assistants from among other facilitators or local activists and farmers-leaders specified during preliminary acquaintance. Why? Because somebody has to govern the meeting; and it is preferable to select for this role a respected local inhabitant or water user who is a good public speaker. At the same time, somebody should record all the most important details of the discussion. It is necessary to use small school blackboards (if available) or big paper sheets to record and demonstrate key general decisions and proposals of water users. First of all, water users have to tell about actual water distribution related to their off-takes and technical state of irrigation and drainage networks, as well as relations between agricultural water users and other consumers. After specifying the existing problems related to water distribution (all this information should be recorded and demonstrated on small school blackboards or big paper sheets), it is necessary to ask water users what ways do they see to solve these problems? Those proposals which coincide with the concept of WUGs, as well as similar opinions presented by different participants of this meeting, have to be recorded and demonstrated on school blackboards or paper sheets for all. During the meeting, it is easy to specify the most active water users as the potential leaders of WUGs; at the same time, water users can inform on their lessons learnt from solving the problems, and a facilitator, based on this information, should only link them with the idea of establishing WUGs and then gradually come towards the targets of a WUG. At that, a facilitator has to tell about advantages, objectives and the need in establishing WUGs. In the course of his presentation of WUGs' objectives, experienced farmers can exemplify their approaches for improving crop productivity based on rational irrigation. At the end of the meeting, it is necessary to specify a date of the next meeting for setting up WUGs and selecting their leaders.

**The fifth step:** the meeting for establishing a WUG. This meeting should be held according to agreements reached at the previous meeting. WUA specialists needed to be invited to this meeting in order to learn the experience of establishing WUGs and in the future to be able to establish WUGs on another irrigation module.

During the meeting, the active participants should have an opportunity to tell about their lessons and to confirm the possibility to provide high and sustainable crop yields under effective use of irrigation water. Experienced farmers can give examples of positive effects of applying an optimal irrigation schedule, stressing that both water deficit and over-irrigation are harmful for crops. Participants of the meeting should also mention water management problems, and how they can be solved based on activity of WUGs. A decision on establishing WUGs and electing its leader from among active water users is made based on the findings of discussion. It is not obligatory that a leader of the WUG should be an irrigator, former foreman or experienced farmer, but he/she has to be a respected person among water users and community people. He/she must have leadership qualities in order to organize water users for joint actions to solve common issues - maintaining their off-take in operating conditions and ensuring equitable water distribution. Water users can also discuss the matter of provision of incentives for a WUG leader. Figure 4.15 shows the dynamics of establishing WUGs on the pilot irrigation canals where more than 40% of WUGs were established based on the community initiative under participating water users.

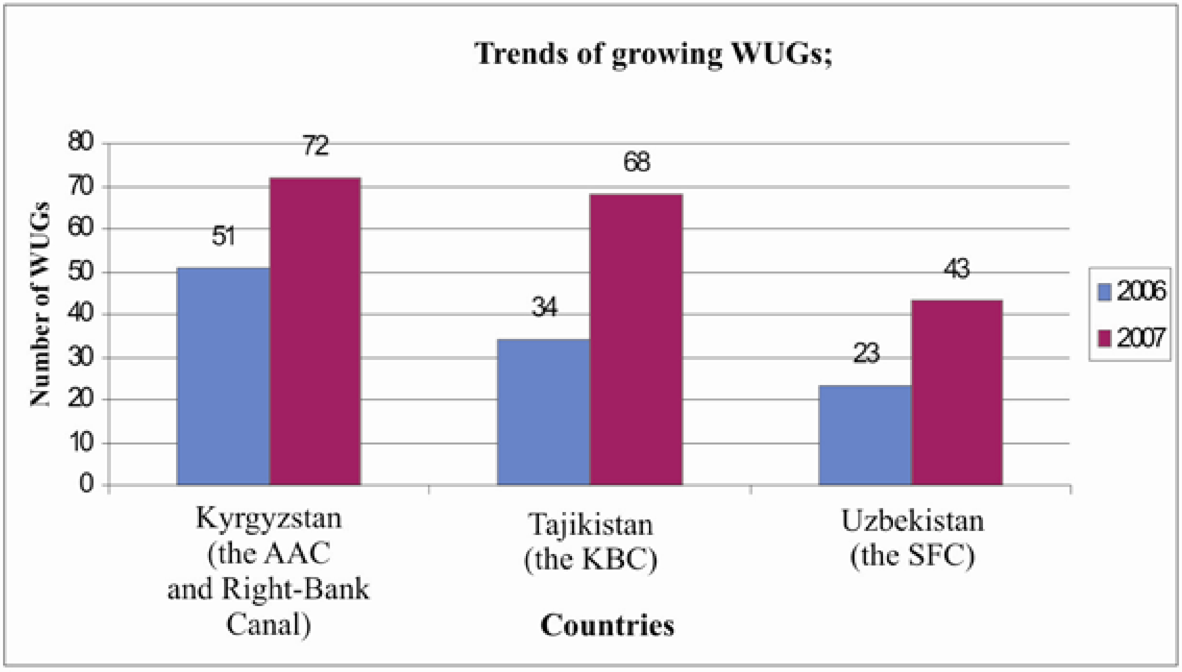



**Figure 4.15 Trends of Establishing WUGs on Pilot Canals**

***A Water Users Group can tackle the following issues:***

- Timely water diversion in the head of their lateral (both on tertiary canals and lower level canals where farmers have small irrigated plots and on secondary canals where there are mainly large water users);
- Distribution of water diverted among water users based on the principles of fairness and publicity;
- Collection of information on their lateral to facilitate activity the Water Users Association under drafting the water use plans;
- Involvement of all water users in the water management process including collective works aimed at cleaning and repairing their laterals, as well as regulators;
- If necessary, drawing up of an agreement between the WUG and WUA covering irrigation water supply;
- Problem-solving of agricultural practice and water allocation jointly;
- Collection of applications for irrigation water supply (for their lateral) and submitting an aggregated application to the WUA Administration;
- Close co-operation with WUA specialists, participation at the meetings held by the WUA, business contacts with their representatives in the WUA Council to discuss current problems on their laterals;
- Drafting the water rotation schedule under active participation and close co-operation of all water users, as well as providing transparency of planning and implementing the schedule based on the participatory approach; and
- Assistance to a WUA in collecting of fees for water services from own water users.

### Participation of WUGs in the process of water governance in the frame of the WUA

A top priority task for WUA specialists is water allocation at the tertiary and lower level of irrigation canals. Water users needed to be involved in water distribution on these canals through establishing WUGs.

When water users have small irrigated plots, it is rational to transfer their powers related to water distribution to WUG leaders (based on the general authority or the written agreement of water users located on this lateral) [27]. In addition, this simplifies signing the agreement on irrigation water supply between the WUA and water users, since such agreements will be signed with authorized leaders, who enjoy water users' confidence within the group, rather than with individual water users.

Thus, a leader who, on behalf of water users, participates in the processes of water resources planning, management and distribution at the level of WUA, its administration, Council, and general meeting is elected in each WUG. Water users, by the democratic way and according to their own free will, transfer their powers for representing their interest in water management. At that, a WUG leader will be responsible for collection of information required for drawing up the plans of water use (crop patterns and areas under crops in the command area of a lateral, its technical state, including data on an efficiency factor), as well as collection, aggregating, and submitting of applications on behalf of water users, drafting and implementing the schedules of water distribution and rotation, and signing the agreement on irrigation water supply with a WUA.

During the growing season, a WUG leader collects applications of own water users and, after their generalization, submits the aggregated application to the WUA Administration. WUA specialists, based on the aggregated application from a WUG, revise own plan of water use. A WUG leader, based on collected applications and consent of all water users, drafts the water distribution schedule for their lateral.

Thus, the WUA (its irrigators) delivers water up to the head of tertiary canals i.e. to the border of a certain WUG. Then, within the WUG, its leader distributes water according to the schedule agreed by all appropriate water users.

### Supporting the initiatives of water users groups

The IWRM-Fergana Project has supported WUG initiatives related to the construction of hydrometric posts at the most problematic sites, promoting their participation in water resources management at the WUA level. Key indicators of selecting sites for construction of hydrometric posts were the following: activeness of water users, existence of established WUG, and close relations between the WUG and WUA. For this purpose, the project procured construction materials (cement and metalwares); however, most of costs were covered by WUGs in the form of labor force and local construction materials (sand, rocks). A Working Commission consisting of water users has selected 20 WUGs (10 on the KBC and 10 on the AAC), using transparent and fair procedures and based on the criteria that meet the requirements of water users. The chief achievements were the following: an increased will of the WUAs to mobilize own financial and labor resources for step-by-step rehabilitation of water infrastructure; enhanced role, prestige, and confidence to WUA among water users; intensification of social mobilization; enhanced management responsiveness; intention of WUAs to establish new WUGs on the problematic sites; and, finally, improving of water distribution.

## 4.6. A Role of Drainage Infrastructure in the Frame of IWRM

**(V.A Dukhovny, H.I Yakubov, P.D Umarov)**

The Turan lowland where major irrigation schemes of Central Asia are located is a zone of intensive mobilization and accumulation of salts due to arid climate and geomorphology, as well as hydro-geological conditions formed under the influence of natural hydrostatic head of ground waters.

Intensive water management development during the second half of 20th century was accompanied by the considerable expansion of irrigated areas and large-scale construction of drainage systems. At the beginning, the network of main collector-drains was constructed; and after that, constructing of the systems of open and subsurface drainage, drainage tubewells, and horizontal drainage with booster-wells were developed. At that, most of new-developed lands were characterized by prevalence of saline soils or soils subjected to salinization.

At present, it is necessary to keep and maintain the drainage network, and to develop additional drainage infrastructure in some places, as well as to create an appropriate system of drainage management as a part of integrated water resources management.

In the arid zone, land drainage plays an enormous role as a tool to remove excess surface and subsurface water from the land and to manage of groundwater levels, creating the normal conditions for maintenance of buildings and irrigation structures, for implementing of agricultural operations and crop growth. At that, land drainage prevents the accumulation of salts in the root zone that can adversely affect crop growth and at the same time, creates the conditions for optimal management of soil moisture and groundwater within irrigation schemes as a whole. The fact is that large-scale irrigation causes the mobilization of millions of tons of salts; and proper tools are necessary in order to manage these processes and to support the ecological equilibrium of landscapes and water bodies, especially in lower reaches of the rivers.

Scientifically grounded selection of drainage parameters at the stage of designing allows minimizing the salts exchange between an aeration zone and groundwater due to capillary rise and upwards movement of soluble salts, as well as between irrigated lands and drainage water sinks (local depressions, rivers, wetlands etc.). It is very important to understand that excessive drainage results in not only removal of harmful salts from soils but also useful salts (gypsum) and nutrients, causing damage on soil texture and fertility. Therefore, the optimal water and salt regime in the root zone under minimum water exchange between the aeration zone and groundwater is a tool for maintaining irrigated land fertility.

However, it is not sufficient only to build a drainage system with optimal parameters because it is also important to establish a well-grounded system of joint management of drainage and irrigation in such a way, which can provide minimal salts mobilization and minimum salts exchange between irrigated lands and surface water streams. At present, in Central Asia, under conditions of transition towards the market economy, organizing of proper drainage management faces considerable difficulties due to the following causes:

- Abrupt decrease in the scope of work related to construction and rehabilitation of drainage systems, when drainage infrastructure continues deteriorating;
- A lack of funds for timely repairing, maintaining and developing drainage infrastructure;
- Fragmentation of management and maintenance of drainage systems, especially in transboundary river basins and under arising of thousands of new land and water users; and
- Collapsing the technical base of former organizations responsible for land reclamation; and insufficient efforts for establishing a new institutional framework for drainage management.

### 4.6.1. Developing Drainage Infrastructure in the Aral Sea Basin: the Past and Present

Intensive development of irrigation in the 20th century, especially, in its second half, including developing virgin lands in Golodnaya, Karshi, Jizak, and Sherabad steppes, in the command areas of Karakum and Kyzylkum irrigation canals, in Central Fergana, in the Asht Irrigation Scheme in Tajikistan made drainage issues especially topical in the region. Irrigation systems turned into irrigation and drainage systems that are the integrated ameliorative systems of irrigation and drainage, which only jointly allow to create conditions for sustainable agricultural production and to maintain land fertility. The rates of constructing these systems were really unique – up to 60,000 ha/year.

As a result of these works, by the beginning of the 1990s, 200,000 km of drainage networks were constructed, including 45,000 of inter-farm and main collector-drains, 155,000 km of on-farm drainage network (including 48,600 km of subsurface field drains), as well as 7,762 drainage tubewells covering the area of 836,600 ha. An area serviced by the horizontal drainage amounts to 4,750,860 ha.

However, if prior to 1990, the rates of constructing the drainage systems were really great, since 1990 they were practically suspended (Fig. 4.16).

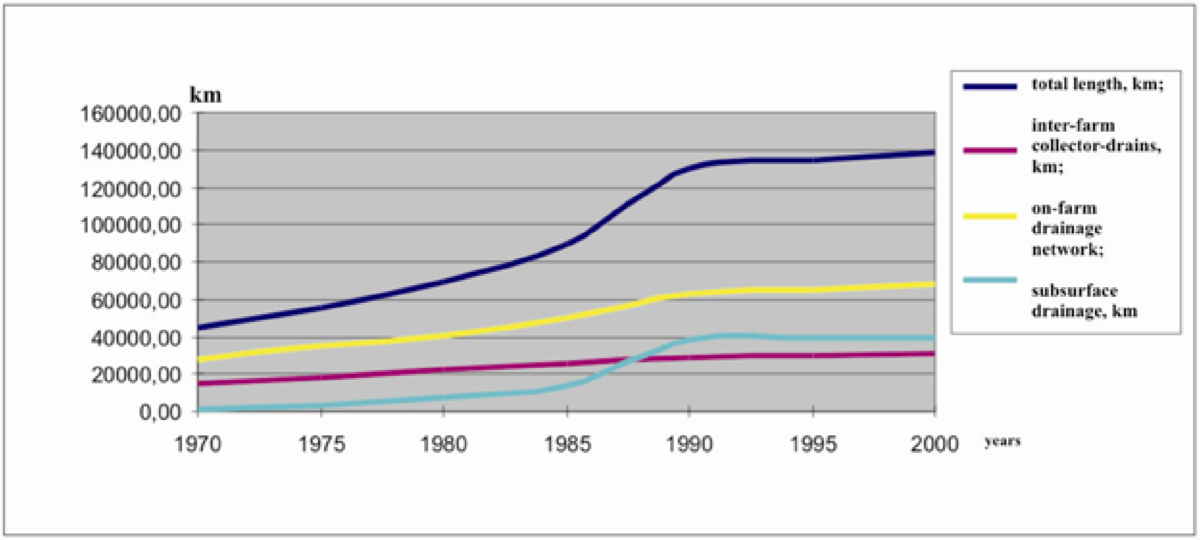



**Figure 4.16 Trends of Drainage Development in Central Asia**

At the same time, most of areas artificially drained are located in Uzbekistan where the advanced types of land drainage were introduced: subsurface field drains and drainage tubewells with the serviced areas of 550,000 ha and 450,000 ha respectively. Taking into consideration availability of drainage facilities, including the systems of drainage tubewells, per one hectare, irrigated lands in Kazakhstan, Tajikistan, and Uzbekistan can be classified as sufficiently man-made drained. In Turkmenistan, where a specific length of drainage makes up 14.7 m/ha, the irrigated lands can be referred to the category of insufficiently man-made drained. At that, irrigated lands of this country are located in the zone with more complicated hydro-geological and soil conditions.

At the same time, irrigated areas serviced by drainage tubewells (in 2000, this area amounted to 380,400 ha against 450,000 ha in 1990) have quite reduced during last years due to closedown of some tubewells.

Prior to 1991, in all Central Asian countries, main collector-drains, inter-farm collector-drains, drainage tubewells and partly subsurface drainage were on balance (in the books) of the state and were maintained by specialized organizations of the Republican Ministries of Land Reclamation and Water Resources, but on-farm open drainage network and most of subsurface drains were transferred from the books of the state to farms.

Therefore, the inter-farm collector-drains, drainage tubewells and part of subsurface drains were maintained by the Provincial Hydro-Geological & Ameliorative Expeditions or other specialized organizations such as National Drainage Network Administrations financed by the states. On-farm drainage systems were maintained by the farms using own funds.

Owing to economic weakening the water sector and transition of the agricultural sector towards market relations, the state water management organizations don't pay due attention to O&M of the inter-farm drainage systems; at the same time, on-farm drainage network of former collective farms and state farms is not maintained at all. As a result of funds shortage, the scopes of rehabilitation works, cleaning of collector-drains, and repairing and flushing of field drains were abrupt reduced resulting in the catastrophic technical state of drainage systems. Dynamics of two integrated indicators (a readiness factor and costs per unit) shows that consequences are the most adverse for the subsurface drainage systems and on-farm open drains (Table 4.5).

**Table 4.5. Assessment of Horizontal Drainage Status in Uzbekistan**

| Type | Parameters | Prior to 1990 | 1995 | 2000 |
|---|---|---|---|---|
| Inter-farm open drainage network | Readiness factor | 0.88 | 0.83 | 0.71 |
| | Costs, USD/ha | 5.4 | 2.64 | 2.86 |
| On-farm open drainage network | Readiness factor | 0.86 | 0.80 | 0.70 |
| | Costs, USD/ha | 7.1 | 2.7 | 3.0 |
| Subsurface drainage | Readiness factor | 0.89 | 0.78 | 0.63 |
| | Costs, USD/ha | 7.8 | 2.6 | 2.1 |

Much worse situation is observed for drainage tubewells, operation and maintain of which became extremely expensive and unprofitable under new conditions of transition towards the market (Table 4.6).

**Table 4.6. Operational Indicators of Tubewell Drainage in the Republic of Uzbekistan (over the period of 1970 to 2002)**

| Indicator | Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2002 |
| Total number of drainage tubewells, pcs | 543 | 939 | 1952 | 3137 | 4239 | 3908 | 3530 (2700)* |
| Drained area, 000' ha | 174.45 | 198.65 | 310.62 | 406.83 | 447.51 | 447.86 | 380.4 |
| Mean Annual OEC | 0.47 | 0.67 | 0.64 | 0.58 | 0.57 | 0.33 | 0.24 |
| Pumping-out, mln. $m^3$ | 568.01 | 1116.84 | 1577.47 | 2048.4 | 2203.35 | 810.2 | 925.18 |

Such a situation has resulted in abrupt deteriorating agricultural land conditions during last decade. The irrigated areas with a depth of groundwater table less than 2 m have increased on 21% in the Amu Darya basin and on 65% in the Syr Darya basin. At the same time, the areas with heavy and medium saline soils have increased on 57% and 78% in the basins of Amu Darya River and Syr Darya River respectively. Droughts observed during last decade also contributed to the intensification of soil salinization since water resources were insufficient for implementing proper leaching operations.

Thus, desalinization of soils within the irrigated schemes, which took place prior to 1990, gave way to salts accumulation gradually causing complete soil degradation.

In spite of their efficiency and capacity to provide conditions for establishing optimal water and salt regime of soils on irrigated lands and for reducing total production costs per unit of yield, advanced types of drainage systems (subsurface drainage, drainage tubewells, and horizontal drainage with booster-wells) were rather expensive and required due quality of O&M, permanent monitoring of land condition and water consumption.

Disintegration of the USSR was accompanied by destruction of all customary O&M norms and rules for the drainage systems; by economic and institutional weakening the water and agricultural sectors and decreasing the state economic potential as a whole. As a result, the rates of reconstruction and developing the drainage systems have reduced practically up to zero; O&M costs were decreased in a few times, and the capacity of land reclamation services has lowered in such degree that it resulted in soil salinization, waterlogging and loss of productivity of irrigated lands. Most surprising is that, when only 30-50% of drainage systems are operable, “cancerous tumor” of salinization did not affect all irrigation lands, although some similar processes are observed. Of course, in the past, under designing the drainage systems, some aspects such as additional drainage capacity of open collector-drains, introduction of water saving technologies, and methods of more rapid desalinization of saline soils were taken into consideration insufficiently. Moreover, excessive drainage capacity was accepted in the design and predictive estimates of drainage facilities density in order to provide more rapid rates of soil desalinization, not considering possible water deficit in the future.

Due to such a reserve capacity, if normal O&M will be provided the existing drainage systems in Central Asia can meet the requirements of management of water and salt balance on irrigated lands in most of regions under providing proper water delivery for leaching operations, excluding the irrigation schemes where drainage capacities are evidently insufficient. At present, practically in all regions of Central Asia, the technical state of existing drainage systems does not meet the requirements of ecological and land reclamation management.

Total economic losses related to soil salinization amount to US$ 354 million in the Amu Darya River basin and US$ 254 million in the Syr Darya River basin [6].

### 4.6.2. A Role of Drainage in IWRM

One of the IWRM components in the water sector in the arid zone is the integration of irrigation and drainage, i.e. consideration of their two-way influence aimed at effective use of water and land resources. In other words, the integration of water and land resources is provided by means of joint management of the water and salt regimes of irrigated lands using the tools of drainage and irrigation.

Irrigated lands can be represented as biologically active “living organism” with its inherent productivity, in which irrigation canals and other components (distributed ditches, irrigated furrows) play a role of “arteries and arterial capillaries,” and drains and collector-drains play a role of “venous capillaries and veins.” External surface of this “living organism” - soils play a role of a skin that absorbs solar radiation and is subjected to climatic changes, but, at the same time, soils are a generator of biological life of plants, supplying to them not only water but also nutrients (fertilizers) through “arterial capillaries.”

If to consider land productivity in its dynamics (Figure 4.17) it is possible to see opportunities for its raising and also lowering.

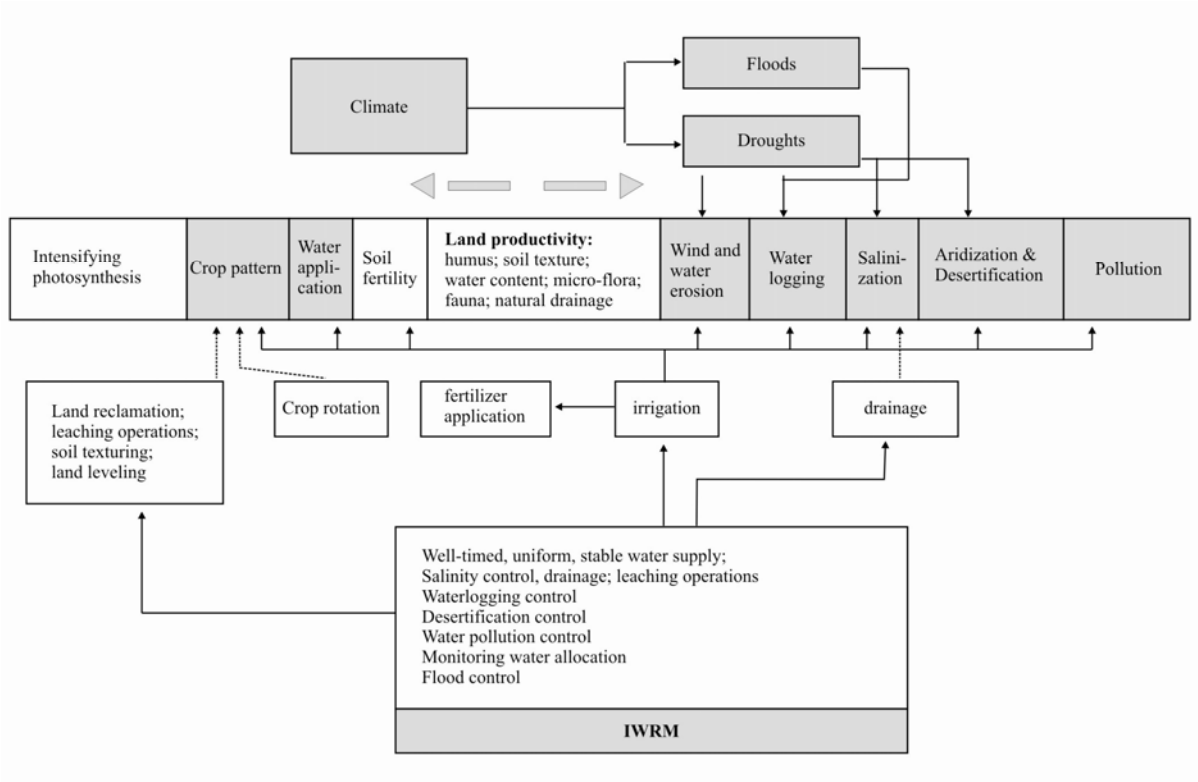



**Figure 4.17 Irrigated Land Productivity Factors and IWRM**

Key factors that predetermine irrigated land productivity are the following: i) fertilizers including organic manure; ii) maintaining the optimal water regime of soils; iii) structure-forming of soils and keeping of their aggregated structure; and iv) intensification of photosynthesis by means of mulching and other agro-technical measures. On the other hand, lowering of irrigated land productivity can be caused by water erosion, wind erosion, waterlogging, salinization, desertification, and soil pollution.

Thus, factors that predetermine productivity of irrigated lands related to proper management of land reclamation activity, which is the combination of irrigation, drainage, agro-technical improvements, and fertilizer application. In exactly the same way, a decrease in productivity is the consequence of improper management of irrigation and drainage. A correct combination of drainage and irrigation depends on:

- Sustainable and equitable irrigation water supply in sufficient amounts;
- Prevention of waterlogging and salts accumulation in the root zone based on sustainable operation of the drainage system and employing of irrigation with the leaching fraction and leaching operations;
- Prevention of desertification by means of establishing the required water regime using specific methods of wetting, keeping natural soil moisture, accumulating rainfall, and planting drought-resisting trees and bushes;
- Prohibiting pollution of land and water resources;
- Monitoring water distribution; and
- Flood control and prevention.

From this point of view, confunction of drainage and irrigation should be accompanied by such land reclamation measures as deep ripping (up to 1.5 m), improving soil texture applying special amendments (as well as addition of sand to heavy (clayey) soils or clay to sandy soils), and recurrent land leveling.

The joint operation of irrigation and drainage is also important in the light of the following aspect: use of brackish water from collector-drains and drainage tubewells (as one of components of IWRM, which envisages joint usage of all available waters: surface water, ground water, and return water) is possible only when there is sufficient artificial drainage on irrigated lands and, at the same time, irrigation with the leaching fraction is employed. Under considering interaction of soil and plants, upward and downward depth-variation water fluxes controlled by irrigation and drainage, it is necessary to link them with spatial changes resulting from horizontal water fluxes in soil and subsoil depending on a mutual layout of field drains and plots under irrigation. Cascade-located irrigation schemes, which intensively interact with each other, can be a special example.

Apart from three dimensions of interaction of drainage and irrigation (over area, depth, and volume), it is necessary to keep in mind one more dimension – time i.e. in the frame of IWRM an aging of drainage infrastructure and the need of its rehabilitation needed to be considered. The most complicated issue of managing the drainage aspect in the frame of IWRM is the implementation of monitoring and repairing of the drainage systems, since the possibility of meeting the water requirements of crops depends on the sustainability of drainage and irrigation.

Thus, integrating of irrigation and drainage for rational water use and water saving should be based on:

- Science-based selection of design parameters of irrigation and drainage, and their integrating over area, depth and time;
- Correct layout of irrigation furrows and field drains preventing uneven joint effects; and
- Sustainable irrigation water supply that meets the requirements of irrigation with leaching fraction and drainage according to design parameters based on proper management and maintenance of inter-farm and on-farm irrigation and drainage networks.

### 4.6.3. Selecting the Drainage Parameters and Their Correlation with Irrigation Practice

A role of land drainage in arid regions considerably differs from its role in humid regions. If the latter has to control only waterlogging and surface flooding of the farming lands, drainage in arid and semi-arid regions executes two additional important functions. The first function that is well-known and described in western scientific publications [59, 60] is salinity control and creation of conditions for irrigation without leaching fraction. At the same time, the second function is typical only for water-deficit regions and consists in providing the optimal water and salt regime of soils. This function was studied and widely described in the publications of Soviet scientists [62, 63], but, in our view, it was to some extent ignored by foreign scholars. As known, high evaporation and insufficient natural drainage resulting in rising groundwater table under irrigation and accumulation of soluble salts in the aeration zone are typical features for arid regions. The amount of salts being accumulated within the rootzone and a rate of soil salinization depend on a salt content in groundwater and the intensity of capillary upward flux that, in turn, depends on soil properties, depth of watertable, and soil water gradient. A key indicator of drainage efficiency is the ability of drainage systems to keep groundwater table at a design active depth that is specified by such design parameters as a depth of field drain, design of drain pipeline (a pipe diameter, envelop thickness and materials, and drain gradient), and drain spacing. All these parameters should be considered in relation to their areal layout in a field.

Designing the drainage systems for arid conditions taking into consideration the water-saving aspect and controlling removal of soluble salts, preventing salts accumulation with simultaneous keeping of useful nutrients in soils is based on selecting of the optimal land reclamation regime [6, 63]. This problem is considered in many scientific publications. A kernel of this approach can be briefly described as the search of an optimal ratio of average-weighted watertable over area and maximum capillary height under considering different values of groundwater salinity (Table 4.7).

Figure 4.18 shows that minimizing of salts removal and water consumption per unit volume of salts removed [6] corresponds to optimal costs (reduced costs per one hectare). A correlations between the optimal salt and water regime and cotton yields (Fig. 4.19) that are plotted based on data collected at six pilot stations of the SOUZNIKHI[12] and represented in the same publication shows that sustainable and maximum cotton yields are observed under the optimal water and salt regime of soils.

**Table 4.7. Correlation of Groundwater Salinity and a Relative Depth of Groundwater Table under the Optimal Soil Water and Salt Regime**

| Groundwater salinity | $\frac{H_{mgs}}{h_c}$ | Salt removal, t/ha |
|---|---|---|
| 1 g/l | 0.5 | 1-2 |
| 2-3 g/l | 0.6 | 3-7 |
| 5-7 g/l | 0.9 | 5-10 |
| >10-15 g/l | 1.2 | 10-15 |

were: $h_c$ is a maximum capillary height;

$H_{mgs}$ is a mean GWT over a growing season.

1: M = 1 g/l;
2: M = 2 g/l;
3: M = 3 g/l;
4: M = 5 - 7 g/l;
6: M = > 10 - 15 g/l.

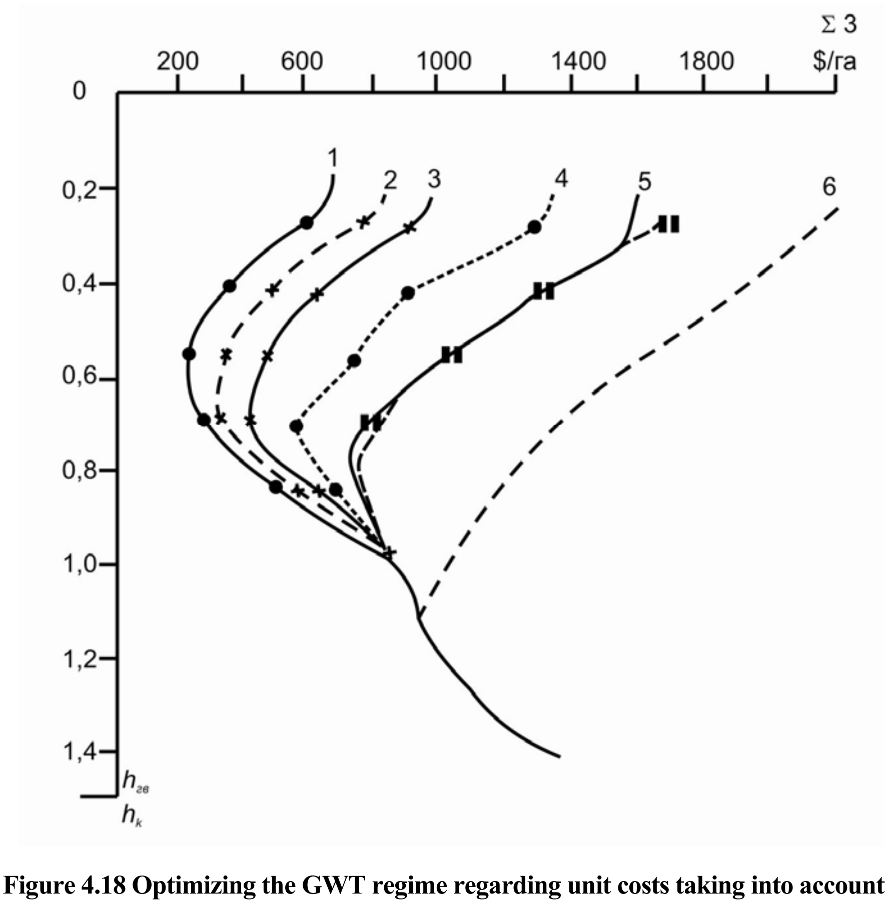



**Figure 4.18 Optimizing the GWT regime regarding unit costs taking into account water consumption and crop yield:**

[12] Scientific-Research Institute of Cotton Growing

**Regimes of soil formation:**

I – hydromorphic;
II – semi-hydromorphic;
III – semi-automorphic;
IV – automorphic.

**Pilot Site of SOUZNIKHI:**

1 – Pakhta-Aral;
2 – Bukhara;
3 – Golodnaya Steppe;
4 –Fedchenko;
5 – Akkawak;
6 – Khorezm.

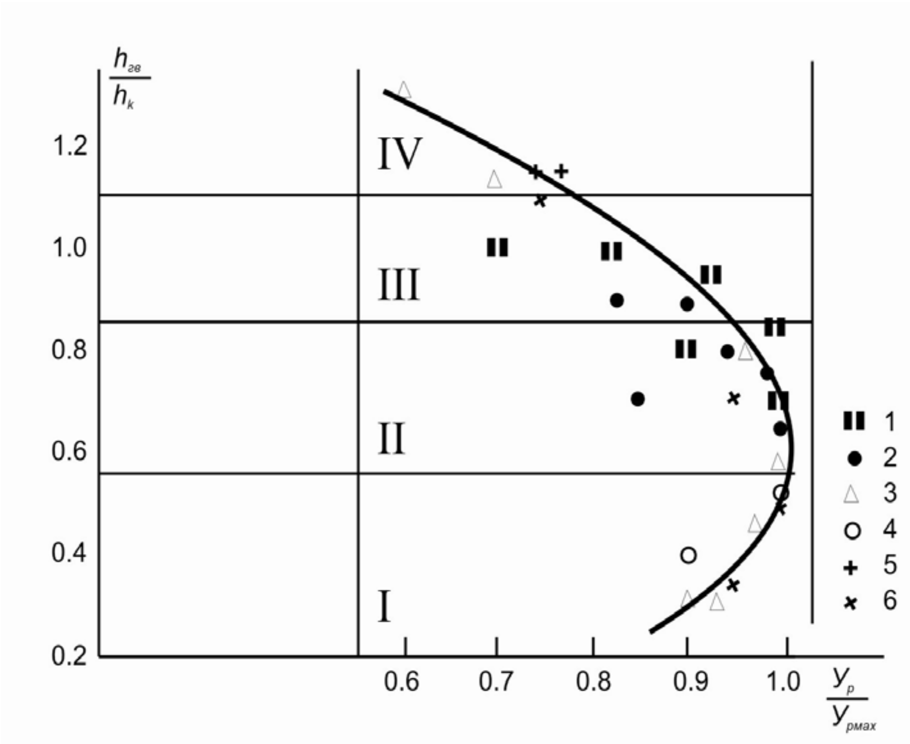



**Figure 4.19 Impact of Relative GWT and the Hydro-Ameliorative Regime on Cotton Yield**

Without considering other factors, a maximum crop yield corresponds to values of a relative GWT (a ration of an average depth of GWT over the growing season to a capillary height) ranging from 0.5 to 0.75. However, an optimal depth of GWT also depends on groundwater salinity.

A hydraulic head midway between real drains differs from a hydraulic head midway between ideal drains by the entrance head losses that depend on sizes and materials of the envelop, pipe parameters, construction method and by the extra head loss caused by the radial flow when a pipe drains do not reach the impervious layer and the flow lines converge towards drains, as well as an underground water head, if necessary, should be also taken into consideration. Due to the above factors, an actual hydraulic head midway between real drains can be less by 30 to 100 cm. In case of leaching operations or check irrigation, when discharge of drains is abruptly increasing, a so-called “effective drainage depth” can be decreased as well.

It is necessary to keep in mind that the design scheme of subsurface drainage (various design formulas used in our and foreign practice) considers a drain spacing for one specific transverse fragment that is perpendicular to the drain pipeline rather than for an irrigated field as a whole. For assessing the actual situation on the irrigated field some additional transverse fragments have to be considered, and then to evaluate a mean depth of groundwater table over the whole field. However, even under such an approach, it is additionally necessary to take into consideration the influence of deep collector-drain causing the specific drawdown curve in the direction along subsurface drains (Figure 4.20).

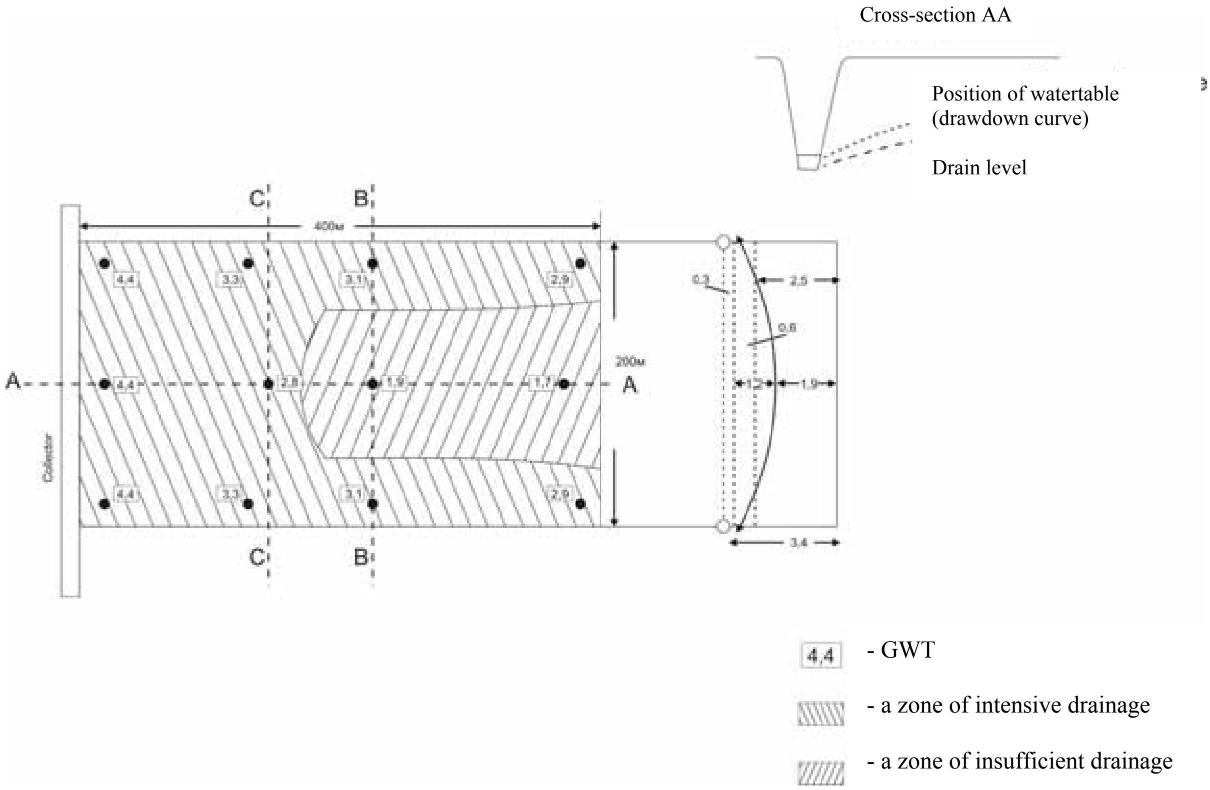



**Figure 4.20 Forming GWT on Good-Leveled Fields with Well-Designed Drainage System**

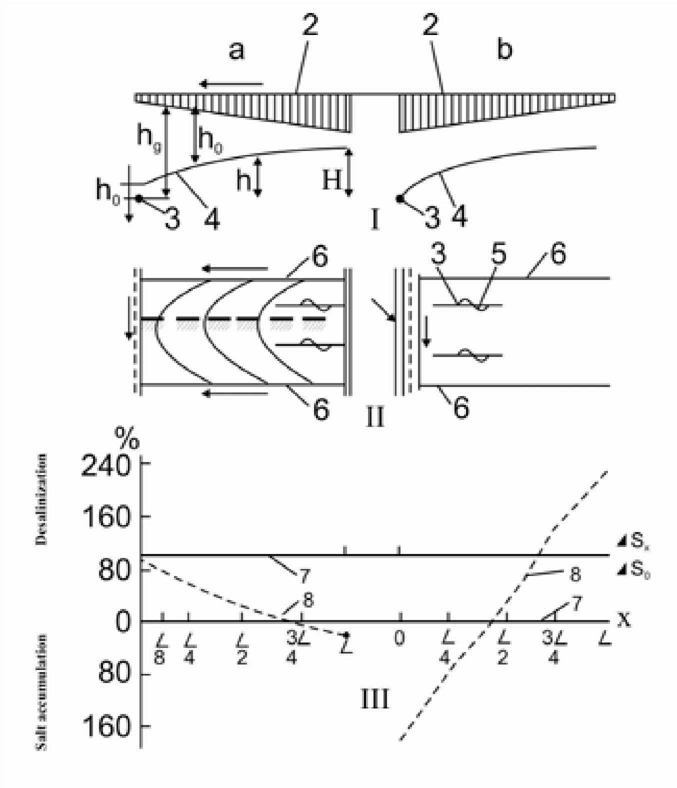
***Hence, the following interesting facts can be mentioned:***

- In the Golodnaya Steppe, where loess soils are characterized by high capillary properties (a capillary rise ($h_c$) equals 3 m and even more), a depth of GWT averaged over the growing season has to be 2.7 m under groundwater salinity ranging from 5 to 8 g/l; and correspondingly an installation depth of subsurface drains should be 3.0-3.5 m. The correctness of such technical solution was proved by all the practice of land reclamation in the Golodnaya Steppe where land desalinization was provided under gross water consumption of 9,500 to 10,500 $m^3$/ha;
- In lower reaches of Central Asian rivers, in particular in Khorezm Province, stratified soils with thick sand layer (a capillary rise equals 1.6 m), a depth of GWT averaged over the growing season has to be 1.1 m under groundwater salinity ranging from 3 to 5 g/l; and correspondingly a depth of subsurface drains should be 1.5 -2.0 m.
- On irrigated lands with sandy soils (hc = 0.5 m, for example, in the pilot farm of SANIIRI in Khorezm Province), the drainage system with subsurface drains 1.5 m deep has created the automorphic regime causing the need of frequent water applications

Just that very case can explain the success of drainage practice in Egypt on sandy soils of the Nile River delta. There are different soils on drainage sites in India and Pakistan, but it is necessary to keep in mind that the monsoon climate with considerable rainfalls creates the conditions for intense leaching of soils over the vast area of drainage projects in Pakistan and in the state of Haryana in India.

At the same time, we can refer to data collected at their pilot drainage site in Iraq (personal communication of V. Dukhovny with Mr. Hulbols), where in the Dajilakh Irrigation Scheme the leaching regime of soils was provided based on shallow drainage (a drain depth of 1.2 m) only under gross water consumption of 16,000 -17,000 $m^3$/ha.

Let us consider, for example, a combination of the transverse pattern of furrow irrigation with non-regulated flow in a head of furrows with the transverse network of field subsurface drains. Assuming for estimate the most advanced strip AB (Fig. 21) along the axis of drain spacing, we consider contributors of the salt balance within the aeration zone and their distribution over a length of the strip AB from a collector-drain to an irrigated distribution flume[13].




a – under coincident directions;
b – under opposite directions;
I – cross-section;
II – plan;
III – salt accumulation curve.

1 – an irrigated distribution flume;
2 – an infiltration diagram;
3 – a collector-drain;
4 – a drawdown curve;
5 – a direction of water application;
6 – field drains;
7 – an average design salt accumulation depending on interaction of drainage and percolation flows;
8 – the distribution of salt accumulation areas against interaction of drainage and percolation flows.

**Figure 4.21 Desalinization Effect under Different Combinations of Directions of Water Application and Field Drains:**

Assuming the widespread pattern of field drains lengthwise an irrigated plot 400 m long, a design drain depth of 3.5 m and drain spacing of 200 m, we have assessed the extent of desalinization effect against groundwater salinity up to 8 g/l and irrigation water salinity of 1 g/l. Long furrows, direction of which coincides with field drain gradient, are employed for a water application. As shown in Fig.6a, the decrease in percolation intensity under moving from a drain head is overlapping on the increase in a groundwater depth. Since a minimum groundwater table is observed near an irrigated flume, velocities of convection transport are minimal here, but greater percolation values in accordance with the percolation diagram compensate them. In the direction towards an outlet of field drain, where a maximum groundwater table is observed, water percolation values in accordance with the percolation diagram are tending to zero. As a result, the desalinization is provided over the 90 percentage of field area, having a considerable margin. Under the contrary pattern, where water applications are conducted in the direction from a drain outlet towards its head, percolation intensity over the 50 percentage of field area does not create necessary velocities of convection transfer of salts resulting in the lack of leaching affect over this area that should be delineated (leaching requirements have to be increased 1.8 times here!!!).

As shown in our publication [5], the duration of water applications and the extent of their covering the area that is simultaneously drained and irrigated are also significant for maintaining uniform soil moistening and water percolation downwards. Forming the big local mound in the watertable does not occur if the duration of water application is ranging from 12 to 24 days, but elongating of water application terms and a high percentage of a simultaneously irrigated area within the drainage plot (more than 50%) cause the rise of

[13] Precast lateral lifted above ground for irrigation water delivery to fields.

watertable by 0.5 to 1.0 m and create an additional load on the drainage system (a drainage rate increases two times); in addition, at the same time, useful salts and nutrients are leached and carried away from soils.

From this point of view, introducing the water rotation, control of water application arrangement according to the daily schedule recommended by the SIC ICWC [24] and deconcentration of simultaneously irrigated areas facilitate more uniform soil moistening, desalinization and enhancing soil fertility. More attention should be paid to these matters under introducing the field passports and recommended schemes of water applications.

## Organization of Land Reclamation and O&M Works

Problem-free land reclamation activity depends on many factors predetermined by natural conditions within the irrigation scheme and by its irrigation and drainage components as well. Different organizations and even sometimes different departments "have in their hand" the sustainable operation of these territories and simultaneously the irrigation and drainage systems. At the same time, only the coordinated actions of all actors, on which proper irrigation water supply and drainage depend, can provide high crop yields under minimum water consumption based on uniform effects of irrigation and drainage (Fig. 4.22).

Even earlier, under the administrative system of governing irrigation and drainage, it was difficult to provide the coordination and integration of all actors. In the Soviet time, the state water management organizations under supervision of the Provincial Hydro-Ameliorative Expeditions (PHAE) have incurred all costs related to O&M of the drainage systems. Now this task is more complicated due to many causes. However, new forms and methods of the integration have to be searched out under present conditions.

After independence, practically all Central Asian countries considerably abated the activity related to maintaining the drainage systems, especially at the on-farm level. The Republic of Uzbekistan maintains the satisfactory operating conditions of inter-farm and main collector-drains, but has also reduced the scope of O&M works on the on-farm drainage network. As a result, during last 15 years, the operability of drainage systems abrupt dropped. In conjunction with deficit of water resources needed for leaching salt-affected soils, this has resulted in restoration of irrigated land salinization. Up to now, this process is not stopped and continues to strengthen: about 60% of irrigated areas are subjected to salinization in Uzbekistan; 70% in South Kazakhstan and 80% in Turkmenistan.

The problem of organizing O&M of former on-farm drainage systems became more acute after restructuring collective farms and state farms. Without touching the peculiarities of operating the irrigation network that were presented in other sections in detail, we will consider management of drainage systems including drainage infrastructure and issues related to drainage water and salts disposal out of the irrigation schemes.

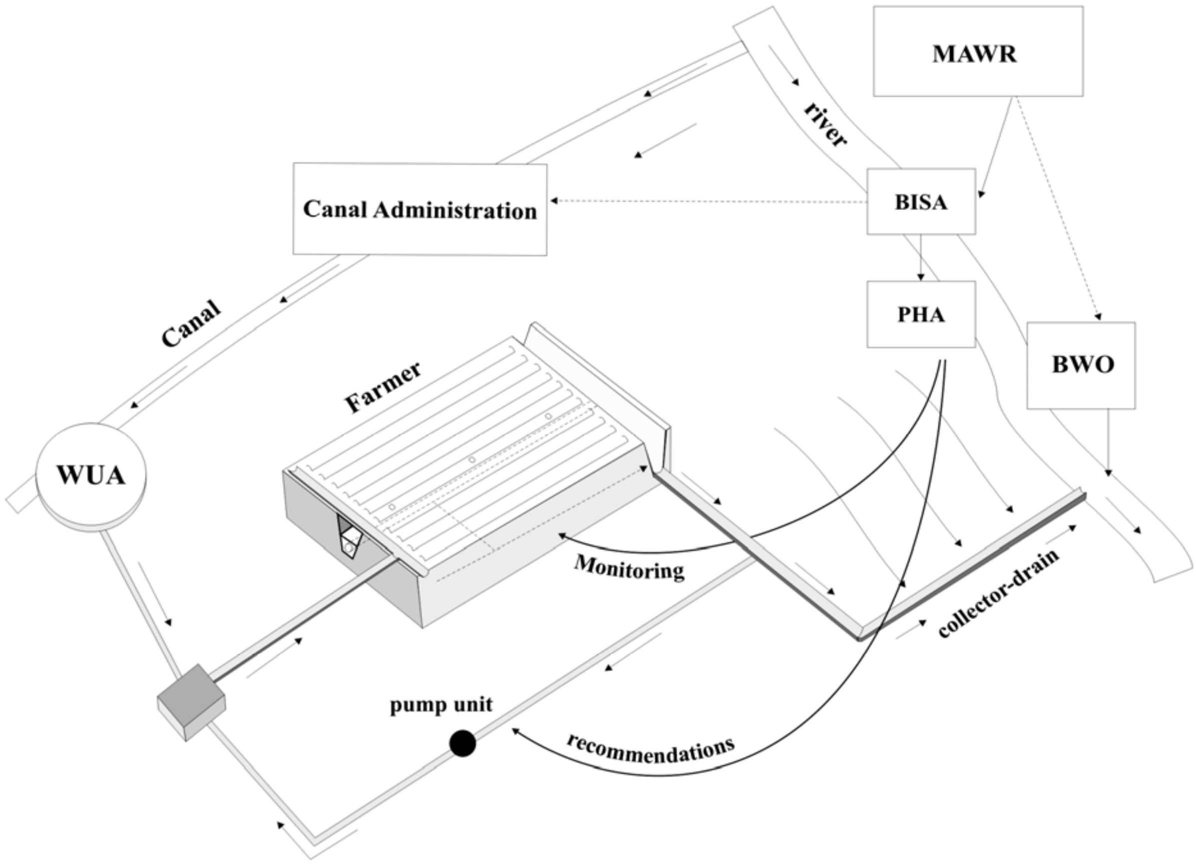



**Figure 4.22 The Problem-Free Land Reclamation System**

**Sustainability of land productivity depends on the following key factors:**

- Timely watering of soils and crops depending on their water requirements using the proper method of irrigation and providing uniform water distribution over a field;
- Preventing soil salinization above admissible limits;
- Preventing also waterlogging the rootzone, maintaining soil moisture relevant to specific crops and soil characteristics and properties; and
- Maintaining uniform topsoil quality relevant for supporting the proper crop growth and a field micro-relief to prevent over-application of water and flooding low places and under-application of water on higher places in the process of irrigations.

Keeping in mind numerous technical and agrarian peculiarities of soil salinization processes, a farmer can not in the least know the methods for their specifying, but it is very important in order that partners of farmers such as WUAs and Land Reclamation Bureaus (PHAE) could provide them with required information, on regular basis, and simultaneously execute their commitments regarding land reclamation activity.

On what reasons the implementation of each above requirement depends? And who should provide these ameliorative conditions, without which high crop yields are impossible?

***Irrigation water delivery to a field and crops depends on the following aspects:***

- Operational condition of the intra-farm irrigation network (the executor: a farmer);
- Submitting the applications covering the current year and season and their adjustment according to the water use plan approved by the WUA based on the existing norms and allocated limits for water use (the executor: a WUA);
- Good preparation of a field; and proper water distribution within the farm (the executor: a farmer);
- Installation of a water meter on the off-take to farmer's field (the executor: a farmer);
- Operational condition of the conveyance canal to a farm (the executor: a WUA with participating a farmer);
- Maintaining sustainable management of irrigation water delivery and distribution within the irrigation network under its responsibility (the executor: a WUA):
- Maintaining uniform, stable and sustainable water delivery to WUAs' irrigation canals according to their water use plans and agreed and adjusted applications (the executor: the WMO);
- Timely payment for WUA's water services (the executor: a farmer);

***Preventing soil salinization above the permissible limits in farms can be provided by*:**

- Field surveying and soil sampling; and then plotting of a soil salinization map of farm fields with the legend containing the advisable norms of leaching operations for a farmer (the executor: the PHAE);
- Studying opportunities for using drainage water for leaching operations (the executor: the PHAE at the expense of the state budget or developing more detailed recommendations according to the decision of WUA and farmers at the expense of farmers);
- Follow-up annual soil sampling and modification of soil salinization maps by the PHAE;
- Construction of necessary additional drainage facilities by the WMO under supervision of the PHAE (at the expense of budgetary funds);
- O&M of field drains and collector-drains within own farm with an annual detailed survey and current inspection every ten days (the executor: a farmer);
- Maintaining the inter-farm drainage network providing its design depth with appropriate preventive and emergency repairing of the collector-drains and field drains (the executor: WUAs);
- Cleaning and repairing the collector-drains and field drains based on the contractual relations with WUAs (the executor: the WMO under supervising by the PHAE);
- Drainage water disposal out of the WUA's area by gravity or using the pumping units for maintaining the design depth of groundwater table over the area of WUA (the executor: the WMO with participation of the PHAE, at the expense of budgetary funds);
- O&M of drainage tubewells are implemented by specialized organizations (PSA) or the PHAE at the expense of budgetary funds in case of the intercepting drainage and with shared financing by farmers in case of regulating the groundwater table over the farm areas; and
- Water delivery for leaching operations in necessary amounts (the executor: the WUA and WMO).

***Maintaining a necessary depth of groundwater table can be provided by means of:***

- Monitoring and plotting a depth-to-watertable map for farms and developing measures for areas with the inadmissible groundwater table with the purpose of its lowering (the executor: the PHAE);
- Hereinafter, all positions of the previous paragraph is repeated in the same sequence and with the same executors

***Creating the uniform background for providing soil fertility over the irrigated area requires the following:***

- Assessing the current state of topsoil fertility in farms by means of remote sensing and on-ground surveys implemented by the extension services or specialized organizations based on the contract with farms;
- Implementing the land leveling by employing long-wheelbase scrapers or laser land leveling equipment funded at the expense of farmers, credits or donors' grants;
- Improving the soil texture by means of deep ripping, addition of sand, clay or other amendments (the executor: a farmer);

*A field* is the area of farm's responsibility. Farmers should monitor the technical state of field drains and collector-drains, and prevent releasing of irrigation water into the drainage network causing its erosion and damage. Farmers also have to clean the collector-drains, to flush pipelines of subsurface drains (by the gravity method) and to mow weeds overgrowing collector-drains within the own plots.

At the same time, farmers must timely prepare their fields for leaching operations and water applications and then implement them according to the established schedule. If possible, farmers should use return water, mixing it with irrigation water based on the permission and recommendations of the PHAE.

*The drainage network within the WUA's area* is the field of responsibility of a WUA that should maintain collector-drains, sign the agreements on the technical servicing of on-farm drainage systems, monitor and account the drainage discharge, and involve farmers in necessary works on the drainage network using the "khashar"[14] method. In addition, a WUA plans the usage of return water and delivers it for irrigation (sometimes a WUA organizes use of drainage water on the centralized base). However, a WUA itself cannot execute all necessary works within its area; and part of works should be implemented by the specialized organizations.

At that, first of all, funds should be available and, secondly, specialized machinery or the contractors that can execute necessary works based on the agreement are also needed. At the same time, there is no way to turn the works related to cleaning the collector-drains or repairing and flushing subsurface drains into the contractual intervention.

## 4.7 The End User of Water and the Extension Service for Farmers

**(Sh.Sh. Mukhamedjanov, A.G. Galustyan, S.A. Nerozin)**

Depending on vectors of the agrarian policy, reforms in the agrarian sector have specified the different economic environment for developing agriculture in Central Asian countries. For example, in Kyrgyzstan, the agricultural lands have been completely transferred for private use in the form of small plots under the

[14] "Khashar" is voluntary participation of the population in socially necessary works profitable for all or as aiding a member of their community.

absolute self-determination of directions in agricultural activity. In Uzbekistan, private farms were established based on the long-term land leasing with the state order on crops and fixed prices on agricultural output specified by the state. In Tajikistan, the collective farms are mainly kept and only some private farms are being established; and although there is not the formal state order on crops, at the same time, farmers cannot manage their plots and output at own discretion.

However, in spite of different ways selected for reforms, all three republics face the similar problem due to the reforms implemented. Prior to reforms, all large collective farms were managed by a chairman and specialists (agronomist, irrigator, economist etc.) with higher education in agriculture. All farm operations were implemented under their direction; and common agricultural workers only executed their instructions. Now, each peasant himself manages all processes on small areas; and the key problem is the lack of necessary knowledge within the required norms (soil treatment, fertilizer application, pest control, irrigation methods and land reclamation practice etc.). Moreover, peasants face problems related to legal and economic aspects. All this adversely affects crop productivity and profitability. The governments keep track, somehow or other, these problems; but decisions made for their solving are not yet effective. At the same time, under solving the existing problems each country proceeds from own economic and political conditions and interests.

Monitoring conducted in the frame of the project over territories belonging to three republics in the Fergana Valley has shown that private farms differ in areas of allocated plots and in crop patterns. In Uzbekistan, private farms having the sown area of ten hectares and more cultivate mainly cotton and winter wheat because the state order in force does not allow farmers to select crops independently. A set of crops is more diverse in Tajikistan and Kyrgyzstan. Small plots allocated to farmers in Kyrgyzstan do not allow them to manage their agricultural production efficiently and gain good profit. There is more complicated situation in Tajikistan where dekhkan farms were created. Here, the members of dekhkan farms have practically no voting right and do not participate in the decision-making process, being only a labor force under subordinating to the director of the dekhkan farm.

In spite of some differences in reforming the agricultural sector, the overall situation of helplessness is typical for farmers in these countries. After receiving their plots but without infrastructure developed for new conditions, farmer faced the need to solve financial, legal, technical and administrative issues but most of them never solved these problems in the past. Under considering the process of restructuring the agricultural sector and establishing the private farms in each country, the community of problems, on the one hand, and specific differences, on the other hand, become obvious and understandable.

In 2002, some shortcomings in agricultural activity in private farms were revealed in the course of monitoring at the demonstration sites that was conducted in the framework of the IWRM-Fergana Project. The low efficiency of irrigation water and land use was marked practically in all farms under studying in the region. Total losses of irrigation water on the field (deep percolation and surface releases) reach 55% of irrigation water supply at a field border and exceed the normative values 1.5 to 2 times. Water productivity in some farms amounts to 0.14 to 0.19 kg/m$^3$.

Our field survey of the irrigation and agricultural practice has shown that the key factors of decrease in land productivity, apart from the lack of inputs and machinery, are low professional skill and non-normative use of all resources, although farmers in the territories belonging to three republics in the Fergana Valley did not mention the low level of agricultural knowledge. The fact is that the farmers, even those who worked long time in former collective farms and state farms and participated in different farm works, including water applications, have carried out only instructions of an agronomist, irrigator or skilled foreman. At present, a farmer himself should solve all issues because he does not have “consultants” as before. A less skilled farmer tries to make his job in the manner employed by his more skilled neighbor or asks an advice of the elders. However, as our study has shown, most of farmers make considerable mistakes in the process of cultivating crops. Most of farmers cannot correctly specify the terms for water applications or select the correct technological pattern for irrigation resulting in difficulties with water distribution over their fields and overwetting of some sites and insufficient wetting of others; at the same time practically all farmers use the overrated water application norms. Most of farmers do not have technical knowledge on natural factors and specific land conditions within their farms that needed to be accounted under planning water applications. Apart from the irrigation practice, most of problems are related to the lack of any knowledge on norms and terms of fertilizer applications, pest and crop disease control. Phosphate fertilizers are not practically applied in Tajikistan and Kyrgyzstan in spite of an insufficient content of phosphates in soils. Application of nitrogen and potash fertilizers is not timely and does not meet the required norms. Based on analysis of collected data it is necessary to note that private farms, lacking any state support, have a lot of problems of technical and organizational nature. Key problems faced by farmers in the process of their agricultural activity are similar to problems that are revealed at the demonstration sites. First of all, it is necessary to note the following problems:

- irrigated water supply does not meet the established norms;
- ill-founded terms of water applications;
- incorrectly selected technological schemes of water applications (too long furrows and often water application along the full length of a field);
- incorrect selecting the sorts of fertilizers and rates of their application; and
- lack of knowledge on pest control and preventing crop diseases.

Based on assessment and analyzing of data collected in the process of monitoring, the project consulting team has prepared the recommendations on improving the land and water productivity. Since 2003, the project executors attempted to manage the agricultural production based on these recommendations. As a result of the project activity and impacts on all components of the agricultural production, the situation was changed. In 2003 and 2004, overall productivity at the demonstration sites has increased ranging from 0.29 to 1.4 kg/m$^3$ over farms. During these years the increase in overall productivity amounted to 21 to 135% in comparing with 2002, including reducing irrigation water consumption by 16 to 83% and the rise of crop yield by 11 to 72%. Analyzing the actual use of irrigation water shows that most of farms have the real possibilities for improving the efficiency of water use. Increase in the efficiency can be provided without considerable investments into interventions at the field level and planning water distribution at the level of private farms. At that, development of the simplified and understandable methods of planning and use of irrigation water at the field level, as well as dissemination of learnt experience among other private farms are very important.

It is necessary to note that a lack of farmers' knowledge on correct planning of water use results in considerable lowering the level of their land productivity. To improve water and land resources use at the farm level through disseminating the project experience and introduction of existing advanced technologies, development of the extension service and the training of local consultants are needed.

The experience leant at demonstration sites in the frame of the IWRM-Fergana Project shows that there are great opportunities for improving irrigation water use and productivity. It is obviously that the training of farmers may result in the considerable improvement of agricultural production. In 2005 and subsequent years, the project activity was aimed at improving farmers' knowledge and introducing the advanced technologies facilitating water saving and increase in land and water productivity. Dissemination of the project experience among farmers was organized through the training and consultation process, as well as by means of conducting the advanced courses for specialist of water agencies and extension services that are servicing private farms. Liaison with the local organizations and extension services, activity of which is aimed at supporting farmers, was established in each province of the Fergana Valley. However, most of extension services render services to farmers only in case of their request. Activity related to consulting services is conducted by organizations having the consulting specialization and by non-specialized state organizations.

In Kyrgyzstan, where the process of reforming is more advanced than in other countries in the region, consulting services for farmers are rendered through the non-governmental organizations financed by the World Bank and the EBRD with partial payment of these services by the government and farmers themselves. In Tajikistan, most of extension services are rendered through the non-governmental organizations financed by international donors. In Uzbekistan, in spite of lack of the institutional framework for rendering rural consulting services, local authorities and organizations under the Ministry of Agriculture and Water Resources monitor timely and proper execution of land treatment and irrigation by farmers.

Regarding above issues, the IWRM-Fergana Project (the Project) established the co-operation with the Rural Extension Service (RES) and the Agricultural Training and Consulting Center (TES Center in Osh).

In Tajikistan, the Project cooperates with the NGO “Development Process Supporting Agency NAU” (DPSA-NAU) that during seven years is rendering the agricultural consulting services to local farmers, as well as with the CECI[15] Project funded by the Canadian Government. In Uzbekistan, the decision was made to initiate training activity at the field demonstration sites under the umbrella of the MAWR and to establish the specialized unit in the frame of BISA with functions of the extension service for private farmers.

In 2006 and 2007, the training seminars to disseminate the experience learnt in the frame of project activity were held in all provinces. In addition, the operational manuals covering various project topics, forms for entering collected data into the database, and booklets with the detailed description of all necessary land treatment and irrigation methods were prepared and distributed among the local consultants. Field training workshops for farmers were held by trainers of demonstration fields (polygons) in Andijan and Fergana provinces in Uzbekistan, by trainers of the CECI Project and DPSA-NAU in Tajikistan, and by trainers of the RES in Kyrgyzstan.

At the same time, the promising results were achieved on demonstration fields of the Project in each province. Farmers, on whose plots the demonstration fields were established under supervision of field trainers and local project specialists, used irrigated water according to the recommended norms and received crop yields considerably higher than an average crop yields in neighboring private farms. Water productivity amounted to 0.46 kg/m3 on average, reaching 0.8 kg/m3 in some private farms.

Trainers of the extension services, using the operational manuals and booklets, made the presentations for farmers that covered methods of water metering and accounting and effective technologies of irrigation water use on the fields. Joint activity of local project specialists and trainers of the extension services promoted the farmers’ awareness regarding the value of proposed technologies for improving their land productivity and profitability.

Since 2005 until 2007, the following handbooks have been prepared and distributed among local consultants and trainers: “Selection of a technological scheme for irrigations”; “What is the irrigation schedule?”; “Specifying the irrigation rate and method for cotton and winter wheat based on the IWRM-Fergana Project’s findings”; “Selection of water measuring devices & guidelines on their construction, operation and maintenance”; as well as “The consultative assistance to farmers”, comprising the procedures for consulting services based on a visual assessment, questionnaires and surveying private farms. Special forms were drawn up for collecting necessary information, which is used to identify the problems of private farms and to formulate recommendations to farmers. Practical guidelines on water use in private farms, comprising data on daily evaporation and the water metering and accounting methods, was drawn up for specialists and farmers enabling them to schedule irrigations with specifying date and the rate of each water application. In 2007, the handbook “Methodology of work with water user groups having small plots (Case Study of the Sokolok Canal)” was drawn up in Kyrgyzstan.

In 2006 and 2007, the training seminars were held in each province covered by the Project for training trainers and local consultants on topics related to efficient use of irrigation water and the methods for improving its productivity (Table 4.8). 20 trainers of the DPSA-NAU[16] and 10 trainers and local consultants of the CECI Project were trained in **Soghd Province and** among them **8 field trainers** of the DPSA-NAU who work directly with farmers on the demonstration sites and **5 regional trainers** of the DPSA-NAU who works with field trainers and local specialists. Other 8 participants of the training seminar are specialists-consultants who are employees of the central office developing new technologies and assessing the situation in private farms and at the demonstration sites. Activity of the DPSA-NAU covers five administrative districts: Kanibadam, Spitamen, Matchin, Asht and Zafarabad. Demonstration sites, private farms or the associations of dekhkan farms where trainers of this agency are working were established in each district. The agency cooperates with 76 private farms and the associations of dekhkan farms that encompass the irrigated area of 8,564 ha. Apart from participation in the training courses, the specialists of this agency together with specialists of the IWRM-Fergana Project advised farmers.

[15] CECI – the Committee on Economic Cooperation and Integration
[16] DPSA-NAU is the Developing Process Supporting Agency NAU (Tajikistan)

**Table 4.8. Coverage of Private Farms by the IWRM-Fergana Project through Training the Trainers**

| Name of Province and Consulting Service | Number of trainers and farmers participated in training | Number of private farms serviced by trainers | Area coverage | | Total |
|---|---|---|---|---|---|
| | | | Through trainers and farmers | Through Khokimiats & WMO | |
| **Soghd Province** | | | | | |
| DPSA-NAU & CECI Project | 20 | 76 | 8,564 | | 8,564 |
| Private farms | 264 | 264 | 3,000 | | 3,000 |
| **Fergana Province** | | | | | |
| BISA & WUA “Akbarabad” | 16 | 240 | 2,400 | 3000 | 5,400 |
| Private farms | 605 | 605 | 32,457 | | 32,457 |
| **Andijan Province** | | | | | |
| BISA & “Bulakboshi” | 14 | 210 | 2,100 | 3000 | 5,100 |
| Private farms | 800 | 800 | 30,218 | | 30,218 |
| **Osh Province** | | | | | |
| RES | 7 | 200 | 2,000 | | 2,000 |
| **Total** | **1,726** | **2,395** | **80,739** | **6000** | **86,739** |

**40 trainers** representing the BISA were trained in **Fergana and Andijan provinces**. Each trainer is assigned to one administrative district and serves one pilot site and 15 private farms located around the pilot site. As a whole, trainers serve 1400 private farms in the Fergana and Andijan provinces.

Since November 2007, large-scale activity related to training farmers was conducted by local project specialists in command areas of the pilot canals in Soghd, Fergana and Andijan provinces. Altogether, the project specialists have served 264 farmers in Soghd Province, 605 farmers in Fergana Province and 800 farmers in Andijan Province. The project encompasses: 5 administrative districts and 26 WUAs with the total area of private farms more than 30,000 ha in Andijan Province; 4 administrative districts and 19 WUAs with the total area of private farms more than 32,000 ha in Fergana Province; and 2 administrative districts and 4 WUAs with the total area of private farms more than 3000 ha in Soghd Province.

**7 district consultants** representing the RES assigned to seven administrative districts and **10 trainers and specialists** of the TES Center were trained in **Osh Province.** These consultants are engaged in the introduction of new crop varieties and the advanced agricultural technologies at the demonstration sites in each administrative district. They also conduct field training and seminars at the demonstration sites for the neighboring farmers (**up to 20 to 30 farmers**). As a whole, the RES serves about **200 private farms**. Provincial consultants of the RES together with specialists of the IWRM-Fergana Project conduct the field seminars for farmers on the demonstration fields that were established by them.

In Uzbekistan (Andijan and Fergana provinces), apart from activity on the demonstration fields, the trainers are monitoring neighboring private farms. Knowledge acquired at the training courses is the basis for helping farmers to improve their land productivity. In Osh Province, based on knowledge acquired at the training courses and the prepared manuals, the RES consultants provide to farmers the technical assistance related to introducing the water-metering methods and advanced water application technique. ***It is necessary to note that if the technique of water applications was learnt quite well by the RES's consultants, planning of water use (scheduling of water applications and specifying of water requirements) remain the topical problem for them.***

Based on the recommendations and manuals developed for specialists and trainers of the extension services with respect to effective use of irrigation water and land treatment, the regional and provincial project executors have prepared and disseminated the booklets for farmers. These booklets were prepared prior to the beginning of each agricultural operation and handed over to farmers through consultants or trainers of the extension services. The booklets were published in local languages; and all their recommendations were presented in the simple manner understandable for farmers. In 2005, the practice of preparing and disseminating the booklets was introduced by the provincial project consultants in selected 20-30 private farms in each province. Farmers have shown interest in booklets, not only those who do not have sufficient experience in agricultural practice but also the quite experienced farmers. Disseminating the project experience through the booklets allowed covering a lot of farmers during short time without inviting them to visit the special training courses.

In 2005, after analyzing the experience of disseminating the booklets, the regional project group together with provincial executors made a decision to extend the coverage of private farms through the dissemination of booklets by trainers of the extension services since 2006. Especially effective dissemination of booklets took place in the Uzbek part of the project area where apart from dissemination through trainers of the demonstration fields, the provincial executors provided the dissemination of booklets among farmers through the Khakimiats[17] in the course of monthly meetings in Kuva, Tashlak, and Akhunbabaev districts in Fergana Province. In addition, the monthly dissemination of booklets among farmers in Kuva District was organized through agronomists assigned by the Khokimiat (Table 4.9).

**Table 4.9. Dissemination of Booklets through Existing Extension Services, Local Authorities and Water Management Organizations**

| Name of province and consulting service | Number of private farms that received booklets | Number of booklets distributed among farmers |
|---|---|---|
| **Soghd Province** | | |
| DPSA-NAU | 76 | 380 |
| CECI Project | 72 | 360 |
| **Fergana Province** | | |
| BISA & WUA “Akbarabad” | 350 | 1750 |
| Khokimiat | 600 | 3000 |
| **Andijan Province** | | |
| BISA & “Bulakboshi” | 420 | 2100 |
| **Total** | **1518** | **7590** |

[17] Khokimiat is the administrative body (local authorities) of district, city or province.

Disseminating booklets among farmers was also conducted at the training seminars in the Water User Associations located in the command areas of the pilot canals (the SFC in Uzbekistan and KBC in Tajikistan), see the table below.

**Table 4.10. Dissemination of Booklets among Farmers at Training Seminars**

<table>
<tr><th>Province</th><th>District</th><th>WUA</th><th>Number of booklets distributed among farmers</th></tr>
<tr><td rowspan="10">Andijan</td><td rowspan="3">Kurgantepa</td><td>Sobirjon suv bulogi</td><td rowspan="3">204</td></tr>
<tr><td>Mashrapboy sahovati</td></tr>
<tr><td>Khamraboev sahovati</td></tr>
<tr><td rowspan="3">Jalakuduk</td><td>Amir Timur</td><td>340</td></tr>
<tr><td>Jalakuduk vodiy imkoni</td><td>220</td></tr>
<tr><td>Pakhtakor gidrotech</td><td>216</td></tr>
<tr><td rowspan="4">Kadjiabad</td><td>Chinmakhram</td><td rowspan="2">344</td></tr>
<tr><td>Madiyarov</td></tr>
<tr><td>Khodjaobkash</td><td rowspan="2">272</td></tr>
<tr><td>Garagura</td></tr>
<tr><td rowspan="5">Fergana</td><td rowspan="5">Kuva</td><td>Tolmazr chashmasy</td><td>252</td></tr>
<tr><td>Musajon Ismoilov</td><td>216</td></tr>
<tr><td>Omad Zilol</td><td>276</td></tr>
<tr><td>Zilol suv fayzi</td><td>200</td></tr>
<tr><td>Polvontosh Bakhor</td><td>196</td></tr>
<tr><td rowspan="4">Soghd</td><td rowspan="4">Rasulov</td><td>Madanyat</td><td>132</td></tr>
<tr><td>Zerafshan</td><td>132</td></tr>
<tr><td>Tajikabad</td><td>132</td></tr>
<tr><td>Samatov</td><td>132</td></tr>
<tr><td colspan="3">Total</td><td>3,264</td></tr>
</table>

The project experience proves that after reforming the agricultural and water sector in Central Asia, there is the pressing need in establishing appropriate extension services that could assist farmers to solve their day-to-day problems related to agricultural production and water use. At the same time, under establishing the extension services, existing condition and opportunities for development of the agrarian and water sector as well as the status of infrastructure should be taken into account.

**The strategy for establishing the extension service.** Establishing the extension service as a self-contained agency may be inefficient today due to socio-economic and institutional conditions in all three states and the lack of financial support. Therefore, a more effective way is the establishment the extension service based on or in the frame of existing organizations, activity of which is related to the agricultural and water sector and aimed at the assistance to farmers. What organizations can become the base for developing extension services in the rural area today?

Firstly, the **Provincial Water Management Organizations** (PWMOs), which have not lost their key role in agricultural production, are active in all states whose provinces are located in the Fergana Valley. The PWMOs are planning delivering and use of irrigation water for meeting the needs of agricultural production. Their divisions managing the water use process have links with canal administrations and WUAs as primary agricultural water users. The planning of water use by all primary water users is being annually implemented based on analyzing the crop pattern. Just like water users, the PWMO holds its interest in effective use of limited water resources allocated to the province.

Secondly, **Water User Associations** (single nongovernmental organizations that are operating in the close interaction with land and water users) are intensively developing in the region. Principal activity of WUAs consists in distribution of water among water users based on the water use plans taking into consideration the crop pattern. Due to its activity, WUAs possess necessary information regarding water users: an irrigated area, crop pattern and crop yields, planned and actual amounts of water use, and land condition. Economic capability of water users is important for WUAs from the point of view of collecting fees for water services. In this case, the higher production output and incomes the more opportunities of WUAs to pay the canal administration for water delivered. WUAs hold an interest in effective use of water and land resources and also in awareness of each water user regarding the importance of rational use of water and other agricultural inputs enhancing irrigation water productivity. Specialists of WUAs contact with each water user prior to the growing season at the stage of drawing up the water use plan and during the growing season in the process of water distribution. Somehow or other, specialists of WUAs provides specific advices and recommendations to water users concerning water use and enhancing irrigated land productivity. Establishing the extension services with the staff of necessary specialists (agronomist, lawyer, economist etc.) enables to provide comprehensive consultations to water users regarding all matters of agricultural production.

Keeping in mind the above, the establishing of extension services under the umbrella of the provincial WMOs and existing WUAs is the most practical and effective way in all regions of the Fergana Valley under the sovereignty of three states, may be, with some exception for Tajikistan where WUAs were established over a small part of the country. The fact that these organizations already have specialists in the field of hydraulic measurements and water management speaks in favor of the establishing of extension services under their umbrella, because the lack of specialists is the key problem for establishing extension services independently from a type of department or organization. Although some WUAs in Uzbekistan do not have the complete staff of specialists (sometimes a WUA has only the director and book-keeper) the process of staffing and strengthening WUAs is in progress. The establishing of extension services in the frame of WUAs is the most promising in Kyrgyzstan where practically all WUAs were staffed with necessary personnel and have the experience of planning and water distribution among farmers.

### 4.7.1 Developing the Extension Services in Kyrgyzstan

In Kyrgyzstan, first of all, the extension services in the field of water use and agricultural methods are developing based on the existing consulting organizations. The second way is the establishing of extension services in the frame of each WUA with headquartering at the PWMO where the provincial unit for supporting WUAs and consulting services is organized (Fig. 4.23).

***The provincial unit for supporting WUAs is responsible for the following activities:***

- developing and coordination of training programs and manuals, as well as plans of joint activity of the extension service and water users associations;

- training specialists of WUAs and consultants of the extension services by advanced methods to enhance the efficiency of irrigation water use and land productivity;
- collecting data on private farms and WUAs;
- assessment and analyzing the existing problems in private farms, water requirements of cultivated crops depending on soil conditions, and the extent of water availability of irrigation canals and WUAs;
- preparing thematic booklets for farmers and district specialists;
- data input into the database and knowledge base; and
- methodological supporting the specialists of WUAs in their consulting work with farmers within the area serviced by these WUAs;

***WUA specialists carry out the following activities in the area serviced by the WUA:***

- monitoring the indicators of land and water productivity in private farms;
- consulting services to farmers regarding preparation of land for sowing, scheduling irrigations, selection of optimal irrigation pattern, implementing agricultural methods according to the process map of crop growing;
- studying the bottlenecks and shortcomings in agricultural practice and water use; and
- dissemination of thematic booklets in national language prior to execution of each farming operation namely before tillage, sowing, arranging irrigation sites (system of water applications), irrigations, fertilizer application etc.

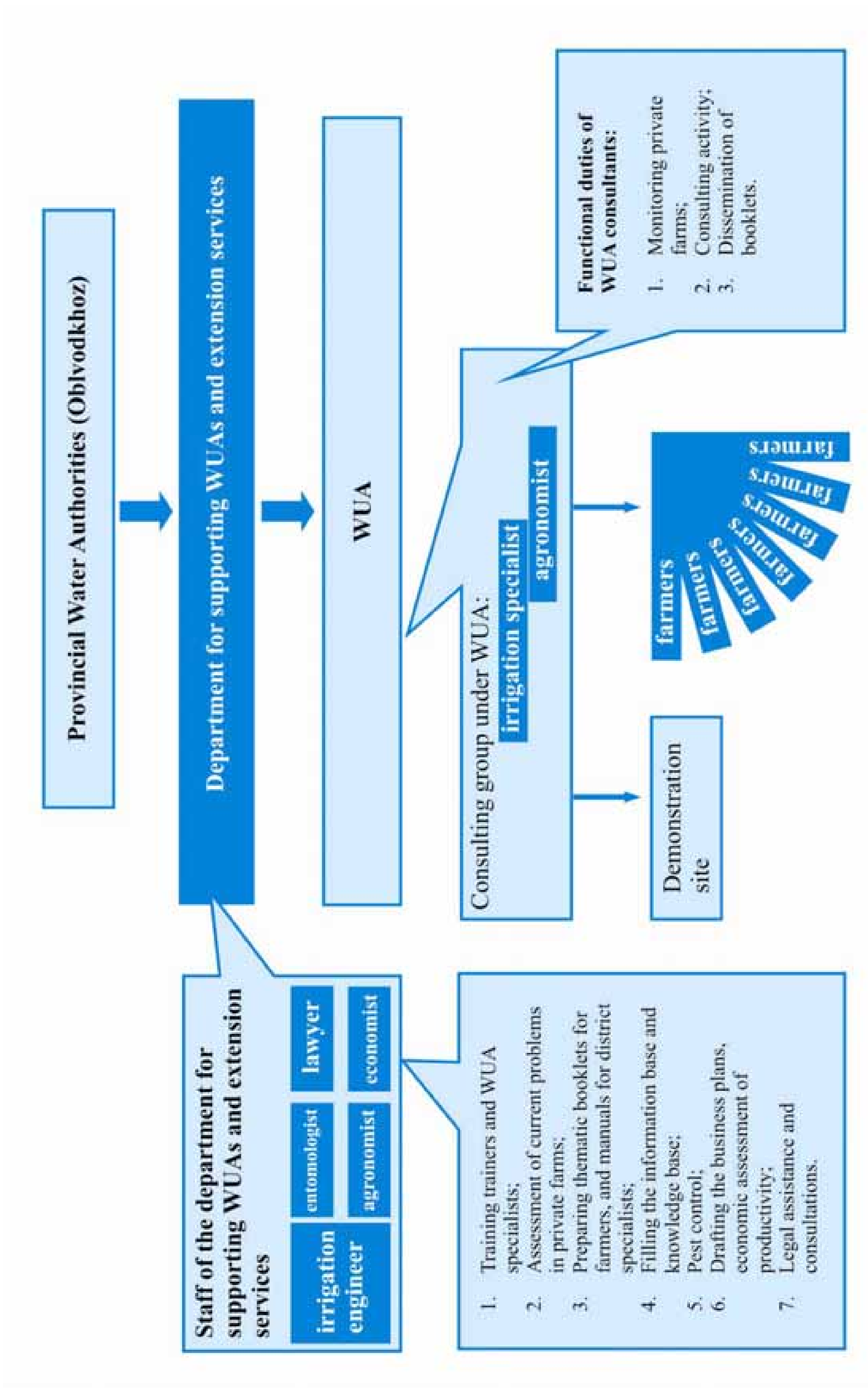



**Figure 4.23 Institutional Framework of Extension Services in Kyrgyzstan**

### 4.7.2 Developing the Extension Services in Tajikistan

In Tajikistan, the extension service department is established in the **Provincial Water Management Organization** *for consulting services to farmers* on matters of efficient irrigation water use and for *training the consultants of existing consulting organizations* (Fig. 4.24).

At present, the insufficient development of the WUAs in Tajikistan and the existence of large dekhkan farms (collective farms) do not allow establishing the extension services only in the frame of WUAs. In addition, the extension services aimed at improving activity in the agrarian sector are being intensively developed in the province under consideration.

Exiting extension services in this province are mainly focused on economic, legal and land treatment issues. The extension services for farmers and WUAs focused on water management and irrigation are practically absent. Such an extension service can be organized as the NGO under the umbrella of PWMO. Local specialists who are engaged in implementing the IWRM-Fergana Project can staff this organization since they already participate in activity of various CECI projects in the agrarian sector, DPSA-NAU and WUAs.

In our opinion, the key staff of extension service should consist of three specialists (irrigation engineer, agronomist and entomologist); and besides them, economist and lawyer can be included into the staff. This extension service will cover all private farms and WUAs over the whole province under cooperating with all pilot projects and their consultants and coordinating by the Khakimiat and Ministry of Agriculture.

***The extension service will be responsible for implementing the following activities:***

- Conducting the training seminars for farmers and specialists of WUAs;
- Preparing the manuals on rational scheduling the water allocation process, effective use of irrigation water at the field level, enhancing water and land productivity, establishing the irrigation water accounting system;
- Monitoring irrigation water use and agricultural methods in private farms;
- Drafting the thematic booklets and their dissemination among farmers at the training seminars and through various agricultural and water agencies;
- Training trainers of the extension services and pilot projects who work directly with farmers and WUAs;
- Technical assistance to specialists of the extension services and pilot projects who work directly with farmers and WUAs;
- Analyzing and assessment of monitoring data on irrigation water use and its productivity; and
- Establishing the information database comprising data on private farms, normative indicators, existing “bottlenecks” for analyzing and assessment of the current status of water use and irrigation water productivity.

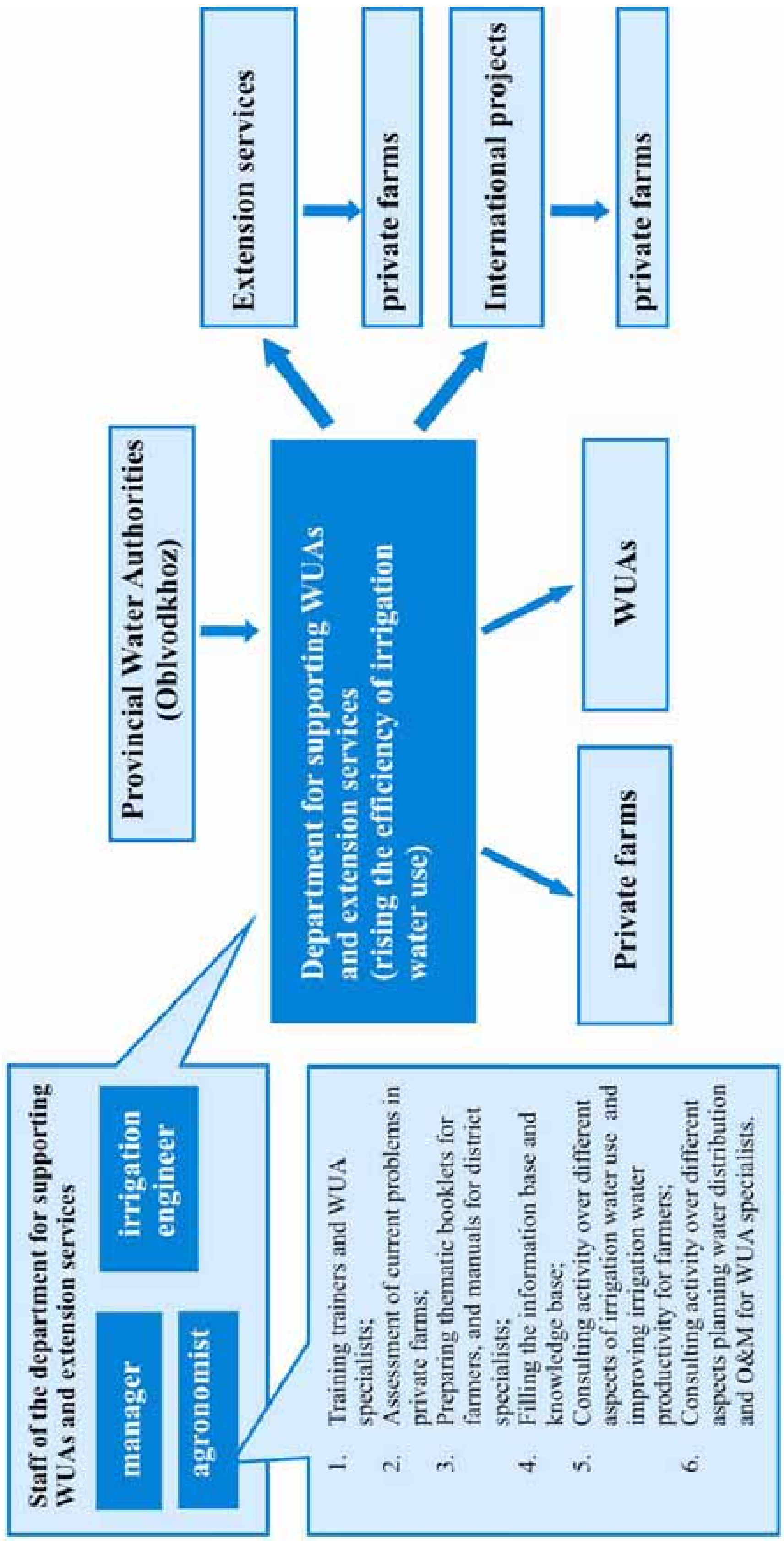



Figure 4.24 Institutional Framework of Extension Services in Tajikistan

### 4.7.3 Developing the Extension Services in Uzbekistan

In Uzbekistan, the extension services are developing in the frame of Basin Irrigation System Administrations (BISA). A department for supporting WUAs and consulting services for farmers in the field of effective use of water and land resources is established at the BISAs (Fig. 4.25). This department is the central office with district affiliates under WMOs. Different specialists such as irrigation engineer, agronomist, lawyer, entomologist and others are working at the central office and are responsible for the following activities:

- training district specialists by advanced methods to enhance the efficiency of irrigation water use and land productivity;
- assessment and analyzing the existing “bottlenecks” in private farms, water requirements of cultivated crops depending on soil conditions, and the extent of water availability of irrigation canals and WUAs;
- drafting the thematic booklets for farmers and the manuals for district specialists;
- data input into the database and knowledge base;

Two specialists (irrigation engineer and agronomist) are working in each district affiliate. At the district level, consulting activity is conducted based on demonstration sites of the BISA and existing WUAs in which specialists of WUAs form the consulting group. Irrigation engineer and agronomist organize the following activities over the whole district:

- monitoring the indicators of land and water productivity at demonstration sites (so-called “demonstration polygons”) and in private farms neighboring with demonstration sites;
- consulting services to farmers regarding preparation of land for sowing, scheduling irrigations, selection of optimal irrigation pattern, implementing agricultural methods according to the process map of crop growing;
- studying the bottlenecks and shortcomings in agricultural practice and water use;
- dissemination of thematic booklets in national language prior to execution of each farming operation namely before tillage, sowing, arranging irrigation sites (system of water applications), irrigations, fertilizer application etc.
- transferring data collected at demonstration plots and in private farms to the central office for their analyzing and data entry into the information database of the consulting service; and
- methodological assistance to specialists of WUAs in their consulting work with farmers.

WUA’s specialists implement the works in private farms within the area serviced by a WUA like activity of district office’s specialists at the district level:

- monitoring the indicators of land and water productivity in private farms located within the area serviced by a WUA;
- rendering the consulting services to farmers regarding preparation of land for sowing, scheduling irrigations, selection of optimal furrow irrigation system, implementing agricultural operations according to the process map of crop growing;
- studying the bottlenecks and shortcomings in agricultural practice and water use; and

- dissemination of thematic booklets in national language prior to execution of each farming operation namely before tillage, sowing, arranging irrigation sites (system of water applications), irrigations, fertilizer application etc.

Establishing the advisory schools under WUAs is one of effective methods of the extension service activity. Organizing the training seminars for farmers' groups covering issues of efficient agricultural practice and irrigation water use might be one of directions of their activity. Consulting services to farmers including a key role of advisory schools should be included into WUAs' charter. In cooperation with and under participating of WUA's administration, two specialists can manage all activity of the advisory school including preparation of the seminars' program, invitation of lecturers for specific seminar topics, conducting of the training seminars, preparing the thematic booklets, and assessing current problems in farms related to technical and institutional aspects.

**Basic provisions and principles of extension service's activity:** During the first phase of reforming the agricultural and water sector, extension services should take into consideration interests of all land users, including farmers, and cover the following aspects related to improving water and land productivity:

- Information and legal supporting the farmers and enhancing their knowledge;
- Planning the agricultural practice to provide a maximum profit per a unit area;
- Selection of the most profitable crops for this region and specific time periods;
- Recommendations to reduce production costs;
- Advising the farmers in respect to achieving potential productivity (based on the field passports);
- Assistance in marketing, input supply and output processing;

Activity of extension services should be aimed at satisfying the present and future needs of farmers. An extension service has to study the specific conditions of private farms and provide appropriate recommendations based on new advanced technologies, selecting all the best and demonstrating their adaptability for specified conditions. An extension service communicates with the research institutions and makes orders for investigations in which farmers hold an interest in.

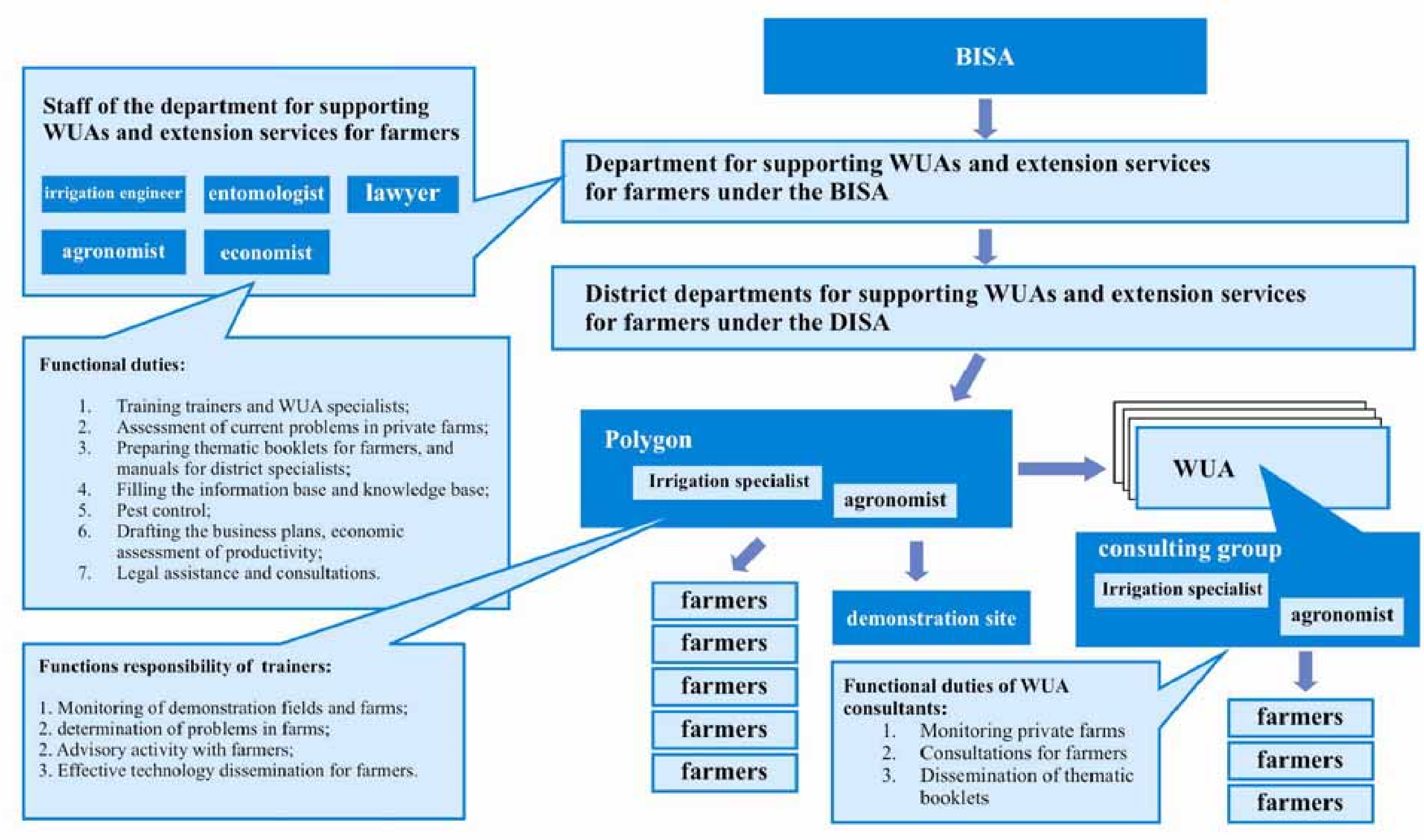



**Figure 4.25 Institutional Framework of Extension Services in Uzbeksiatn**

**Basic principles guiding activity of an extension service:** Under providing the professional consultations, an extension service is guided by the following principles:

- Consulting activity is aimed at satisfying the present and future needs of farmers-water users;
- An extension service itself has to initiate establishing of contacts with each farmer by the direct or indirect way;
- Comprehensive studying of conditions in private farms and providing appropriate recommendations;
- An extension service shouldn't be satisfied by transferring the recommendations as the need arises. It has to search new technologies, select the best of them and demonstrate their adaptability for specified conditions;
- An extension service communicates with the research institutions and makes orders for investigations in which farmers hold an interest in;
- Experienced farmers have to be involved in activity of extension services.
- To provide a farmer with necessary manuals, recommendations and information without dictating own solutions;
- Focusing on carefully selected top-priority objectives with purpose to save the limited resources;
- Searching an alternative crop pattern for the command area of irrigation canal that will not result in increasing its carrying capacity;
- Planning water use based on the principle of equitable sharing of water among water consumers; and
- Be guided by water saving principles at different levels of the irrigation system;

**Liaisons of an extension service:** An extension service has to encourage liaison with:

- sectoral consulting services under the Ministry of Agriculture and Water Resources at the national, provincial and district level, having the right of free access to necessary information and receiving the assistance in solving relevant issues;
- scientific-research institutions for acquiring new technologies and designs and ordering the research-and-development activities;
- the marketing service to facilitate sale of agricultural output within the country and abroad; and
- legal institutions;

***General: An extension service, as the consulting organization, should also carry out the following works:***

- studying, adoption and introduction of the best centuries-old methods of agricultural practice;
- search and introduction of the best scientific achievements in irrigation and farming techniques;
- detailed studying the conditions in private farms;
- advising farmers how to improve irrigation water and land productivity;
- consultations regarding farming techniques;

- consultations related to choosing crops and crop patterns taking into account the carrying capacity of the main canal and the uniformity of water distribution among water consumers;
- providing information on international and domestic markets and access to them for farmers; and
- consultations regarding water saving and rational use of irrigation water.

**Basic tasks of an extension service:** the following activities should be undertaken for information support of the farmers and rise in their awareness of the existing methods for increasing crop productivity using proper irrigation rates and irrigation methods for different crops on their plots:

**Key actions of an extension service**: Gathering background information on private farms is conducted in each district with assistance of local consultants. As far as possible, private farms are grouped according to their principal activity typical for this district and location.

***Dissemination of project experience and thematic booklets among farmers, and conducting the training seminars on the following topics:***

- Irrigation scheduling in line with the crop water requirement zoning;
- Methods of flow measurement and water-metering devices;
- Irrigation techniques and field irrigation systems in private farms;
- Crop diseases and pest control;
- Zoned stock seeds; and
- Extension services and their activity.

***Gathering background information:***

- Data on private farms: principal activity, gross area and irrigated area, crop pattern, length of irrigation and drainage networks, soil type, groundwater table depth, and soil salinization;
- Data on irrigation water supply to farms for the last three years, if available; when such information is absent then gathering data on the number of water applications and their dates (irrigation duration in hours);
- Data on belonging an area under consideration to any crop water requirement zone;
- Data on fertilizer applications (application rates, terms etc.);
- Data on crop diseases and pests (terms of their appearance);
- Information on all farming operations;
- Data on major crop yields over the last three years; and
- Data on production costs over the last three years;

***Analysis and assessment of:***

- Efficiency of irrigation water use under irrigating crops;
- Farming practice including pest and crop diseases control;
- Soil fertility and soil status as a whole; and

- Economy of agricultural activity.

***Methodological recommendations and their application regarding:***

- Establishing the measuring system and record keeping of irrigation water at the border of private farms;
- Methods of irrigation water use;
- Improving the efficiency and productivity of land and water;
- Types and rates of fertilizer application;
- Pest control;
- Optimal scheduling farming operations; and
- Rising of crop yield.

Assessment of water availability and sustainability of irrigation water supply at different levels of the irrigation system and within WUAs should be made. Demonstration sites for developing and testing methodological approaches to solving formerly revealed problems in private farms are established.

## 4.8 Social Mobilization as the Base for Successful Progression of IWRM

**(Dr. H. Manthrithilake, J. Kazbekov, O. Anarbekov)**

Social mobilization is the process, through which all stakeholders are involved in water resources management and decision-making related to governance and proper maintenance of water infrastructure [7] and which can be established in the form of the consultative platform where all stakeholders try to reach overall understanding of their needs and problems in the field of water management and are conducting a regular and comprehensive dialog for co-ordination of collective actions with purpose to reform and improve water resources governance by means of establishing community-based associations for water resources management such as WUAs, CWUU, and the joint governmental and community-based partnerships like the Canal Water Committee (CWC).

Social mobilization is the continuous process, in the course of which field consultants and initiators of social mobilization meet with farmers, representatives of water management organizations and local authorities and other stakeholders to disclose to them the institutional framework of IWRM, measures for improving governance of pilot canals, procedures for establishing community-based associations that will participate in future management of irrigation systems when their role and votes will be of decisive importance, as well as the essence of transferring powers from the state towards water users and the need to keep a role of the government in water resources management. This process is a so-called “bilateral dialog” when opinions and new ideas of all stakeholders are taken into consideration and documented to be the basis for adjustment of the public participation policy.

The experience of SMID[18] obtained at Phase III of the IWRM-Fergana Project is presented in this section. A new SMID policy with the more intensive and extended coverage of stakeholders differs from the approach used during Phase II when SMID has included only establishing single community-based organizations such as pilot WUAs, Canal Water Users Unions and Committees. In particular, the measures in the frame of SMID are aimed at strengthening earlier established institutions engaged in water management and disseminating the experience of pilot projects over the extended area with the ultimate goal to provide the sustainability of newly-established organizations.

[18] SMID – social mobilization and institutional development

**The SMID policy** for Phase III of the IWRM-Fergana Project and the organizational arrangement of field works related to social mobilization are given in Fig. 4.26. To provide the single approach and efficiency of SMID it was decided to increase the number of field consultants-initiators and to appoint a Task Manager for overall management of project activity and its coordination with all key actors and stakeholders based on regular and comprehensive dialog, implementing project tasks planned for Phase III.

At the beginning of each year, project team has consulted with stakeholders of each pilot canal regarding the matters related to the correct, effective and intense arrangement of SMID activity. All proposals and recommendations were being documented, and then, based on analyzing the proposals on improving project activity, the SMID policy appropriate for each pilot canal was developed. Workshops where each project consultant had the opportunity to express his opinion regarding the proposed SMID action plan (the field and practical experience of initiators was always quite useful) were held after completing the draft action plans in each country that participates in the project implementation. Based on the general action plan that was adjusted after discussions at workshops, each group of initiators has developed their individual plans for a current year that were a tool of monitoring and assessing group's activity.

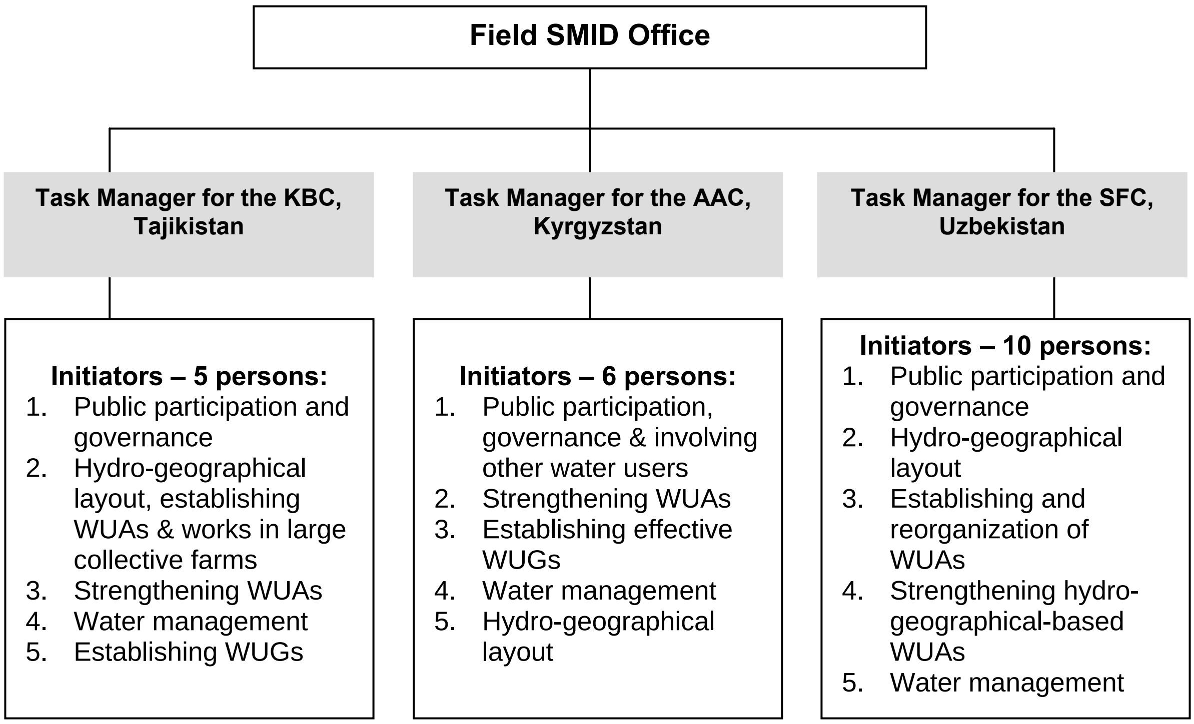



**Figure 4.26 Organizational Arrangements of SMID Field Works**

A strategy of SMID can differ in each country that participates in the project implementation due to local peculiarities, water management set-up and socio-economic conditions, but is built up based on the following integral framework:

***Hydro-geographical layout of potential WUA:***

- Meetings with representatives of WMOs, local authorities and water users for general presentation and specifying the service area;
- Inspection of the service area for identification of problematic sites and visiting local WMOs, local authorities, and primary water users (existing WUAs) and water users;
- Preliminary consultation with water users for outlining the area of potential WUA;

- Drafting a map of potential WUAs along the secondary canals; and discussion and approval of the plan for establishing WUA at the meeting with CWUC members; and
- Involving the CWUC members, chiefs of hydro-operational sites, representatives of District Water Administration and primary water users in discussing this map.

***SMID for establishing new WUAs based on the hydro-geographical principle or re-organizing existing WUAs established based on the administrative principle:***

- Meetings with key parties i.e. managers of primary water users (shirkat farms, WUAs established according to the administrative principle etc.) are organized for presentation of the plan of establishing a WUA that will be arranged according to the hydro-geographical principle;
- Establishing the relations with secondary water users within WUAs established according to the administrative principle and shirkat farms and explanation the essence of restructuring their WUAs and a role of new type of WUAs in solving present problems;
- Developing the plan of restructuring WUAs established according to the administrative principle by means of revising the agreements on irrigation water delivery with neighboring WUAs, solving the problems related to transferring a property of former owners, consultations with local legal bodies regarding the planned restructuring (or with project legal consultants), studying the water users' attitude to restructuring their WUAs and discussing the issues concerning changes in the management staff, fee rates for irrigation services etc.;
- Coordinating the plan of restructuring WUAs established according to the administrative principle with decision-makers (BISA, District WMO, and local authorities) based on the official letters of support and the minutes of joint meetings of two or more WUAs;
- Consulting assistance to directors of WUAs established according to the administrative principle and chairmen of their Councils with respect to restructuring their WUAs in the course of regular meetings;
- Assistance to the group of initiators in organizing the general meetings of WUAs for discussing their restructuring and in gathering the documents necessary for official registration of new WUAs; and
- Assistance to the WUA administration in completing the constituent instruments of the restructured WUA for re-registration (or registration of a new WUA) by the justice bodies.

***Strengthening WUAs established according to the hydro-geographical principle[19]:***

- On-the-job training to improve water resources management in such fields as drawing up the plan of water use and its implementation (i.e. water distribution among water users, calculating crop water requirements, water accounting and assessment of WUA activity in water management);
- Institutional improvements (practical assistance to WUA administration in documenting of production activity (the registration book of WUA members and non-members receiving water from the WUA, the registration book of applications for irrigation water supply and their execution, certificates of water delivery and acceptance etc.), in establishing relations with local authorities, tax administration and public utilities, as well as assistance in providing the normative and methodical documents, introducing of advanced methods of management such as developing business plans etc.); and
- Enhancing WUA Council's activity (assistance to WUA Council in documenting its activity: minutes of general meetings, sessions of the Auditing Committee and Council, decisions of the Arbitration

[19] At that, only the methods tested in pilot WUAs are employed.

Commission, as well as in establishing the working relations with the CWUC and organizing the meetings with water users; settling disputes and conflicts at the Council's sessions etc.).

***Establishing WUGs[20]:***

- Identification of problematic areas within the WUA;
- Field inspection of problematic areas and off-takes;
- Meeting with water users and specifying active water users;
- Leading a discussion with water users; and
- Holding the general meeting of water users for establishing a WUG under active assistance of so-called the group of initiators.

**Social mobilization policies in the region:**

***Kyrgyzstan***

1. Restructuring WUAs in the Aravan – Akbura Canal command area according to the hydro-geographical (hydrological) principle;
2. Establishing WUGs:

- Formalization of WUGs through signing the agreement on irrigation water supply by a leader of WUGs and the WUA (water users of single off-take authorize a leader of WUG, through signing the general agreement, to receive water from the WUA);
- Plans of water use are drawn up for each WUG (a single off-take) as the legal base for signing the agreement on irrigation water supply between a WUG and WUA with two principle provisions: an amount of water delivered by the WUA according to the plan of water use and total cost of planned amount of irrigation water supply; and
- Differential payment (according to water volumes) for each WUG (per off-takes).

3. Strengthening existing WUAs.

***Uzbekistan***

1. Planning the potential WUA layout and arrangement according to the hydro-geographical principle[21];
2. Establishing new WUAs according to the hydro-geographical principle or re-arranging WUAs according to the administrative principle;
3. Capacity building the existing WUAs established according to the hydro-geographical principle in the SFC command area; and
4. Establishing WUGs within the problematic areas;

***Tajikistan***

[20] Active leaders of WUGs established at problematic sites are the candidates for membership in the WUA Council and are an important actors of the group of initiators engaged in establishing a future WUA
[21] Discussion and approval of this plan take place at the sessions of CWUC and CA.

5. Planning the potential WUA layout and arrangement according to the hydro-geographical principle;
6. Capacity building the existing WUAs established according to the hydro-geographical principle in the KBC command area;
7. Establishing WUGs and their formalization; and
8. SMID measures in line with the WUA concept and water management in non-restructuring farms based on IWRM principles.

**Water governance and public participation: A group of local initiators, using working meetings, training seminars and round tables, has initiated the dialog with all stakeholders for selecting optimal options for restructuring the institutional framework of water sector within the command areas of the pilot canals to provide efficient water resources management at all levels of irrigation systems resulting in the rise of water productivity in the long run. All-round social mobilization and measures aimed at institutional development have facilitated the involvement of all types of water users in the process of restructuring the WRM framework in line with IWRM principles. The integration process comprises the following activities:**

- Top-down integration of different levels of water resources management hierarchy from the main canal, WUAs and WUGs towards farmers (Figure 4.27);
- Mobilization campaigns covering the horizontal integration of economic sectors and allowing to integrate the cross-sectoral interests in the process of governing the pilot canals (industry, water supply, ecology etc.);
- Differentiation of functions related to water governance and management within the single institutional framework established for management of pilot canals.

Information on these activities is disseminated among water users on the regular basis. The Project has practically assisted in formal registration of all CWCs in three countries, as well as in gathering necessary legal documents, mobilization of water users and holding the constituent assemblies.

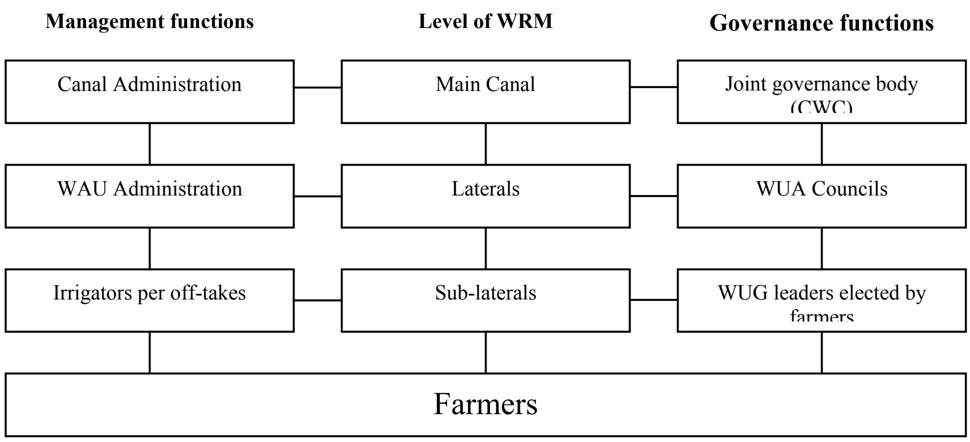



**Figure 4.27. Differentiating of the functions of governance and management at different levels of the pilot irrigation systems**

To provide the efficient work of CWC, active field divisions of the CWC at nine hydro-operational sites were created initially on the SFC and additionally on the Shakhrikhansay stream in 2007. The Project promotes activities supporting the sustainability of CWC in institutional and financial aspects. In particular, all CWCs have developed the business plans with the project's assistance. In Uzbekistan and Tajikistan, CWCs participate in SMID activity to re-arrange WUAs established based on the administrative principle.

**Table 4.11. Information on Social Mobilization & Institutional Development Activity**

| | Topic of SMID activity | Pilot Canal | | | | | |
|---|---|---|---|---|---|---|---|
| | | AAC | | KBC | | SFC | |
| | | Number of mee-tings | Number of partici-pants | Number of meetings | Number of participants | Number of meetings | Number of participants |
| 1. | IWRM project: institutional changes | 9 | 245 | 8 | 229 | 12 | 281 |
| 2. | A role of public participation in improving water resources management | 11 | 155 | 13 | 106 | 21 | 387 |
| 3. | Functions of irrigation canal management and the hydro-geographical principle | 8 | 96 | 6 | 72 | 14 | 156 |
| 4. | Canal Water User Union as self-reliant body of water users | 3 | 43 | 4 | 37 | 8 | 93 |
| 5. | Difference in concepts «Governance» and «Management» | 2 | 14 | 3 | 23 | 9 | 72 |
| 6. | Transferring powers in governance of the canals to joint governmental and community-based body: functions of the CWC | 5 | 56 | 7 | 38 | 10 | 166 |
| 7. | Re-organization WUAs according to the hydro-geographical principle and their membership in the CWC | - | - | 6 | 54 | 17 | 189 |
| 8. | Cross-sectoral integration – involving all water users in water governance | 24 | 83 | 5 | 25 | 4 | 73 |
| 9. | Establishing the field divisions of the CWC at hydro-operation sites and their composition | - | - | - | - | 20 | 364 |
| | **Total** | **62** | **692** | **52** | **584** | **115** | **1781** |

In Tajikistan, since large commercial agricultural enterprises are the founders of the CWCs, activity related to involving WUAs as members of the CWCs is conducted. All CWCs receive the technical assistance in preparing necessary key documents.

Mobilization related to transferring the powers of water governance to the joint body established on the AAC, KBC and SFC was conducted; at the same time options and procedures for transferring governance functions on the pilot irrigation canals were discussed. The IWRM-Fergana Project has promoted creating “the critical mass” of key stakeholders for signing the appropriate agreements and adapting them to local conditions. Agreements on establishing CWCs on the AAC and KBC and transferring to them appropriate powers were already signed. Background of establishing the similar body on the SFC was created; and the mobilization process is in progress. The groups of initiators practically assist dissemination and elucidation of the CWC decisions among water users.

Social mobilization for involving non-agricultural water users were also conducted in the command areas of AAC, KBC and SFC (identification of all water users was carried out for these purposes). The meetings with non-agricultural water users for discussion of their membership in the CWC, provisions of the agreement on water supply with the Canal Administration and methods of payment for water services were organized according to the established schedule. In the AAC command area, the following non-agricultural water users were covered by the social mobilization campaign: the territorial administration of Dostuk Settlement, administrations of two brickyards, construction company “Zelenstroy” and hippodrome, community committees of residential quarters No 4, 5, 6, 7 and 8. Mobilizing the community committees of residential areas “Bobolashkar” and “Ishkavan” is in progress. At the same time, other water users are also invited for participation in the regular sessions of CWC. In the KBC command area, mobilization activity related to involving the water supply company of Chkalovsk City, as the main water consumer, in the work of CWC was initiated.

**SMID based on the cooperation with local educational institutions:** To ensure the long-term sustainability of the IWRM-Fergana Project’s results it was decided to share the positive experience learnt from the project with local educational institutions engaged in training specialists for the water sector. For achieving this goal, working relations were established and appropriate Memorandums of Understanding were signed with institutions of higher education and technical colleges (Markhamat Hydro-Ameliorative College; Osh Agricultural Institute; Khodjent Affiliate of the Tajik State University). Visits to the demonstration sites and seminars for know-how activity were held; in addition, technical publications and the project reports were handed over to educational institutions; and the working groups of teachers were established for adapting project know-how in their curricula.

In 2007, above-mentioned educational institutions included additional courses covering IWRM topics in their curricula (50 academic hours: 20 academic hours of theory and 30 academic hours of practice); and 50 students of second and third years of study had practical training at pilot sites, working together with initiators and specialists of WUAs. Working relations were also established with Bishkek and Dushanbe Agrarian Universities with signing appropriate Memorandums of Understanding regarding the future cooperation and handing over of project documents and know-how.

Since 2007, mobilization activity related to dissemination of project experience was initiated on the Right-Bank Canal in Kyrgyzstan. Studying the hydrographical net within the command area of this canal is in progress. Contacts with decision-makers concerning establishing the single canal management system are also initiated. At the same time, measures for raising awareness of key stakeholders regarding establishing the CWC are undertaken.

Positive experience of social mobilization obtained at pilot sites is disseminated on two pilot areas of STR[22] (Shakhimardansay and Khodjabakirgansay). According to the project strategy of social mobilization, disseminating of IWRM principles will be arranged at the following levels: the irrigation system (STR and irrigation system), WUAs (and local communities) and grass-root level (disseminating of the projects methods through local consultants).

**Development of WUAs through social mobilization:** If social mobilization activity during Phase II was aimed at establishing single pilot WUAs, then during Phase III social mobilization was addressed to dissemination of experience obtained at pilot sites over the whole command areas of pilot canals where first WUAs were predominantly established by the administrative method. Therefore all mobilization activities were aimed at all-round development of WUAs in the command areas of pilot canals. SMID field teams consisting of specialists trained in the new strategy of developing WUAs were formed for this purpose.

[22] STR – small transboundary rivers

SMID strategies differed over countries due to peculiarities of local water management and socio-economic conditions. The mobilization process included such interventions as establishing WUAs based on the hydro-geographical principle, re-organization of WUAs established by the administrative method, capacity building of WUAs including training of their personnel (institutional aspects, water resources management within WUAs, drawing up business plans), strengthening activity of WUA Councils and their participation in works of the CWCs, establishing active WUGs. Members of CWUCs, specialists of the BISA and local administrations, chairmen of community-based committees of rural settlements and villages, WUA managers, personnel of hydro-operational sites and water users (farmers) themselves were involved in establishing or re-organization of WUAs according to the hydro-geographical principle. All interventions were jointly coordinated by the provincial executors and field consultants of the SIC ICWC (Table 4.12).

**Table 4.12. Social Mobilization for Developing WUAs**

| Social mobilization and Interventions | | Irrigation Canal | | | |
|---|---|---|---|---|---|
| | | AAC | PMC | KBC | SFC |
| 1. | Number of WUAs established according to the hydro-geographical principle | 6 | 16 | 5 | 12 |
| 2. | Number of WUAs established according to the administrative principle where the SM is in progress | - | - | 5 | 64 |
| 3. | WUGs established due to activity of groups of initiators | 26 | 2 | 35 | 18 |
| 4. | WUGs established by WUAs | 37 | 7 | 33 | 25 |
| 5. | WUA development strategy | Re-arranging WUA according to the hydro-geographical principle;<br>Establishing WUGs and promoting of Council activity;<br>Formalization of WUGs through signing the agreements;<br>Training in water management, drafting business plans, and documenting WUA activity. | | Mapping of potential WUAs;<br>Mobilization in non-restructured farms; involving the CWC;<br>Establishing WUGs in the problematic areas;<br>Training in water management, drafting business plans, and documenting WUA activity; | Mapping of potential WUAs;<br>Re-arranging WUA according to the hydro-geographical principle; involving the CWC;<br>Establishing WUGs in the problematic areas;<br>Training in water management, drafting business plans, and documenting WUA activity; |
| 6. | Number of initiators | 6 | | 6 | 10 |
| 7. | Service area, ha | 9125 | 18000 | 8600 | 96,215 |
| 8. | Area covered by SM activity, ha | 8647 | 5600 | 3245 | 48,107 |

| Social mobilization and Interventions | | Irrigation Canal | | | |
|---|---|---|---|---|---|
| | | AAC | PMC | KBC | SFC |
| 9. | Monthly meetings of WUA leaders | ✓ | ✓ | ✓ | ✓ |
| 10 | Number of trained WUA specialists | 12 | 26 | 6 | 32 |
| 11 | Number of trained WUG leaders | 54 | 18 | 26 | 24 |

The principal task of WUA is uniform, equitable and sustainable distribution of irrigation water among water users. The sustainability of WUA depends on proper water governance and involving water users in the process of water allocation. To bridge some institutional gaps in WUA operation, the project has initiated establishing of water users groups (WUGs) on tertiary irrigation canals and at problematic sites. Enormous mobilization activity was undertaken for establishing WUGs. At that, WUGs have allowed properly arranging water distribution, reducing the number of conflicts, improving the contractual relations with WUAs and technical state of on-farm irrigation systems, enhancing collection of fees for water services

The manual covering all issues of establishing WUGs aimed at WUA irrigators and specialists has been prepared based on the project experience. Objectives and tasks of establishing WUGs and their advantages for improving water productivity, as well as procedures of establishing, functioning and developing were described in this manual in detail. The manual contains the recommendations on water distribution within WUGs (i.e. among water users that take water from a single off-take on tertiary irrigation canals) with detailed description of successive steps necessary for introduction of simple methods of water distribution within and between WUGs.

Apart from other SMID activities in all three countries, field teams facilitate monthly casual meetings of WUAs' managers (informal dinners in line with local traditions) on the voluntary basis for all comers. These meetings were initiated in the frame of pilot WUAs as experiment, but later WUA directors supported this idea and continued these meetings. A major purpose of such meetings is to discuss the burning issues with colleagues, to share their experience in solving these issues and to coordinate a mutual aid of neighboring WUAs etc. Such informal dinners are organized in neighboring WUAs in turn. The meeting is started by firsthand acquaintance of visitors with the WUA (a short guided tour) and by a brief presentation of its achievements and critical problems. After that, all participants jointly cook the pilau[23], and in the process of cooking and during the dinner, participants continue to discuss these problems. The decision on placing at neighbor WUA's disposal of special machinery for cleaning irrigation canals is the telling illustration of the effectiveness of such meetings. Another example is the election of one of experienced dispatchers of the Kuva District Water Administration for rational water distribution among all WUAs established based on the hydro-geographical principle during the periods of water deficit (excessive irrigation water delivered into one WUA can be re-distributed to another one, which needs more water). Initiatives of WUAs' directors related to creating the incentives for planned fee collection (for example, bonuses to WUG leaders who managed to collect 80% of planned fees) are discussed as well

**Water management:** a new method of water rotation between and within WUGs with the complete ten-day cycle was proposed since the ten-day planning of water distribution is employed in Central Asia countries.

Duration of irrigations can be calculated: (1) based on crop pattern and irrigation scheduling; (2) proportionally to farm size receiving irrigation water from an individual off-take. The manual was prepared by us jointly with specialists of the SIC ICWC who have proposed daily water distribution for large plots. This method, earlier tested on the tertiary irrigation canal "Sokolok" (WUA "Japalak"), was widely disseminated among WUG leaders through training seminars. A package of training aids

[23] Pilau is the national favorite dish

was developed; and the training seminars covering five topics: crop water requirement, methods of irrigation scheduling and planning of water use, irrigation water rotations, water measurement methods, monitoring and evaluation of WUA activity based on evaluation indicators were held.

**Small Transboundary Rivers**: Over the past period, social mobilization activity was aimed at introducing IWRM principles and preparing the basis for involving water users according to the principle “bottom-up” on small transboundary rivers Shakhimardansay and Khodjabakirgansay on both sides of the border like SMID activity on the pilot canals and covered the following levels:

1. Irrigation system – Small Transboundary River and main canal
2. WUAs
3. WUGs

For disseminating the project experience and initiating large-scale social mobilization the following arrangements were implemented:

- Cartographical data necessary for implementing the hydro-geographic analysis and planning social mobilization activity related to adoption of the hydro-geographical principle under establishing WUAs were gathered;
- At present, reconciliation of maps with WMOs and water users is in progress;
- An explanatory campaign and mobilization of key parties for establishing the single irrigation system administrations (ISA: a river and main canal) were completed;
- Identifying of all types of water users that have to be covered by large-scale mobilization with purpose of creating the Irrigation System Users Union (ISUU) was implemented;
- Workshops aimed at raising awareness of key parties regarding a role of river commissions, which in the nearest future will be composed by Irrigation System Committees (a joint representative body consisting of the members of ISUU and ISA), are being held;
- Meetings with WUA specialists and irrigators of local communities to explain to them the IWRM principles and to disseminate the project manuals and booklets were organized;
- Initiators have held a number of training seminars concerning irrigation water management within WUAs (topics: crop water requirements, drafting the water use plan; principles of irrigation water allocation, water measuring and accounting, evaluating WUA activity based on established indicators etc.);
- To provide effective mobilization the pilot WUGs were established in pilot WUAs; and
- Field seminars for farmers were held with purpose of dissemination of the project experience and thematic booklets covering the topics related to rise of water and land productivity in private farms.

# CHAPTER 5
# INSTRUMENTS FOR INTEGRATED WATER RESOURCES MANAGEMENT

## 5.1. IWRM Toolbox

**(V.A Dukhovny., V.I.Sokolov)**

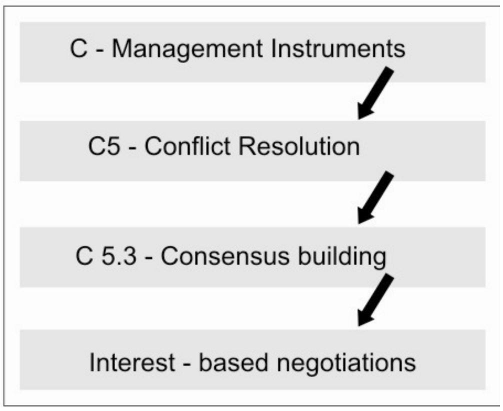
In 2002, the Global Water Partnership (GWP) has published the IWRM toolbox (in 2004, it was translated in Russian and this version can be found on the web at **www.gwpcacena.net**).

In addition, the interactive ToolBox (regularly updated) is to be found on the web at **www.gwptoolbox.org**.

Altogether about 50 different tools are represented in the ToolBox, and the areas covered are set out in Table 5.1.The characteristics of each tool described in the ToolBox allow the user to select a suitable mix and sequence of tools that would work in a given country, context and situation. The problems faced by water professionals are numerous and diverse, as are the political, social and economic conditions, so no blueprint for the application of IWRM can be given. Therefore, the ToolBox provides a range, which users can select and modify according to their needs. Some tools are preconditions for others; at the same time, other tools are complementary, e.g. demand management is strengthened by a simultaneous cost recovery policy. Integrated water resources management, by its nature, establishes and stresses the interrelations of actions, so the tools in the ToolBox are not designed to be used randomly or in isolation. Thus, for instance, water resources policies must take account of other sector policies, in particular land use.

Structurally, the ToolBox is organized in the hierarchical manner with each tool embedded in the wide perspective of IWRM. This structure is illustrated in a cascade below.

For example, a conflict over water resources may be the issue that a user wants to address. Entering Part C in the ToolBox under management instruments, the user will find a chapter on conflict resolution (C5) with a variety of tools. The user may choose to focus on consensus building (C5.3) as the primary goal and study the options listed under the consensus building tools. Going through this, the user may settle on interest-based negotiation as an appropriate approach. The tool is linked to complementary tools, and the user is directed to C 4.4 (communication with stakeholders), C 1 (demand and resource assessment) and A 3.5 (investment appraisal).




The tools are illustrated by real case experience. The cases give examples of how a tool has worked in a given combination and context. Cases are at varying levels of detail and include references to sources of further information.

As the ToolBox demonstrates there are numerous tools available to improve water governance; tools, which differ greatly from each other in their characteristics and the sequence of their use. It is, however, rare for one tool alone to be able to address the identified problems. Given that multiple problem causes are commonplace, it follows that several reforms, using several tools, may be necessary. In addition, for a tool to be effective and acceptable it may often be necessary to embark on several changes at the same time.

A chief shortcoming of the ToolBox is a set of uncoordinated tools without available instructions how to link, integrate and employ them for complete management integration. At the same time, the ToolBox puts insufficient attention to such management tools as water accounting, MIS, adjusting an irrigation schedule, interrelation of irrigation and drainage or surface and ground waters, methods of water use etc. Social mobilization as the powerful tool of initiating the involvement of numerous water users in water governance must play a special role among other tools.

The given chapter presents the most developed and tested methods and tools of introducing IWRM in Central Asian countries.

**Table 5.1**
**List of Tools in the IWRM ToolBox published by the GWP**

**A THE ENABLING ENVIRONMENT**

**A1 Policies - setting goals for water use, protection and conservation.** A group of tools in the ToolBox deal with water policies and their development. Policy development gives an opportunity for setting national objectives for managing water resources and water service delivery within a framework of overall development objectives.

**A2 Legislative framework - the rules to follow to achieve policies and goals.** The ToolBox includes tools for use in the development of water law. Water law covers the ownership of water, the permits to use (or pollute) it, the transferability of those permits, and customary entitlements and underpin regulatory norms for e.g. conservation, protection, and priorities.

**A3 Financial and incentive structures – allocating financial resources to meet water needs.** The financing needs of the water sector are huge, water projects tend to be indivisible and capital-intensive, and many countries have major backlogs in developing water infrastructure. The ToolBox has a group of financing and incentive tools.

**B INSTITUTIONAL ROLES**

**B1 Creating an organizational framework – forms and functions.** Starting from the concept of reform of institutions for better water governance, the ToolBox can help the practitioner create the needed organizations and institutions – from trans-boundary organizations and agreements, basin organizations, regulatory bodies, to local authorities, civil society organizations and partnerships.

**B2 Institutional capacity building – developing human resources.** The ToolBox includes tools for upgrading the skills and understanding of public decision-makers, water managers and professionals, for regulatory bodies and capacity building for empowerment of civil society groups.

**C MANAGEMENT INSTRUMENTS**

**C1 Water resources assessment – understanding resources and needs.** A set of tools are assembled to assist water resources assessment. Assessment starts with the collection of hydrological, physiographic, demographic, and socio-economic data, and setting up systems of routine data assembly and reporting.

**C2 Plans for IWRM – combining development options, resources use and human interaction**. Tools are available for river and lake basin planning entailing the comprehensive assembly and modeling of data from all relevant domains. The planning should recognize the need for parallel action plans for development of the management structures.

**C3 Demand management - using water more efficiently.** Demand management involves a set of tools for balancing supply and demand focusing on the better use of existing water withdrawals or reducing excessive use rather than developing new supplies.

**C4 Social change instruments – encouraging a water-oriented civil society.** Information is a powerful tool for changing behavior in the water world, through school curricula, university water courses and professional and mid-career training. Transparency and product-labeling are other key aspects.

**C5 Conflict resolution – managing disputes, ensuring sharing of water.** Conflict management has a separate compartment in the ToolBox since conflict is endemic in the management of water in many countries and several resolution models are described.

**C6 Regulatory instruments – allocation and water use limits.** A set of tools on regulation is included covering water quality, service provision, land use and water resources protection. Regulations are key for implementing plans and policies and can fruitfully be combined with economic instruments.

**C7 Economic instruments – using value and prices for efficiency and equity.** The ToolBox holds a set of economic tools involving the use of prices and other market-based measures to provide incentives to consumers and to all water users to use water carefully, efficiently and avoid pollution.

**C8 Information management and exchange – improving knowledge for better water management.** Data sharing methods and technologies increase stakeholder access to information stored in public domain data banks and efficiently. complement more traditional methods of public information.

## 5.2 Monitoring Water Sources and Water Use

**(R.R. Masumov)**

Monitoring water sources and water use is one of ways to improve water management efficiency. The efficiency of water resources use depends on well-handled impacts of specific IWRM instruments on behavior of water users [3] including the following tools:

- ***Building water knowledge*** (workshops, training seminars);
- ***Technological tools*** (water measurement devices);

The given section presents technological tools. Establishing the appropriate water measurement system on all water sources and arrangement of all available information in a common database are of top-priority value under water governance. At that, it is necessary to note that if this activity was earlier organized at top levels of water management hierarchy rather well, may be, without sufficient control, then at the level of water users (present WUAs) the status of the stream-gauging network, water measurement and accounting system including processing and analyzing data is quite low. The IWRM-Fergana Project may be presented as the good example of improving water use efficiency through employing monitoring tools.

Monitoring activity was initiated in 2002 by the field checkup of waterworks on pilot main canals resulting in the drawing up of the list of hydrometric equipment requiring replacement or partial modernization. Replacement of gauging rods (water-depth rods) was implemented at all gauging stations and posts on pilot canals. Modern flow-meters were procured to personnel of all hydro-operational sites under the Canal Administrations (CA). In addition, the IWRM-Fergana Project has held training seminars for CA staff and prepared the manual on water measurement and accounting for the specialists servicing the pilot main canals. On-the-job training in calibration of the gauging stations with using new propeller-type current meters (ISB-01) and a tube-type current meter (GTR-type) that are given in Figure 5.1 was held for the CA staff.

In the process of training, a great consideration was given to the accuracy of available information on flow rates. Participants of training seminars have selectively analyzed flow rate charts and tables for the balance and check gauging stations on the pilot irrigation canals. The analysis has shown that flow rate characteristics calculated for some head and balance gauging stations had impermissible inaccuracy (more than 5%) due to changes in the hydraulic regime at the gauging station resulting from side-slope erosion, sedimentation etc.


An action plan was developed to improve the situation related to an accuracy of flow rate measurements by means of elimination of above-mentioned causes. After rehabilitation of canal cross-sections in the vicinity of gauging stations, the Canal Administration has held on-the-job training for personnel covering the adjustment of a discharge rating curve at gauging stations and preparation of new equations and computational tables using the PC for calculating flow rates.

Putting the obligatory four-time measurements a day into practice of all the water-gauging divisions at all balance and check gauging stations on the pilot canals is another action for improving the accuracy of water accounting practice. All these measures have also allowed entering reliable data on flow rates into the database of the on-line information system that can be used for designing the canal waterworks automation.


**Figure 5.1 Instruments for Flow Rate Measurements**

More precise definition of flow rates of pumping units withdrawing water for irrigation is also critical for improving the accuracy of water accounting. Ultrasonic flowmeters installed on discharge pipelines of the pumping stations in the end of 1990s have failed now due to the lack of proper O&M by the special service of manufacturers. At present, pumping stations' discharges are estimated using the design parameters of pump units. Taking into account that service life of many pump units exceeds 20 years it is possible to assume that the estimate of discharges using the design parameters of pump units can be rather inaccurate. In 2007, this fact was proved by the special measurements of flow rates at the alignment downstream of one pumping station withdrawing water from the SFC. Comparison of flow rates that were measured and computed using the design parameters of pump units has shown the discrepancy in about 30%. Thus, equipping of the pump units with modern flowmeters and updating the discharge rating curves of pump units by means of the traditional flow rate measurements are a topical task that allows improving the accuracy of water accounting on the pilot irrigation canals.

During the growing season of 2002, the field surveys of waterworks on secondary and tertiary canals were implemented under *the Component "WUAs."* These surveys have revealed that all off-takes into private farms and dekhkan farms were not equipped with water-measurement means and regulators. Water accounting and analyzing of water allocation among primary and secondary water users are not conducted within WUAs' areas. As a result of these surveys the needs in equipping all off-takes into private farms and dekhkan farms with water-measurement means were specified. All types of standard water-metering facilities and ancillary hydrometric equipment that allow operating them without special calibration were recommended for equipping off-takes (Table 5.2).

**Table 5.2**
**Summary table of standard water-metering facilities and ancillary hydrometric equipment necessary for pilot WUAs (based on data of field surveys in 2002)**

| Water-metering facilities and ancillary hydrometric equipment | Pilot WUAs "Akbarabad" | Water-metering facilities and ancillary hydrometric equipment | | |
|---|---|---|---|---|
| | | | "Akbarabad" | |
| Weir | 7 | Weir | 7 | Weir |

| **Water-metering facilities and ancillary hydrometric equipment** | **Pilot WUAs "Akbarabad"** | **Water-metering facilities and ancillary hydrometric equipment** | | |
|---|---|---|---|---|
| | | | **"Akbarabad"** | |
| Flow-measuring flume | 35 | Flow-measuring flume | 35 | Flow-measuring flume |
| Fixed channel | 16 | Fixed channel | 16 | Fixed channel |
| SANIIRI orifice | - | SANIIRI orifice | - | SANIIRI orifice |
| Water-depth rod | 86 | Water-depth rod | 86 | Water-depth rod |
| Hydrometric bridge | 30 | Hydrometric bridge | 30 | Hydrometric bridge |

Necessary gauging equipment was manufactured by the special-purpose factory "Suvasbobuskunmash" in Tashkent (Uzbekistan) and delivered to the pilot WUAs in January 2003. Equipping of water users' off-takes with water-metering facilities was implemented in successive steps. First of all, the training seminars for WUAs' water users covering issues of construction and operation of water-metering facilities and their calibration (preparing the passport of water-metering structures) were held. Constructing the gauging stations and posts equipped with different types of water-measuring devices was being implemented under direct supervising of the specialist in hydraulic measurements, and this allowed providing a good quality of works (Fig. 5.3).

**a) WUA «Zarafshan»;**

Constructing the gauging posts equipped with SANIIRI flow-measuring flumes "WLS" was conducted by two methods. The first method is the on-site manufacture of flumes using collapsible portable formwork for pouring concrete; and the second one is delivery and assembling pre-cast flumes (Figure 5.4).

**b) WUA «Japalak»**

**Figure 5.3**
**Gauging posts equipped with Chipoletti weirs: where: 1 – Chipoletti weir; 2 – stiffening bar; 3 –gauging rod "RUG"**

a) On-site manufacturing flumes using collapsible portable formwork

b) Assembling pre-cast flumes

**Figure 5.4 Constructing gauging posts equipped with SANIIRI flow-measuring flumes "WLS"**

A high quality of the gauging posts enabled the pilot WUAs' personnel to certify the ready-built gauging posts in timely manner and without any comments from the National Standardizing Authority. Equipping all off-takes with water-metering facilities was confidence-building measure of water users to water management organizations regarding water allocation. A special form for submitting applications for irrigation water was developed and introduced in the pilot WUAs for more active involving of water users in the process of water management and allocation. As a result, each water user could submit his application for irrigation water beforehand. WUA's personnel was reviewing the applications of each water user and establishing priorities of water distribution for next ten-day period. Introducing such an order enabled the WUA's personnel to establish the rigid schedule of water distribution in accordance with the daily water use plans drawn up beforehand and to supply irrigation water to all water users taking into consideration their real demands in fairer manner. It is necessary particularly to note that, first of all, an end user receives irrigation water according to the established schedule of irrigation water distribution and delivery (Figure 5.5). The so-called "publicity board" recommended by the project personnel and demonstrated in each WUA plays an important role in disseminating information on a sequence and rate of water delivery to each water user on the daily base.

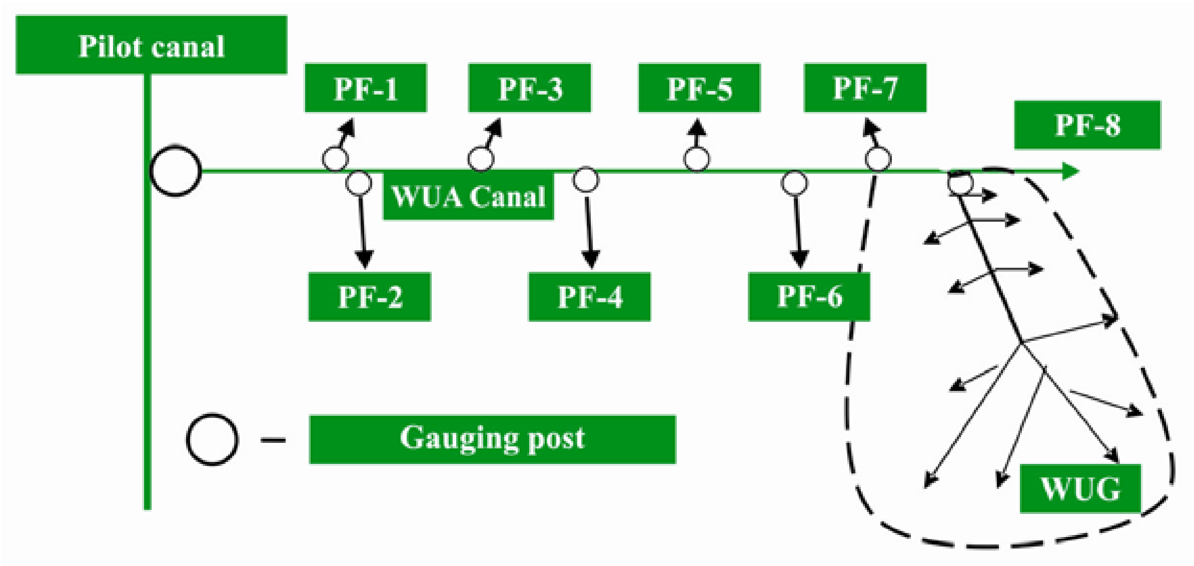



**Figure 5.5 A Linear Network of the Secondary Canal in the WUA**

In addition, the programs of training seminars included topics related to the water accounting in WUAs (daily three-time water measurements at the gauging posts with writing down into the register of an established format) along with on-the-job training of water users covering water measurements using water-metering devices and their maintenance. WUAs' personnel were completely procured with the methodological guidelines developed in the frame of the project (e.g. "Manual on Water Measurement and Accounting for WUAs' Specialists").

By the end of 2004, these measures allowed WUAs' personnel to solve their major task – equitable water distribution among WUAs' members resulting in lowering the level of social tension.

At present division of private and dekhkan farms is in progress within pilot WUAs in the project area. In 2007, according to survey data, the number of private and dekhkan farms in the WUA "Zarafshan" in Tajikistan and in the WUA "Akbarabad" in Uzbekistan has almost doubled in comparison with 2004, and their number in the WUA "Japalak" in Kyrgyzstan has increased up to five thousands. At the same time, in our opinion, the level of availability of water measurement facilities in WUAs has to be reasonable. The project consultants have therefore proposed grouping small farms (see Figure 5.5) into water user groups (WUGs) with delegating their powers to an elected leader who will be responsible for water distribution. In this case, the right of each water user to have water-metering device at his off-take cannot be excluded. Hypothetically, in the process of fund accumulation, raising awareness of the need to support accurate irrigation water supply, and economic strengthening of WUAs, each farmer or another water user will hold an interest in installing water-metering device at his off-take to avoid excess payment and to have grounds for defending his water demands against the WUA.

One cannot be restricted only by activity related to equipping the canal network, WUAs, farms and other water users with water-metering facilities. It is also necessary to provide the methodology and means for specifying numerous indicators (e.g. volumes and quality of return water permissible for reuse) that are important not only for water management organizations and land reclamation agencies but also for water users themselves for successful water use and management, as well as for evaluating the water use efficiency and impacts (see Chapter 3).

It is necessary to establish the system of monitoring and evaluating return water that can be used for irrigation. In dry 2006 and 2007, when available water resources were limited, many WUAs in the SFC command area were forced to use drainage water from inter-farm collector-drains and tubewell drainage (TWD) for irrigation. In particular, drainage water was used for irrigating 300 ha in the WUA "Akbarabad" located in the command area of canal RP-1, raising water availability by 25-30%, on average. At the same time, in some places temporary cofferdams were arranged in collector-drain channels for diverting drainage water by gravity resulting in backwater and raising groundwater table on adjacent areas and, finally, in deteriorating the water and salt balance on lands of upstream WUAs. Therefore, drainage water use must be organized under supervision of the PHAE that is responsible for monitoring drainage water disposal through inter-farm collector-drains.

Climatic conditions essentially affect amount and timing of water applied. For example, rainy and belated spring, relatively cool summer and warm and dry autumn were observed in 2007. Therefore, rapid information on changes in the water and salt balance within the area where drainage water was used for irrigation and daily and long-term forecasts of the Hydro-Meteorological Service were very important. All this information should be promptly transferred to the WUA Council to develop appropriate measures aimed at adjustment of water consumption, lowering groundwater table and preventing soil salinization in the command areas of inter-farm collector-drains.

## 5.3 Evaluating and Managing Water Demands

**(Sh.Sh. Mukhamedjanov, M.G. Khorst, N.N. Mirzaev, G. Stulina)**

The tools simple for understanding and use were developed in the frame of IWRM-Fergana Project for management of the irrigation and agricultural practice, namely the modeling software that can be easily applied by local specialists, taking into consideration available data, in order to draw up the irrigation schedule. Three versions of the modeling software "Daily Computing the Water Balance and Irrigation Schedule" were developed. The first one is based on daily measurements of evaporation in a field. The second one, that uses the formula suggested by S. Ryzhov, is based on daily measurements of the soil water content in a field; and finally third version is based on the model «CROPWAT» [32] with using climatic data (air temperature, rainfalls, relative air humidity, wind velocity). The first two models that are used by local consultants and specialists at the provincial and regional level were designed for timing irrigations and specifying their amounts. The model "CROPWAT" is designed for forecasting and adjusting timing and amount of water applied by the regional specialists. In the process of their developing, the models "Daily Computing the Water Balance and Irrigation Schedule" and «CROPWAT» were tested and calibrated by using field data on actual soil water content. Precondition for providing the required accuracy of calculations is the reliability of daily field measurements and data on soil parameters determined on each demonstration field in the course of special field surveys.

For assessing and analyzing the actual practice of water applications, we have calculated the optimal amounts and dates of irrigations based on data on soil characteristics on each demonstration field, rainfall, evaporation, watertable depth and initial soil water content, and then compared them with amounts that were calculated based on soil moisture deficit. Irrigation water demand depends on the field water balance, crop water requirements and soil water content. Computations of daily water balances for all demonstration fields under cotton were carried out. As a result of these computations, water requirements, amounts and dates of water applications and inter-irrigation periods were established.

Monitoring of actual irrigations over the whole growing season was implemented for comparative analyzing the adequacy of actual water application rates to the estimated ones. It was determined that at the initial phase of project implementation, actual basic indicators of irrigation considerably differed from the estimated ones. For example, unproductive water applications were observed in September and October in farms of Soghd Province (Figure 5.6). In accordance with computations, the water application rates ranging from 700 to 1200 $m^3$/ha would provide optimal soil moisture for crops up to the end of the growing season.

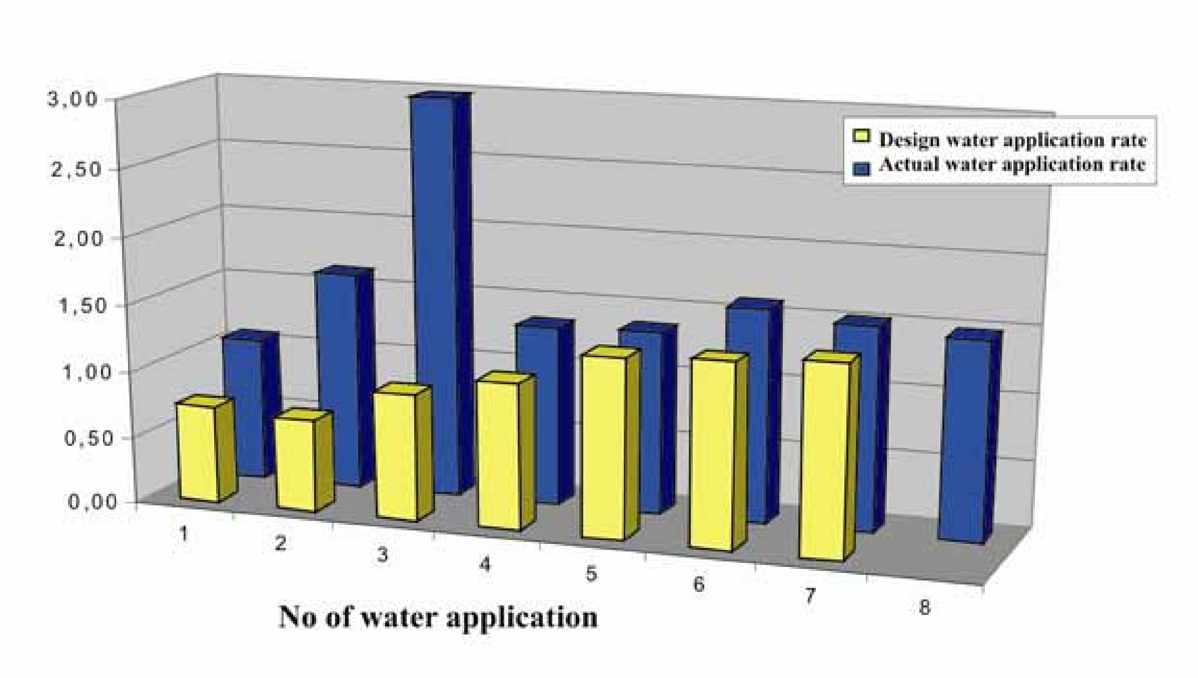



**Figure 5.6 Water Application Rates in the Farm "Bokhoriston" in 2002 (000' $m^3$/ha)**

Extra irrigations can only lead to slowdown of natural ripening of cotton and opening cotton bolls. Insufficient applications of water (both by amounts and timing) took place in farms "Sayed" and "Samatov" in July and August. In Fergana Province, actual irrigations close to the estimated irrigation schedule were observed in three farms with different soil and hydro-geological conditions. Actual irrigation norms exceed the estimated ones two times and even more in farm "Khojalol-Ona-Khodji" where thin topsoil is underlain by the pebble layer with considerable water permeability (Figure 5.7). In accordance with modeling computations more frequent water applications by smaller rates should be more efficient on these plots.

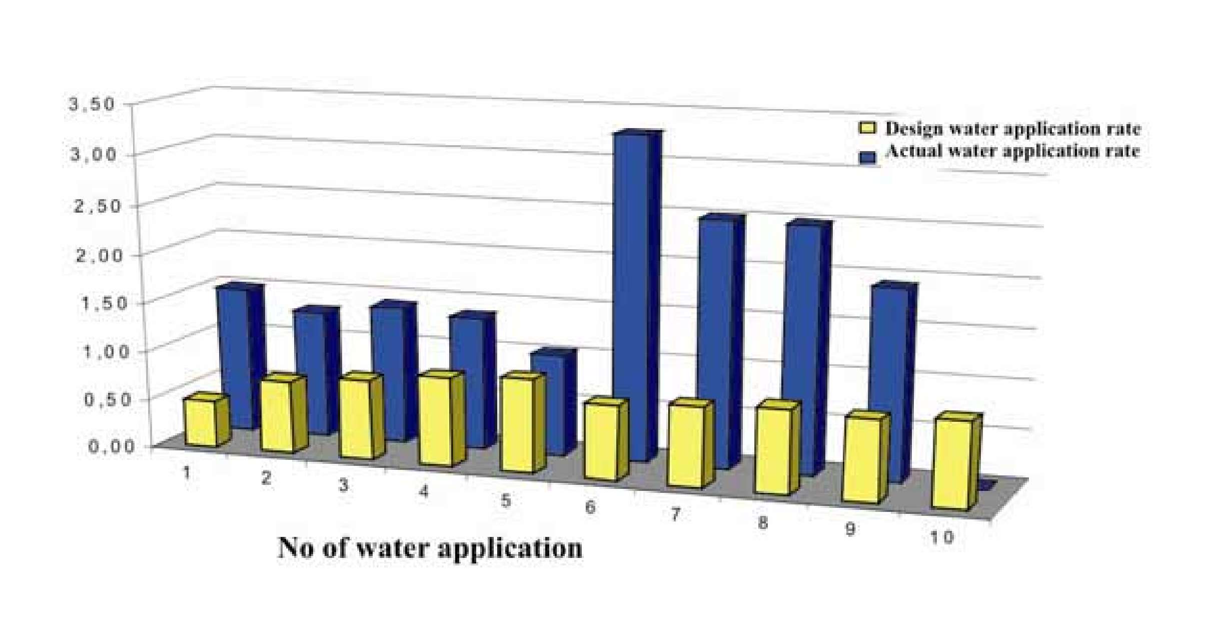



**Figure 5.7 Water Application Rates in the Farm "Khojalol-Ona-Khodji" in Fergana Province in 2002 (000' $m^3$/ha)**

There is some discrepancy in timing and amounts of actual water applications with estimated ones in the farm "Tolibjon" under implementing the same number of irrigations. It was determined that the first belated water application with a high rate disturbed the uniformity of following irrigations (both by amounts and timing). In accordance with computations of daily water balances, the optimal rates for water applications amounts to about 1100 m3/ha with an inter-irrigation period of 15 to 20 days.

In Osh Province, actual rates of water applications coincide with estimated values (only the first over-application of water was observed) but there is some discrepancy in timing. Analyzing soil water content prior to the first irrigation in the farm "Sandyk" has shown that there were not the need to apply high irrigation rates because abundant rainfalls were in May and actual soil moisture deficit on 3$^{rd}$ June amounted to only 505 $m^3$/ha while actual water application made up 1463 $m^3$/ha (Figure 5.8).

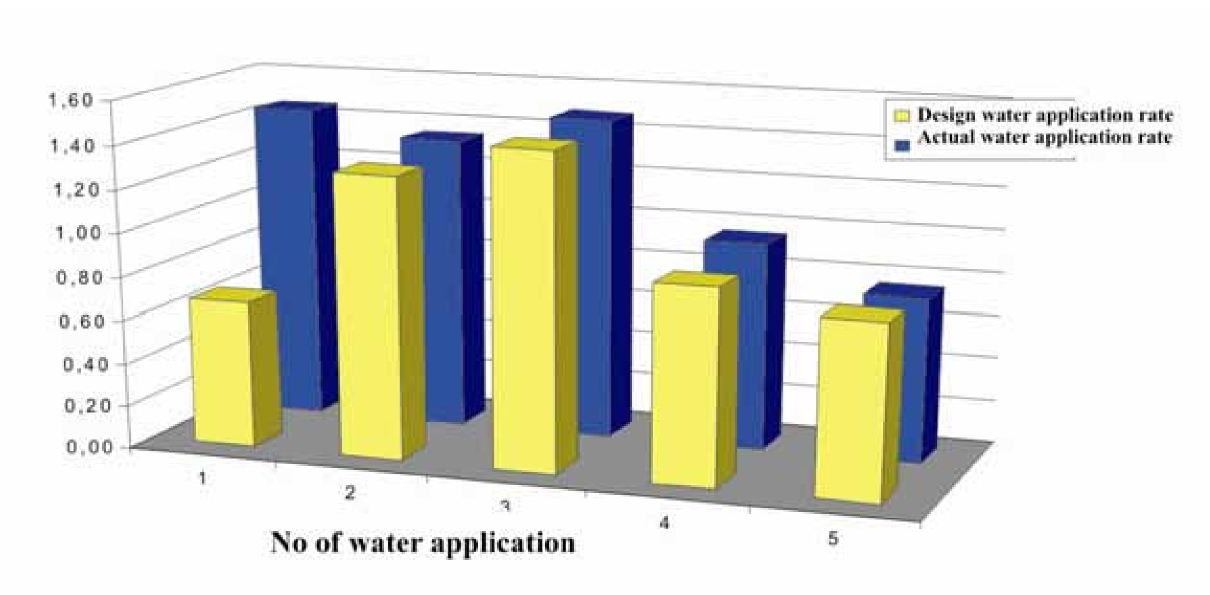



**Figure 5.8 Water Application Rates in the Farm "Sandyk" in 2002 (000' $m^3$/ha)**

**Water application management based on the project recommendations:**

In 2003, scheduling of irrigations basically depended on current weather conditions. This issue should be considered in detail because weather conditions in that year required considerable amendments in irrigation water use, date of sowing, and soil treatment. As subsequent months have shown, a fault in these matters was worth much. Only timely and correct measures implemented at the pilot sites have saved the 2003 yield.

Analyzing meteorological data in March and April enabled the regional project group to identify a more accurate sowing date for cotton that was shifted to later terms than usual. It was recommended to start the sowing season in the end of April or in the beginning of May. Most of farms under pressing of local authorities were forced to start the sowing season in the beginning of April. As a result most of private farms have re-sown cotton in May. Shifting sowing dates has predetermined adjusting the irrigation schedule. Frequent abundant rainfalls in May alternated with sunny days without precipitations did not allow determining real water demand using the simulation program for its computation. It was the situation when the soil-water content over the soil profile was sufficient but an upper soil layer started to dry up. In usual years, plants would grow normally without irrigation because in mid of May a depth of root system makes up more than 10 cm, and roots can extract required water from soils. In that year, a root system of cotton, which was behind the normal growth (a rootage depth was less than 10 cm), could not extract required water from soil horizons where the moisture content was quite sufficient. Computational models have not shown the necessity in irrigation; however, based on assessing an actual situation, the decision was made to start the first water application by small rates in farms which conducted the sowing in the first ten-day period of April. Farmers, who conducted the sowing in the end of April and in the beginning of May, have made watering only to stimulate young growth and then waited for next irrigation in June.

Planning next water applications on each demonstration site was carried out based on the formula suggested by S. Ryzhov and modeling the daily water balance. The regional group, parallel to local specialists, has set daily data on evaporation and a width of shading into the model "Daily Computing the Water Balance and Irrigation Schedule." Daily data were transferred from provinces to the regional office by e-mail. Analyzing the results of modeling for May has shown that there is not the need in irrigation under daily evaporation ranging from 2 to 8 mm/day (a cumulative soil moisture deficit amounted to 12 -24 mm).

The need in the first water application over demonstration sites has arisen since mid until the end of June. Setting a date of water application is carried out based on the results of modeling with some advance time (2-3 days); for this purpose, data on soil moisture deficit and evaporation for a past day are being analyzed. Input data for a past day are set into appropriate boxes of the computational model (a few days in advance in order to specify a date of water application ahead of time). A date of water application is checked and, if necessary, adjusted according to data on actual soil water content, which is measured by observers on demonstration field each two-three days. Pre-irrigation soil water content (a refill point) used for specifying a date of water application is accepted as 70% of field capacity (FC) for all fields on average. Following dates of irrigations were set in line with the same sequence analyzing modeling data on evaporation and soil water content.

**Evaluating water applications and changes in soil water content on demonstration fields:**

Assessment of soil water content was conducted using data of actual measurements in the field. Sampling to measure soil moisture was performed on demonstration field each five days in May and each three days in mid of the irrigation season. On some fields (the farm "Khojalol-Ona-Khodji"), where frequent water applications are needed, a soil water content was measured each two days. A nature of soil moisture distribution depends not only on climatic conditions but also soil properties and hydro-geological conditions in the farms and can vary even within one field.

In Soghd Province, the period of reducing soil water content from FC to the limit when the need in irrigation arises (an irrigation interval) lasts 25 to 30 days in May; in June and first half of July this period makes up 20 days; and in the second half of July and until the end of August the intensity of soil water consumption is increasing and reducing in soil water content up to "wilting point" occurs during 7-8 days (Figure 5.9).

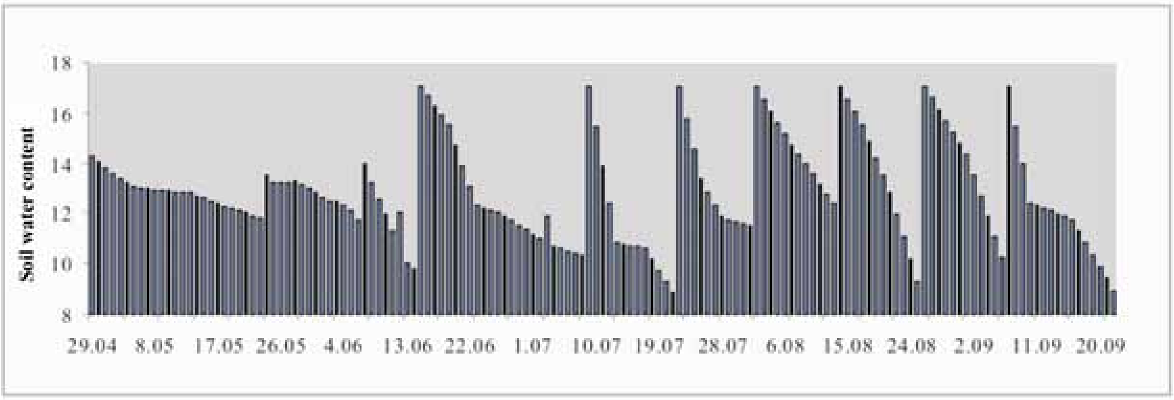



**Figure 5.9 Changes in the soil water content during irrigation intervals[24]**
**(Soghd Province, the Farm «Bokhoriston»)**

If in Soghd Province (Tajikistan) soil and hydro-geological conditions are similar in farms then in Fergana Province (Uzbekistan) these conditions considerably differ over farms and even over fields within one farm. Changes in soil water content also occur according to different patterns in different farms. In the farm "Khojalol-Ona-Khodji", after rainfalls in May and until 10th June, the period of reducing soil water content up to the limit when the need in irrigation arises lasted 20 days, then since July and until the end of the growing season, the period of consumption of water stored in soil amounted to 7 to 8 days (Figure 5.10). Absolutely other situation was observed in the farm "Turdialy" where, due to shallow groundwater table, perceptible reducing the soil water content was not observed during the whole growing season. Changes in soil moisture content on the demonstration field depend on fluctuations of watertable; and any correlation between decrease in soil water content and increase in air temperature was not revealed. Only after irrigation, reducing soil moisture close to field capacity was observed.

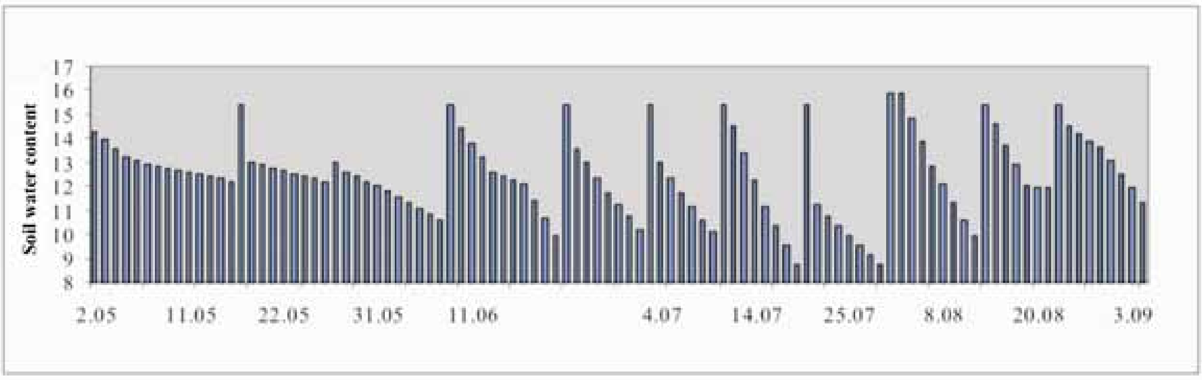



**Figure 5.10 Changes in the soil water content during irrigation intervals**
**in the farm "Khojalkhonona Khoji"**

In Kyrgyzstan, on the demonstration field under winter wheat, irrigation was needed only in May and June. At that, rainfalls in that period have conditioned the dynamics of soil water content, which is quite sufficient for proper crop growth. Decrease in soil water content started in the mid of June; and only one water application with a small rate was needed in June in the farm "Toloykon" (Figure 5.11).

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[24] The *irrigation interval* is the time between subsequent irrigations.

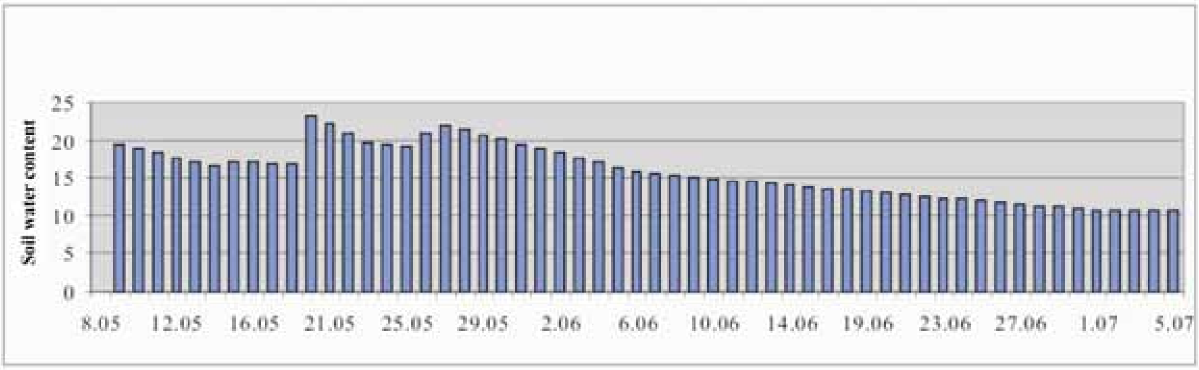



**Figure 5.11 Changes in the soil water content during irrigation intervals in the farm "Toloykon" in Kyrgyzstan**

**Assessment of evaporation on demonstration fields:** Evaluating the evaporation demand of the atmosphere was carried out by daily measurements using atmometers «Atmometers» (ET gage®) that were installed on each demonstration field. The evaporation from a field surface depends on air temperature changing over a year and a specific month. Evaporation values varied over the range of 5 to 12 mm/day during the growing season. The least evaporation values of 1 to 3 mm/day were observed in the first ten-day periods of May and June. Maximum evaporation values of 10 to 12 mm/day were being observed since the second half of June until 20$^{th}$ July. Although, it is necessary to note the non-typical reducing evaporation values in the end of June and in July, which sometimes were reaching 5-6 mm a day.

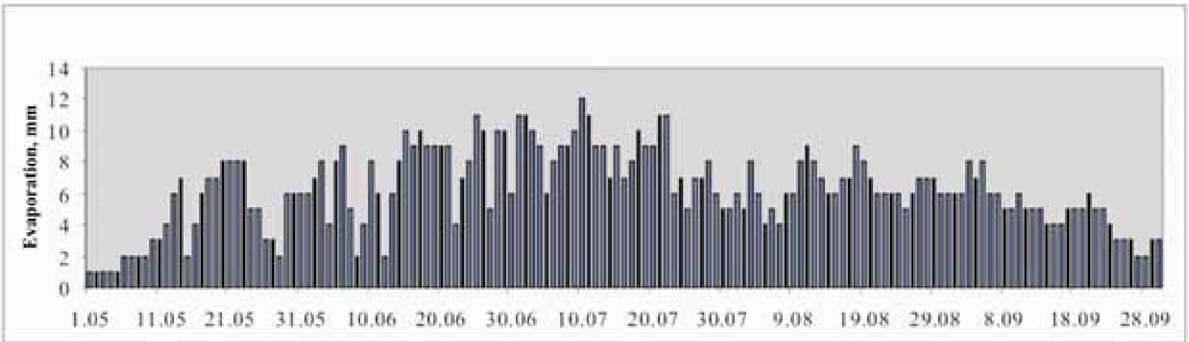



**Figure 5.12 Evaporation values measured on the demonstration site "Bokhoriston"**

Lower values of evaporation and precipitations have predetermined scheduling of irrigations (in May and at the beginning of June, irrigation was not required on all pilot fields). There is some distinction in evaporation values over the regions and some private farms. Maximum mean evaporation rates over the whole growing season were observed in Soghd Province in Tajikistan (7-8 mm/day), at the same time, in Fergana Province in Uzbekistan, mean evaporation rates were ranging from 6 to 7 mm/day, and in Osh Province in Kyrgyzstan from 4 mm/day in the upper zone (the farm "Toloykon") to 7 mm/day in the lower zone (the farm "Sandyk").

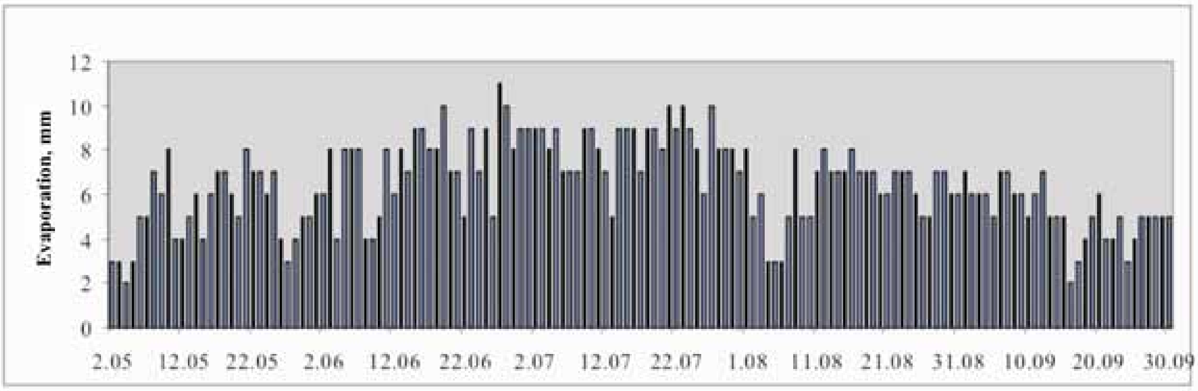



**Figure 5.13 Evaporation values measured on the demonstration site "Khojalkhonona Khoji"**

**Soil moisture content against evaporation on the demonstration fields:** A set of data on soil moisture conditions and evaporation over the growing season allowed us to find out the correlation between these parameters. Measurements of evaporation rates and soil water content in 2003 and 2004 enabled us to compare the soil moisture-evaporation relations for the years with different weather conditions. Both parameters are key factors affecting the irrigation schedule. Under field conditions there are not real possibilities for real-time measurements of soil moisture content but data on evaporation measured at the weather stations are always exist and, moreover, in many instances, satisfactory correlations between air temperatures and evaporation are available. Weather conditions in 2003 have predetermined lower values of daily evaporation and, as a result, more sustainable storage of water in soils. In 2004, weather conditions were more favorable for agriculture with the stable air temperature regime and less amount of rainfalls during the growing season. These conditions, in turn, resulted in higher daily evaporation rates and less sustainable storage of water in soils. The soil water content as a function of evaporation is illustrated in Figure 5.14 (the private farm "Sayed").

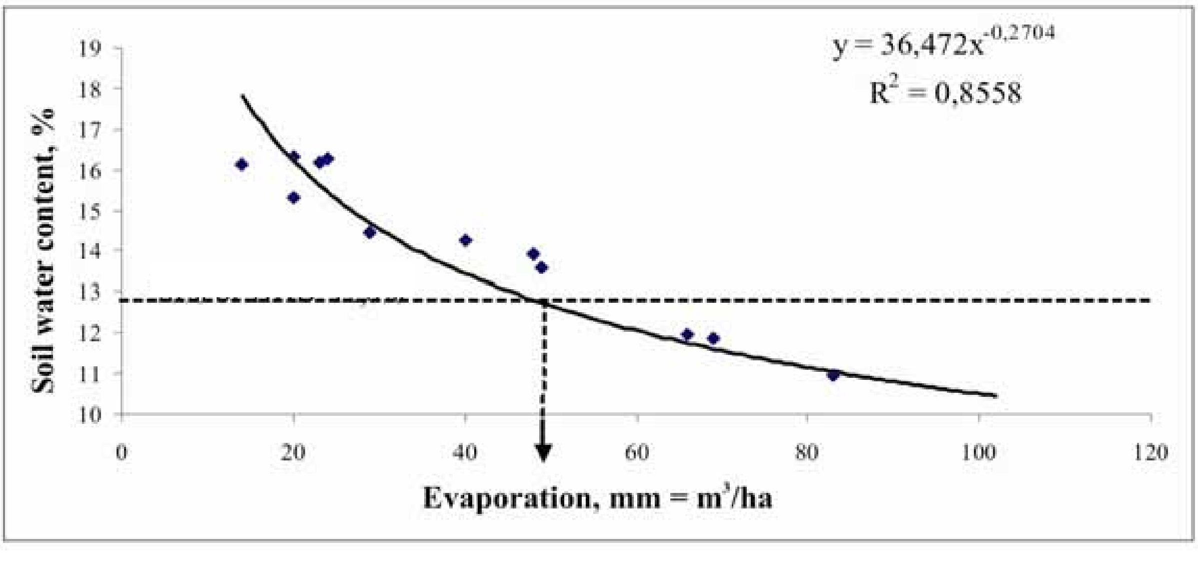



**Figure 5.14 Soil water content as a function of evaporation at the demonstration site "Sayed"**

We recommended this approach for day-to-day forecasting pre-irrigation soil moisture content and timing irrigations if such correlations will be established for each soil-hydrogeological-climatic zone. Under achieving a certain value of daily evaporation (this is happened later in 2003 and earlier in 2004), the soil water content is decreasing up to the level when crops are subjected to water stress (soil moisture deficit). Analyzing the changes in evaporation rates and soil water content has shown that at the project demonstration sites a soil moisture deficit that can cause water stress of crops takes place when total evaporation over an irrigation interval is ranging from 50 to 120 mm, on average. Depending on soil and hydrogeological conditions, the amount of water applied (a net volume of water application in a field) to replenish a depleted soil water storage varies over the range of 500 $m^3$/ha to 1200 $m^3$/ha.

**Adjustment of the irrigation schedule based on analyzing the irrigation practice at demonstration sites:**

**Measuring a watertable depth**

Reforming the agricultural sector in Central Asian countries resulted in division of large collective farms into small private farms. At that, the system of irrigation water allocation among farms has been changed. In the past, irrigation water allocation based on the principles of crop water requirement zoning and was being carried out by the district water management organizations that were responsible for delivering irrigation water towards the border of a collective or state farm. Irrigation specialists of the collective farm were responsible for irrigation water distribution among the irrigated units (brigades) within these farms. Crop water requirements were established based on area-averaged data and sometimes did not meet the actual requirements of crops in water. Such an approach to irrigation water rate setting was justifiable since irrigation engineers and agronomists were implementing irrigation water allocation within a farm taking into account a flow rate of uniform irrigation water supply specified by the district water management organization. In this case, experienced agronomists and irrigation engineers could adjust the irrigation schedule to actual requirements of specific crops in water.

However, most of farm managers could not adjust the planned irrigation schedule which, on the one hand, was limited by the irrigation water supply rates and, on the other hand, by modified soil and hydrogeological conditions on the given area. As far back as in collective farms, the question regarding the contradiction of the planned irrigation schedule to actual requirements of specific crops in water under modified soil and hydrogeological conditions was being raised. After division of large collective farms into small private farms 10 to 20 hectare in area, decisions on water allocation and specifying the irrigation rates became more problematic. First of all, the methodology for scheduling irrigation water allocation among private farms is absent. Secondly, there are not the well-founded irrigation rates and procedures of scheduling irrigation for specific areas in private farms. Initial studying of water use in private farms has shown that the lack of well-founded irrigation schedules (amounts and timing of water applications) results in stochastic use of irrigation water by farmers during the whole growing season. Wrong use of irrigation water results in water losses, over-irrigation in some areas and insufficient water applied in other areas, as well as in low land and water productivity.

**Atmometer (ET gage®)**

Therefore, it is important to develop the scientifically grounded irrigation schedules for different crops and soil and hydrogeological conditions, based on which WUAs can develop the well-founded plans of water use, specifying reasonable volumes of irrigation water supply to private farms. In this respect, a key project objective is to study actual crop water requirements at demonstration sites and develop recommendations on scheduling water applications.Project monitoring and evaluation of irrigation water use on demonstration fields that are described in the following sections in detail has allowed to specify the amounts and timing of each water application and to adjust the irrigation schedule for private farms located within the pilot WUAs: “Sayed” in Soghd Province in Tajikistan; “Turdialy” in Fergana Province in Uzbekistan; and “Nursultan-Aly” in Osh Province in Kyrgyzstan. Based on project findings, the modified irrigation schedules were recommended for appropriate WUAs (Tables 5.3; 5.4 and 5.5). The existing (design) irrigation schedule for above-mentioned private farms was developed based on the crop water requirement zoning performed in the 1960s and 1970s. During past decades, water-management, soil and hydrogeological conditions in many irrigated schemes have changed. As a result, the former crop water requirement zoning and design irrigation schedule do not fit with current conditions. For example, irrigated farmlands of the private farm “Turdialy” belonged to Zone II with the automorphic soil formation process[25] according to the former crop water requirement zoning, however, after many years of irrigation and raise of watertable these irrigated farmlands now belong to Zone VII with hydromorphic[26] soil formation process. As a result, the irrigation schedule has to be also changed for the growing season.

**Table 5.3**
**Adjustment of the irrigation schedule for the private farm “Turdialy”**

| | April | May | | | June | | | July | | | August | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ten-day period | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Design irrigation schedule | 0.00 | 0.0 | 0.0 | 0.5 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 0.8 | 0.6 | 0.5 | 0.5 |
| Recommended irrigation schedule | 0.00 | 0.94 | 0.00 | 0.00 | 0.76 | 0.00 | 0.74 | 0.00 | 0.48 | 0.00 | 0.00 | 0.00 | 0.00 |

As shown in Table 5.3, in practice, water application was needed in the first ten-day period of May. However, according to the irrigation schedule based on the crop water requirement zoning, water application was planned in the third ten-day period of May i.e. the difference between actual and design dates of water application amounts to 20 days. Such a shift in the irrigation schedule results in mismatching of the water use plan and required irrigations. As a result, either reducing crop productivity takes place or modification of WUA’s water use plan and respectively planned water allocation along an irrigation canal as a whole are required.

Comparison of the irrigation schedule based on the crop water requirement zoning and actual irrigation schedule at the demonstration site is illustrated in Figure 5.15. The figure shows that according to the water use plan developed by the WUA, irrigation was not planned for the period since the end of April until the beginning of May, and in July water application rates exceed necessary ones five times; at the same time, irrigation water supply that does not match the real needs of crop in water under existing soil and hydrogeological conditions was planned.

[25] Soil formation without participation (upward recharging) of groundwater
[26] Soil formation with participation of groundwater (according to the classification of Soviet soil scientists)

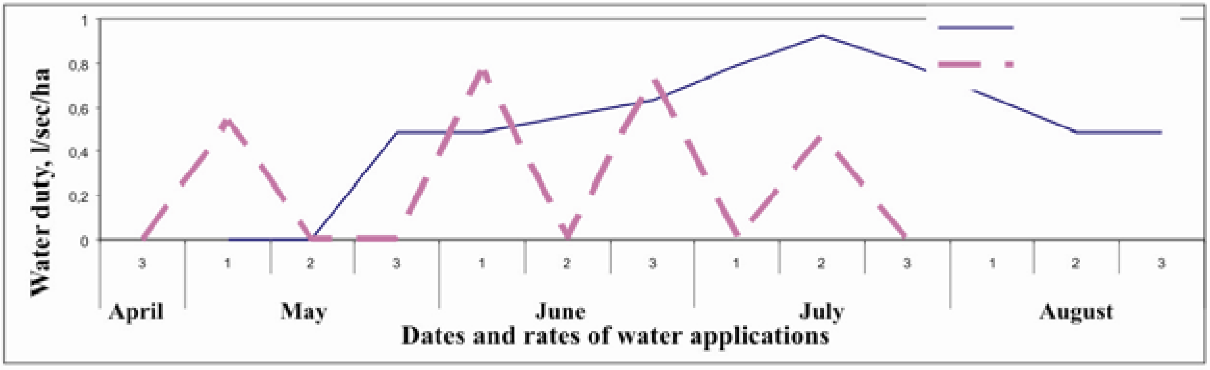



**Figure 5.15 Comparison of the irrigation schedule based on the crop water requirement zoning and actual irrigation schedule at the demonstration site "Turdialy"**

In Soghd Province, the actual number of water applications at the demonstration site was less than according to the irrigation schedule based on the crop water requirement zoning; and crop water requirements were also lower in comparison with design ones (Table 5.4 and Figure 5.16).

**Table 5.4**
**Adjustment of the irrigation schedule for the private farm "Sayed"**

| Month | IV | | | V | | | VI | | | VII | | | VIII | | | IX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ten-day period | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 |
| Design irrigation schedule | 0.13 | 0.51 | 0.13 | 0.0 | 0.29 | 0.61 | 0.7 | 0.8 | 0.91 | 0.99 | 1.1 | 1.3 | 1.03 | 0.82 | 0.72 | 0.36 |
| Recom-mended irrigation schedule | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.63 | 0.0 | 0.99 | 0.0 | 1.07 | 0.0 | 1.41 | 0.66 | 0.79 | 0.69 | 0.91 |

In Osh Province, there are differences in timing, number of irrigations and water application rates for winter wheat (Table 5.5).

**Table 5.5**
**Adjustment of the irrigation schedule for the private farm "Nursultan-Aly"**

| Month | Sep | Oct | | | Nov | | | Apr | | | May | | | June | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ten-day period | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Design irrigation schedule | 0.93 | 0.0 | 0.0 | 0.33 | 0.33 | 0 | 0.0 | 0.46 | 0.5 | 0.41 | 0.37 | 0.45 | 0.45 | 0.32 | 0.32 | 0.1 |

| Month | Sep | Oct | | | Nov | | | Apr | | | May | | | June | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recom-mended irrigation schedule | 0.0 | 0.0 | 0.0 | 0.28 | 0.85 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.59 | 0.0 |

Based on the results of comparative assessment, we have adjusted the irrigation schedule, taking into consideration specific soil and hydrogeological conditions on project demonstration fields (Table 5.6).

One of key components predetermining fair water allocation is clear information on actual crop water requirements, taking into consideration time-dependent hydrogeological, soil and climatic conditions. Therefore, in the frame of the IWRM-Fergana Project, the applicability of out-of-date norms and crop water requirement zoning that were approved more than 20 years ago have been analyzed for the whole territory within the SFC command area using the available data in Fergana Province. Analysis has shown that areas with GWT over the range of 1.5 to 2 m increased and, at the same time, areas with GWT over the range of 2 to 3 m decreased and areas with GWT ranging 0 to 1 m appeared; part of areas with a watertable depth more than 5 m has shifted to the range of areas with a watertable depth of 3 to 5 m. Increase in areas referring to Zones VII, VIII and IX (the crop water requirement zoning) practically in all districts is illustrated in Figure 5.16.

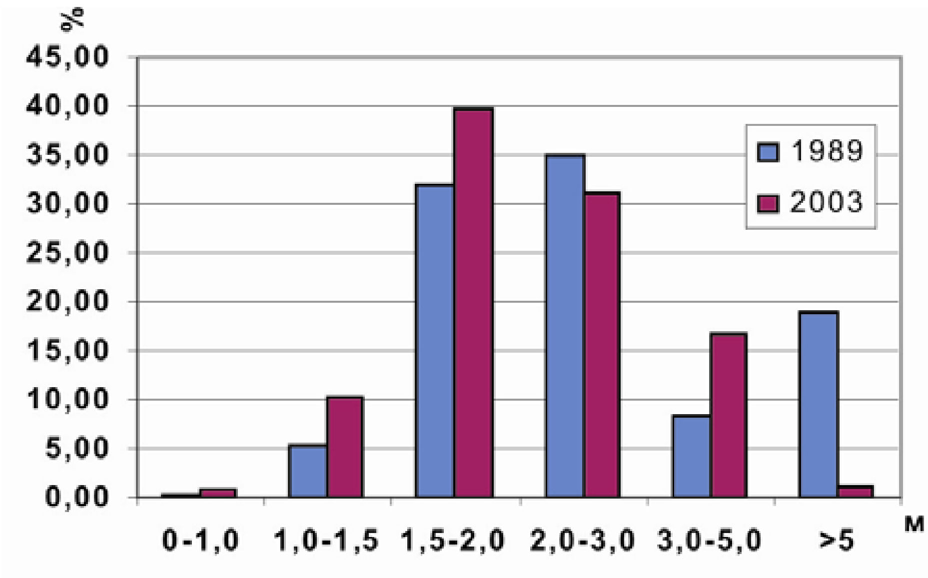



**Figure 5.16 Changes in watertable depth, Fergana Province, Uzbekistan**

Table 5.6

**Adjusting the irrigation schedule at demonstration sites under the IWRM-Fergana Project**

| Demonstration site | Water duty zone | Soil characteristics | Irrigation season | Number irrigations | Water application rate, $m^3$/ha | | Water requirement, $m^3$/ha | | Ten-day water duty |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Net | Gross | Net | Gross | liter/sec * ha |
| **Soghd Province** | | | | | | | | | |
| WUA "Obi Zerafshan" (design zoning) | II | Automorphic (GWT > 3 m), medium thick layer, weak-stony loamy sand and sandy-loam soil | IV - IX | 15 | 500-600 | 600-800 | 6566 | 8550 | 0.6-1.3 |
| Demonstration site "Sayed" | II | Automorphic shallow stony sandy-loan underlain with pebble layer | IV - IX | 7 - 8 | 500-600 | 600-800 | 4995 | 6166 | 0.6-1.4 |
| **Fergana Province** | | | | | | | | | |
| Farm "Turdialy" (design zoning) | II | Automorphic (GWT > 3 m) medium thick layer, weak-stony loamy sand anc sandy-loam soil | IV-IX | 9 | 500-600 | 600-800 | 5600 | 7500 | 0.5-0.9 |
| Demonstration site "Turdialy" | VIII | Hydromorphic (GWT of 0.5-1.5 m) shallow stony sandy-loam underlain with pebble layer | IV-VIII | 5 | 500-600 | 600-900 | 2976 | 3429 | 0.7-1.0 |
| **Osh Province** | | | | | | | | | |
| WUA "Japalak" ( design zoning ) | 4a | Automorphic (GWT > 3 m) | IX-XI<br>IV-VI | 2<br>4 | | 600-800<br>600-1000 | | 1400<br>3000 | 0.7-0.9<br>0.3-0.5 |
| Demonstration site "Nursultan- Aly" | 4a | Automorphic (GWT > 3 m) thick sandy-loam and loam soils, undulating relief | X-XI<br>IV-VI | 1<br>1 (2) | 900<br>400 | 1200<br>500 | 900<br>400 | 1200<br>500<br>(1000) | 1.4<br>0.5 |

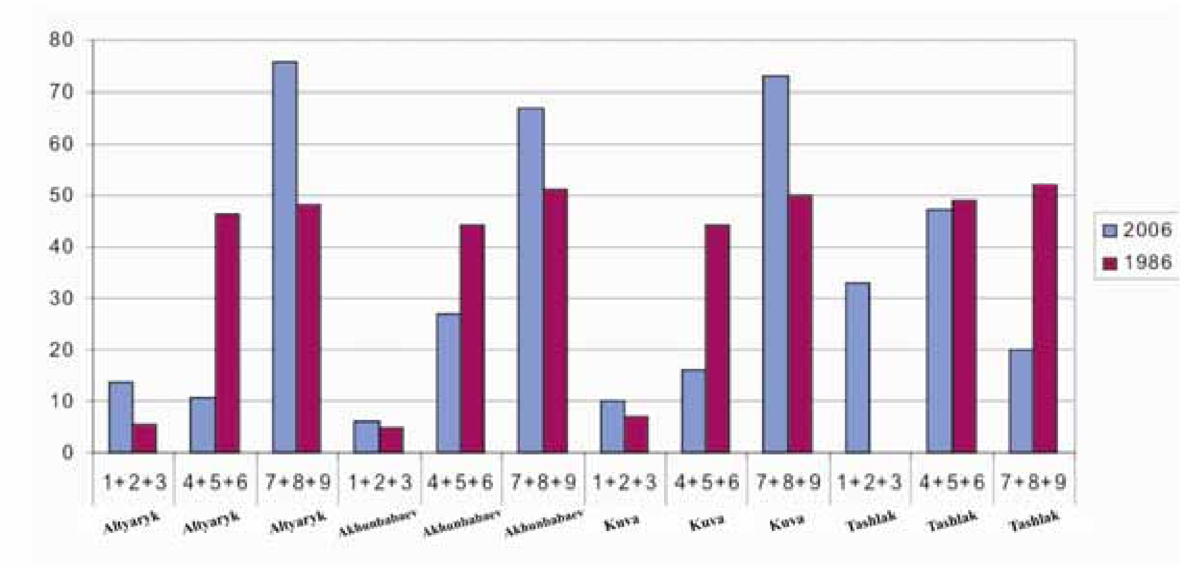



**Figure 5.17 Changes in distribution of irrigated area per the crop water requirement zones in Fergana Valley**

Estimating irrigation water demand for the SFC command area was performed separately for Fergana and Andijan regions, using the following data: areas adjusted to the modified crop water requirement zones; existing crop pattern and areas. The following calculation procedure was employed:

1. Specifying the areas in each modified crop water requirement zone, applying the GIS;
2. Areas under each crop were taken from the database;
3. Percentage of each crop from the total cropped area were calculated since maps of crop pattern are not available;
4. Areas under various crops in each modified crop water requirement zone were calculated proportionally these percentages;
5. Irrigation water demand was calculated as multiplication of an area under specific crop by its water requirement;
6. Crop water requirement is computed for the period since 1st April until 1st October; and
7. Crop water requirement were computed using the program GROPWAT that was calibrated for cotton, new varieties of winter wheat, maize and alfalfa. Water requirements for other crops were specified using the manual “Crop water requirement zoning and irrigation scheduling in Fergana Valley.”

Net irrigation water requirement (without accounting the irrigation system efficiency) computed for the whole SFC command area encompassing all crop water requirement zones in Fergana and Andijan provinces amounts to 522 mln. $m^3$ (Fergana Province – 397 mln. $m^3$, and Andijan Province – 125 mln. $m^3$); and gross irrigation water requirement – 695 mln. $m^3$ (Fergana Province – 529 mln. $m^3$, and Andijan Province – 166 mln. $m^3$).

## 5.4. Water Allocation including On-the-fly Adjusting the Plans of Water Use

**(N.N. Mirzaev, A.I. Tuchin, Alimdjanov A., H. Manthrithilake)**

Establishing Canal Administrations, Canal Water Users Unions, and Canal Water Committees on the pilot SFC, AAC and KBC in the frame of the IWRM-Fergana Project created the background for solving organizational problems of water distribution. However, establishing of these institutional frameworks is not an end in itself. They are needed for creating the environment (openness, transparency etc.) for achieving another key objective – ensuring equitable (uniform), sustainable and effective water distribution. Analyzing the traditional systems of water distribution has shown that not only organizational and technical problems but also technological issues can be mentioned due to the following constraints:

- Lack of proper methods for drawing up the plans of water use (PWU);
- Lack of developed procedures for adjusting the plans of water use;
- Questionable baseline information;
- Lack of the effective process of drawing up the plans of water use; and
- Lack of proper procedures for implementing the plans of water use.

Thereby, the need in the alternative water distribution management system (AWDMS) has arisen [38]. In the broader sense, the AWDMS means the water distribution management system based on the IWRM principles. In the narrow sense, the AWDMS is the system of organizational and technological procedures of water distribution management aimed at observance of the principles of equity, sustainability and efficiency.

The principle of equity should be observed at the stage of planning and adjusting the water use plans, when the key tasks of the CA and CWC are the following:

- to draw up plans of water use and distribution correctly reflecting the water needs of water users;
- to establish the limits (quotas) of water use in the equitable manner taking into consideration available water resources and water users' applications.

The principles of sustainability, uniformity, flexibility and efficiency must be observed at the stage of implementing the water use plans. At this stage, during the growing season, the key tasks of the CA and CWC are the following:

- Enhancing the stability of water delivery from the canal and streamlining operation of pumping stations;
- Providing the uniform irrigation water supply to water users (WUAs and collective farms) and to laterals (groups of laterals) according to established limits during the irrigation season;
- To allow water users to adjust efficiently ten-day water consumption from their canals, in reasonable limits;
- To minimize operational and organizational water losses within the irrigation system.

*Organizational aspects of the AWDMS*

1. Governance of water distribution is implemented with participation of water users through the CWC;
2. The CWC creates the environment of openness and transparency for ensuring the principles of equitable (uniform), sustainable and effective water distribution;
3. Seasonal and ten-day plans of water use are developed and approved by the CA after co-ordination with the CWC;
4. All conflicts and disputes between water users and the CA are discussed and settled by the members of the CWC (Arbitration Board) or with their participation;
5. All information on conflicts and disputes between water users and the CA, as well as water users' proposals on improving the system of water use and distribution should be collected and documented in the CWC;
6. The CWC has to work in close cooperation with the Water Inspection;
7. CWC sessions should be organized both in the CWC office and directly at sites of the irrigation system to rise awareness of water professionals and water users and to discuss topical issues of water distribution;
8. The CWC informs stakeholders and the general public about its activity results.
9. Basic tasks of the CA and CWC:

a) at the stage of planning and adjusting the water use plans:

- to draw up the water use plan (correctly as much as possible);
- to establish the limits of water use in the equitable manner.

b) at the stage of implementing the water use plan:

- Enhancing the stability of water delivery from the canal (streamlining ten-day irrigation water supply and operation of pumping stations);
- Providing uniform irrigation water supply to water users and to laterals (groups of laterals) according to established limits during ten-day periods and over the irrigation season as a whole;
- To provide the flexibility of water distribution; and
- To minimize operational and organizational water losses within the irrigation system by introducing different kinds of water rotation, if expedient.

*Technological aspects of the AWDMS*

1. The following types of managing the irrigation systems are existing:

- Tactical management (running, seasonal and annual);
- Day-to-day management (ten-day period management and daily management);

2. Tactical management of the on-farm irrigation system includes:

- Drawing up the water use plan (for growing and dormant seasons);
- Seasonal adjusting the water use plan.

3. Day-to-day management of the on-farm irrigation system includes:

- Adjusting the water use plan for the next ten-day period (calculation of ten-day water limits and adjusting irrigation water supply);

- Day-to-day adjusting the water use plan (adjusting the planned limits and water delivery into the canal or a group of canals);
- Implementing the modified water use plan.

4. Main canals, laterals and on-farm distribution canals and their groups are the objects of management;
5. Grouping the irrigation canals. Canals are grouped according to their belonging to water users within one irrigation unit (a water-balance site).

## Planning and adjusting the water use plans (schedulining)

***Seasonal planning***

- Water use plans are drafted for different options of water availability in water sources (wet year, average year, dry year) and various weather conditions during the growing season (a rainy spring, hot summer etc.);
- Under seasonal planning, water demand (planned water delivery) of water users (a canal, group of canals etc.) is established for the growing season (April to September) or for dormant season (October to March) taking into account the irrigation schedule and technical parameters of the irrigation system;
- Seasonal planning of water distribution is carried out based on detailed and specified data on:
- water losses within the irrigation system and on a field;
- a carrying capacity of irrigation canals;
- crop pattern and areas (taking into consideration interim and secondary crops);
- availability of internal water resources (return water, irrigation tube-wells, springs etc.);
- an irrigation schedule;
- crop water requirement zoning;
- An option of the water use plan for the coming season is chosen based on the refined forecast of annual water availability.

***Seasonal adjustment***

- Under conditions of water deficit the water use plan may be adjusted for the irrigation season, ten-day period and on the daily base. Non-agricultural water users (the needs of public utilities, industry, nature etc.) exercise a privilege and their water supply rates can not be reduced;
- Adjusting the water use plan should be made due to the following reasons:
  - Changes in irrigated area or crop pattern (based on actual data on areas under crops);
  - Stable difference between water availability in the water sources and planned amounts estimated based on monthly forecasts regarding water availability; and
  - Stable difference between actual weather characteristics and mean annual weather data (abundant rainfalls, higher temperatures etc.).
- Planned quotas for laterals (group of secondary laterals) for a coming season are specified in the process of seasonal adjustment, taking into account the planned quota established by a superior water management organization for the main canal. A quota is an amount of irrigation water (in absolute or relative values) that is prescribed to a water user (canal, group of canals etc.). It is necessary to distinguish a planned quota for the estimated period (a season, ten-day period) and an

actual quota. Limits that are established by the ministry for the SFC or “water allocation percentages” that are used for the KBC are essentially the planned quotas for irrigation water supply;

- A planned quota for the SFC is a seasonal or ten-day limit established by the ministry; for the AAC – a ten-day water withdrawal according to the plan of water allocation; and for the KBC – an estimated (expected) flow during a ten-day period under consideration that is calculated taking into consideration a mean annual discharge of the Khodjibakirgan River and water diversion by Kyrgyz water users;
- A planned quotas for laterals should be specified applying one of two approaches:
  - An approach based on the principle of uniform irrigation water supply (the traditional principle of proportionality when the planned quotas for main canals and their laterals are adjusted for ten-day periods using a single proportionality factor established for the whole irrigation system);
  - An approach based on the principle of equal general water availability (the alternative principle when the quotas are differentially established taking into account a share of industry, water withdrawal from internal water sources and use of groundwater by crops).
- Choice of an approach of calculating the planned quotas for each canal is also the competence of the CWC.

### *Adjustment of the Water Use Plan for a Ten-Day Period*

- Initial adjusting the planned quota taking into account the actual irrigation water supply during the previous period;
- Calculation of the planned quotas for laterals (group of secondary laterals) in coordination with applications for a coming ten-day period;
- Secondary adjusting the planned quota when a total irrigation water limit for the main canal is less than the planned quota plus an amount of water according to applications;
- Iterative calculation of the planned quotas in coordination with the secondary adjusted (increased) planned quota with applications for a coming ten-day period for laterals (group of secondary laterals). An application is a planned irrigation water demand of a water user (lateral, secondary laterals etc.) depending on current natural and economic conditions. An application can cover a ten-day period or its part (intra- ten-day period).
- Applications for the following ten-day period should be submitted by water users to the CA three days before the beginning of the following ten-day period, and applications for an intra- ten-day period – one day before changes in water delivery into the canal;
- Lack of an application can be interpreted in two ways: a) as lack of water demand; and b) as compliance with the planned quota. In the first case, submitting of an application is the rule, and the lack of an application is an exception to the rule. This approach is acceptable for the SFC and AAC. In the second case, submitting of an application is an exception to the rule, and the lack of an application is the rule. This approach is acceptable for the KBC;
- After termination of the estimated ten-day period, an actual quota and actual water limit for the canal is specified based on actual data. A limit is an amount of irrigation water (in absolute or relative values) which the CA has to delivery to lateral (a group of secondary laterals) during a ten-day period. It is necessary to distinguish a planned limit for the estimated period (a ten-day period) and actual irrigation water limit.

### *Adjusting the Water Use Plan within a Ten-Day Period*

- Redistribution of irrigation water among laterals within a group of laterals in the range of planned limits established for a group of laterals is permissible during a ten-day period. The redistribution is implemented in coordination with downstream subdivisions of the CA (hydro-operational sites) based on the secondary applications (for intra-ten-day periods);

- The possibility to redistribute irrigation water among laterals within a group of laterals complicates the water distribution process but rises the flexibility of water management and water productivity;
- The need of adjusting during a ten-day period can be caused by natural factors (rainfalls, return water) and on-farm production factors (for example, fields are not ready for water application because furrows were not cut or missing of fertilizers took place).

***Implementation of the water use plan***

- At the stage of implementing the modified water use plans, the key task of water managers is to minimize deviations actual irrigation water supply from the planned limits during a ten-day period; and
- A role of the CWC that has to facilitate the compliance with principles of sustainability, uniformity and efficiency of water distribution is especially important.

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

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[27], 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.

[27] 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[28]) 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[29] 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.

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

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

[28] District subdivision of the Ministry of Agriculture and Water Resources

[29] Irrigation water by continuous flow is delivered to off-takes of homestead plots or to water users having large irrigated plots

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[30] 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.

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.

[30] 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.

***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).

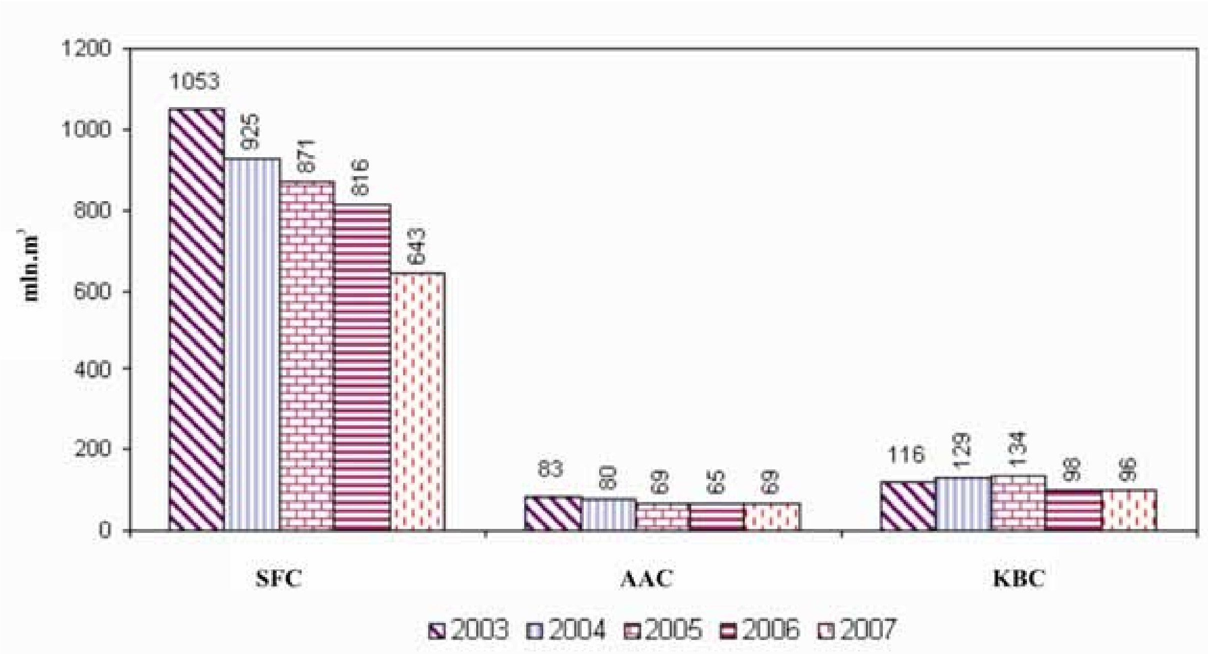



**Figure 5.18 Actual Irrigation Water Supply through Pilot Canals**

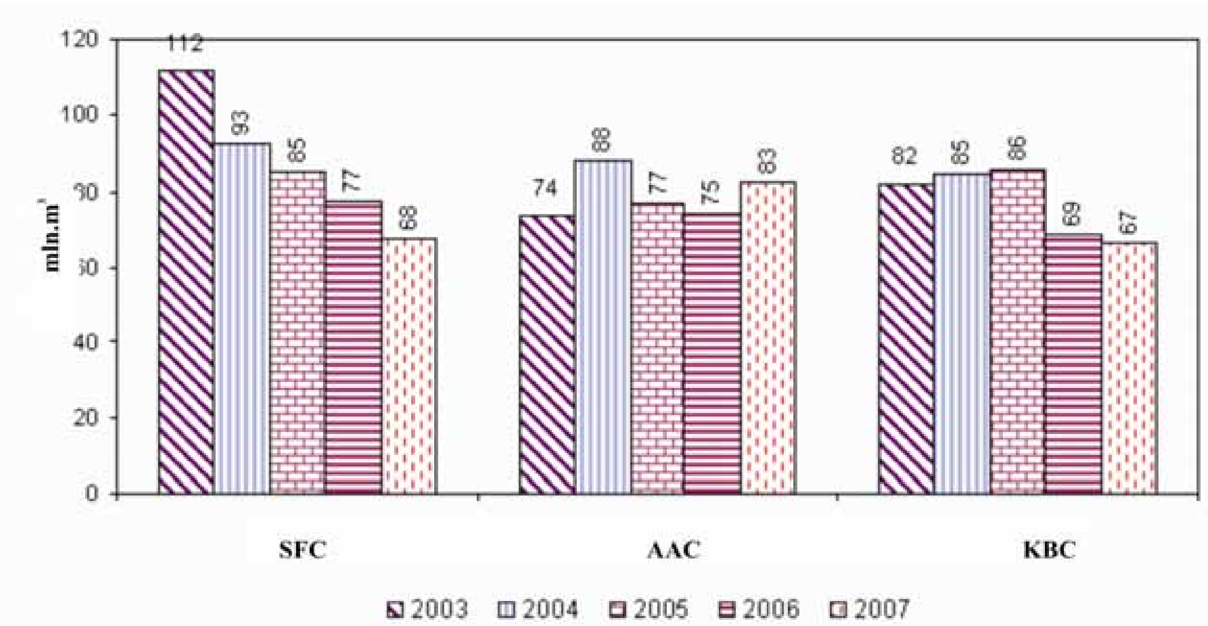



**Figure 5. 19 Water Availability on Pilot Canals**

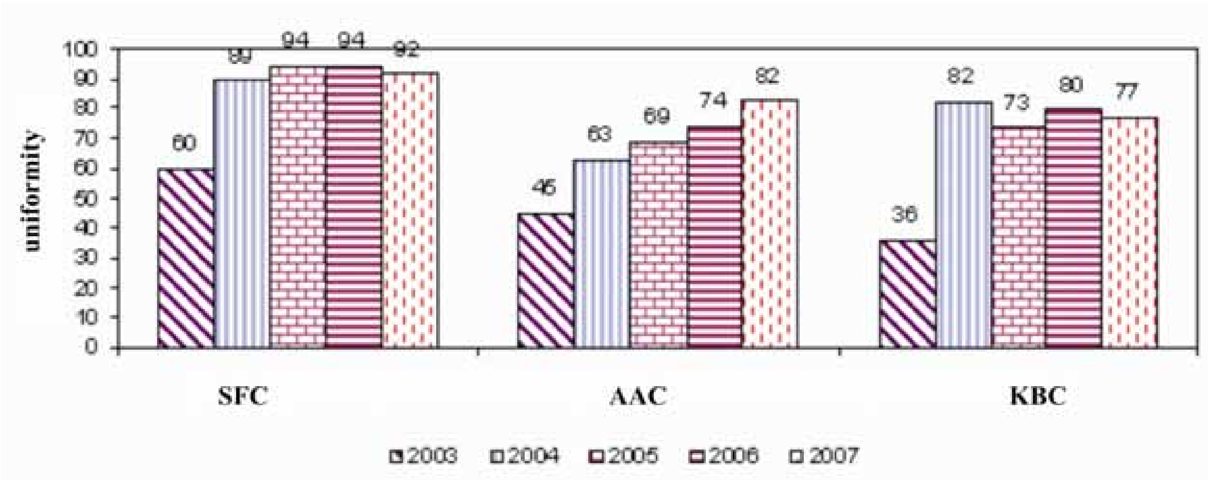



**Figure 5. 20 Uniformity of Irrigation Water Supply**

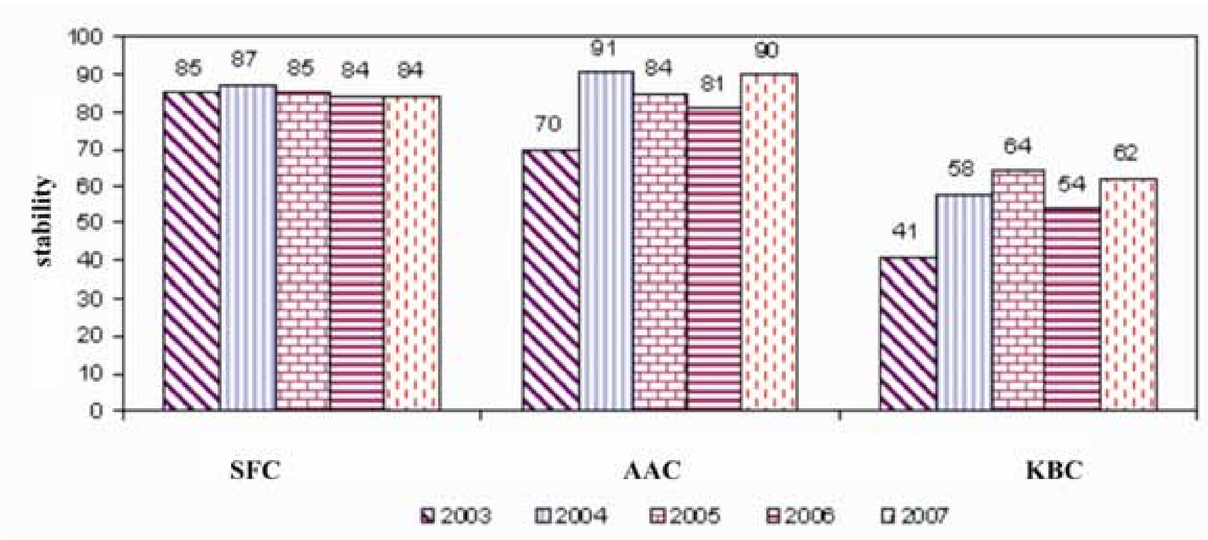



**Figure 5. 21 Stability of Irrigation Water Supply**

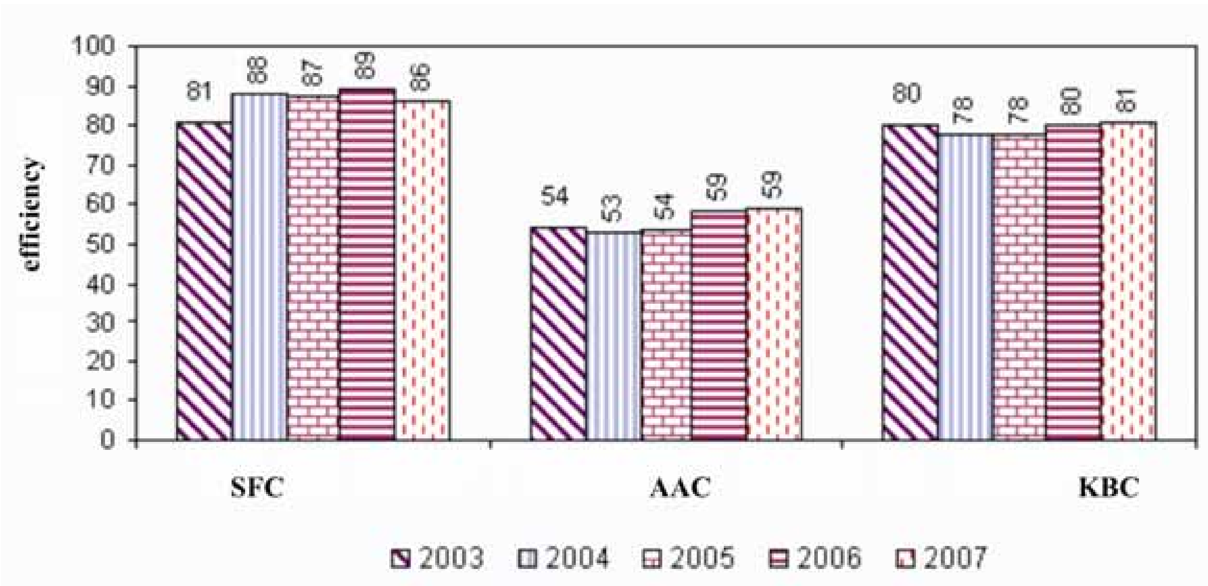



**Figure 5. 22 An Efficiency Factor of Pilot Canals**

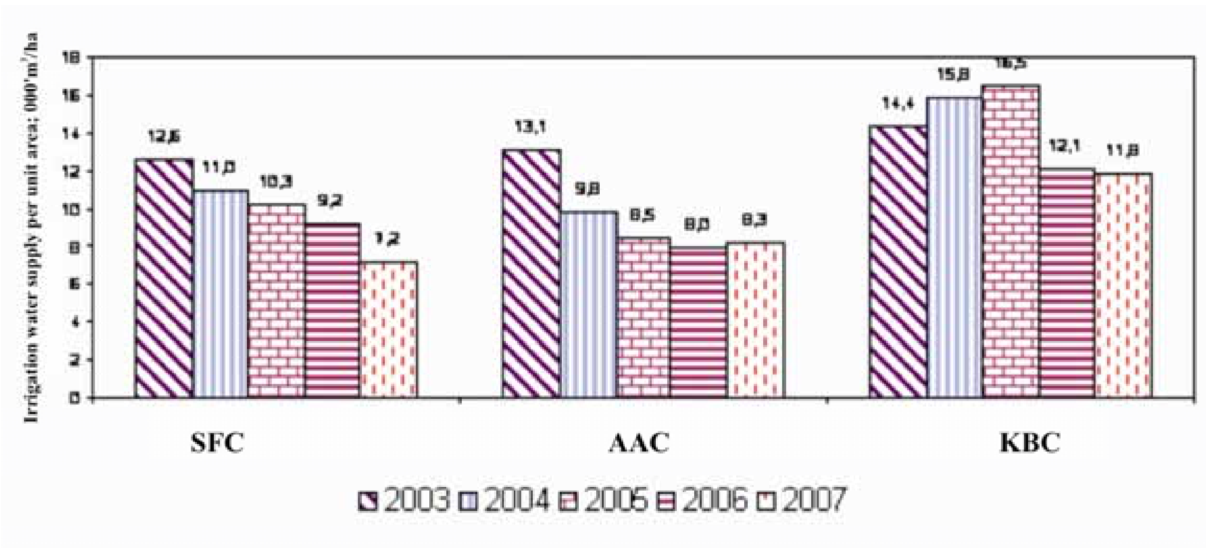



**Figure 5.23 Irrigation Water Supply per Unit Area over the Growing Season**

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].

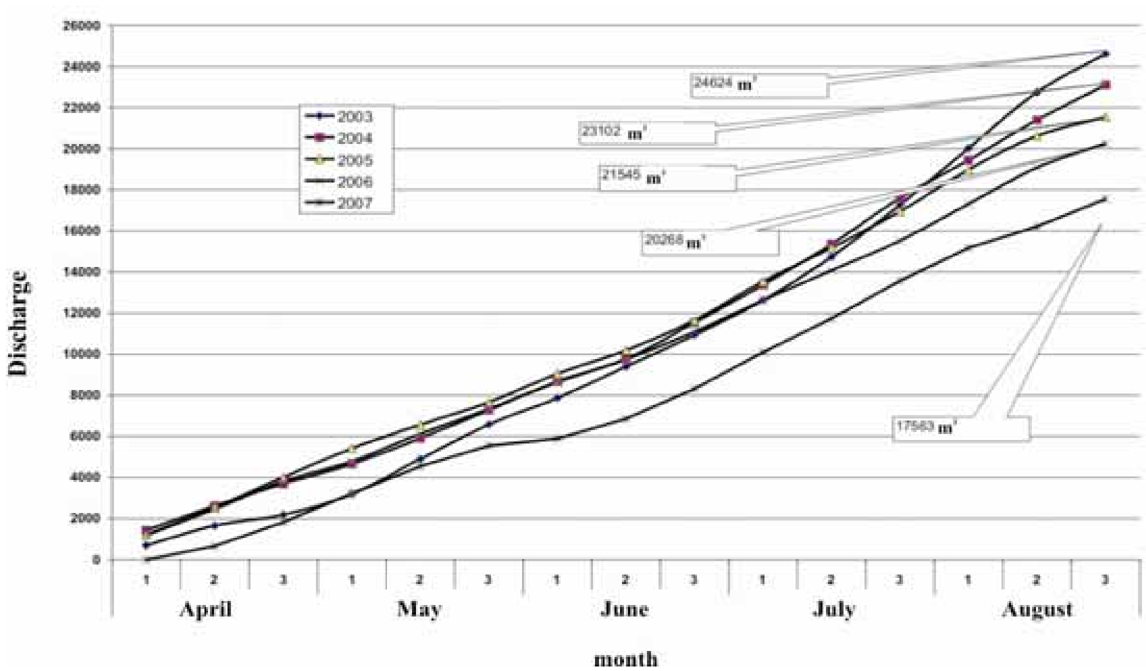



**Figure 5.24 Trends of Actual Irrigation Water Supply into Irrigation Canals of the WUA "Akbarabad" (a Progressive Total over the Growing Season, 000' $m^3$)**

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[31] per WUAs Located along the SFC**

| No | District | Total irrigated area, ha | Total water withdrawal during the growing season, mln. $m^3$ | Including from (in %): | | Cumulative area of irrigation (area* the number of irrigations) | Including area irrigated by water diverted from (in %): | |
|---|---|---|---|---|---|---|---|---|
| | | | | 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 |

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

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 | |
| 4 | Yarmagz -2 | 50.7 | 525 | 274 | 52 | |
| | **Total** | **141.4** | **157.7** | **696** | **44.0** | |

| 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 | | |
| **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).

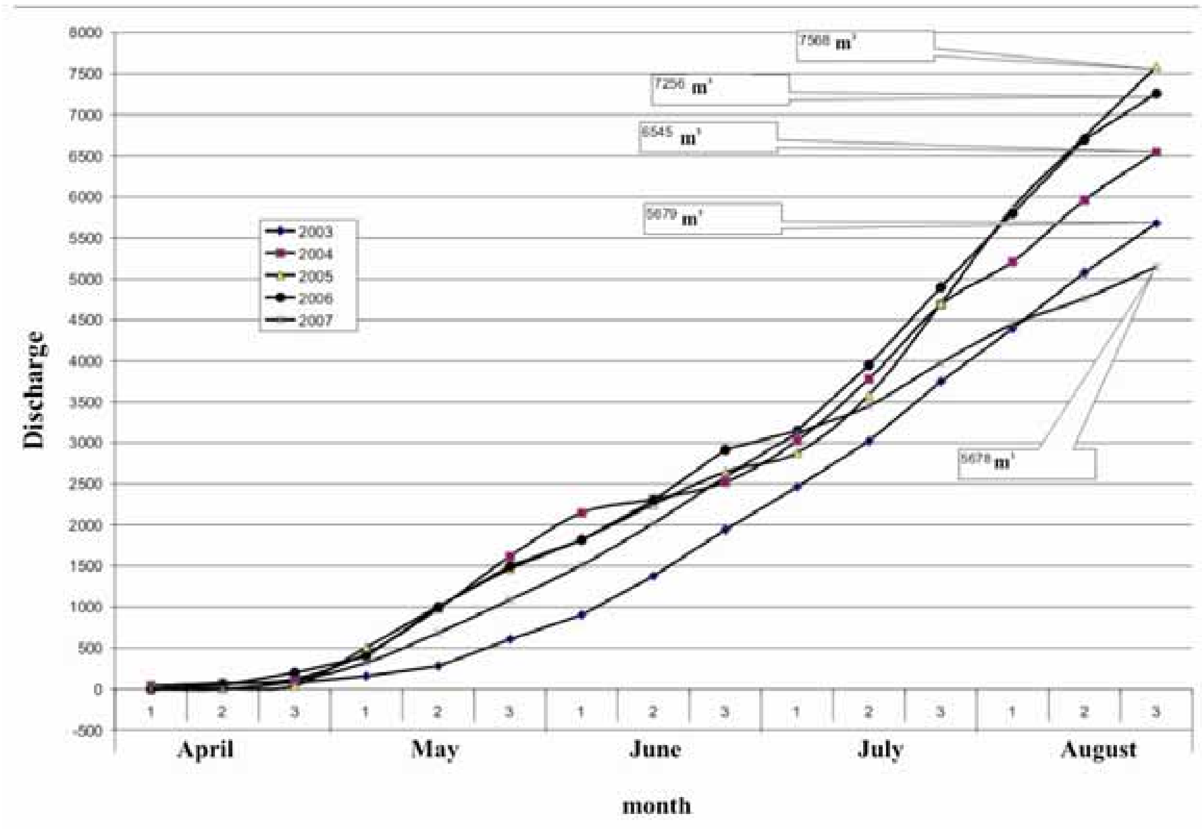



**Figure 5.25 Dynamics of Actual Water Availability in the WUA “Zarafshan”**

**(the progressive total) during the Growing Seasons over the Period of 2003 to 2007**

## 5.5. Automation of the Water Distribution Systems

**(I. Begimov., V.A. Dukhovny)**

A key tool of integrated water resources management is automation of the water distribution system based on introducing the state-of-the-art system of supervisory control and data acquisition (SCADA). This system allows improving the quality, flexibility and reliability of water distribution management and reducing unproductive losses of water resources.

Developing the system of automation and dispatching of the Uchkurgan Hydroscheme was initiated in 2002 simultaneously with launching the IWRM-Fergana Project. The most up-to-date programmable controllers "Decont" manufactured by the company "DEP" (Russia) with home-produced sensors of a water level and gate position were applied in this system.

Introducing the system was funded by the Swiss Agency for Development and Cooperation; and it operates up to now. Specialists of the BWO "Syr Darya", SIC ICWC and SANIIRI monitored this system operation over the period of 2002 to 2007. The framework of archiving and databases were updated to monitor and evaluate qualitative indicators of the system of automation and dispatching of the Uchkurgan Hydroscheme. The system of archiving technological and operational information automatically saves basic values of technological indicators each ten minutes in the form of separated files that can be analyzed to evaluate the quality of system operation.

***The updated database allows solving the following tasks:***

- transferring the SCADA data directly into the database "MS ACCESS" providing storing and processing these data for solving operational tasks;
- averaging and saving values of measurable parameters over a day, ten-day period and month;
- data input of hourly visual observations (the common method), averaging and saving their values over a day, ten-day period and month;
- detecting deviations (errors) in the data of hourly visual observations against the SCADA data; and
- drafting the reports and diagrams that illustrate the telemetry system operation (the prototype of the SCADA) and the data processed.

One of key tasks of automation and dispatching of the Uchkurgan Hydroscheme is to improve the stability of water delivery through the North Fergana Canal (NFC) and the Additional Feeding Canal (AFC) within the system of the Big Fergana Canal (BFC) under fluctuating of water levels in the headrace channel. At present, the system of automation and dispatching of the Uchkurgan Hydroscheme does not directly receive information on flow rates at the gauging station "Uchkurgan" and in the headrace channel of the BFC; therefore a dispatcher of the Uchkurgan Hydroscheme assigns the required parameters for regulating flow rates through the NFC and AFC depending on current flow rates in the river channel and water use limits established.

Figure 5.26 shows the operational regime of the automation system of the Uchkurgan Hydroscheme over the period of 2005 to 2006. As shown in this figure, under fluctuating of water levels in the headrace channel, flow rates through the NFC and AFC are almost stable within the acceptable accuracy of regulation. Stability of water delivery into the NFC and AFC is ensured by the automation system of the Uchkurgan Hydroscheme at the expense of a capacity of the headrace channel and releases of excess water into the tailrace channel.

An average value of deviations of actual flow rates against the established value under automatic regulating does not exceed 2% for the NFC (1.69% for the AFC).

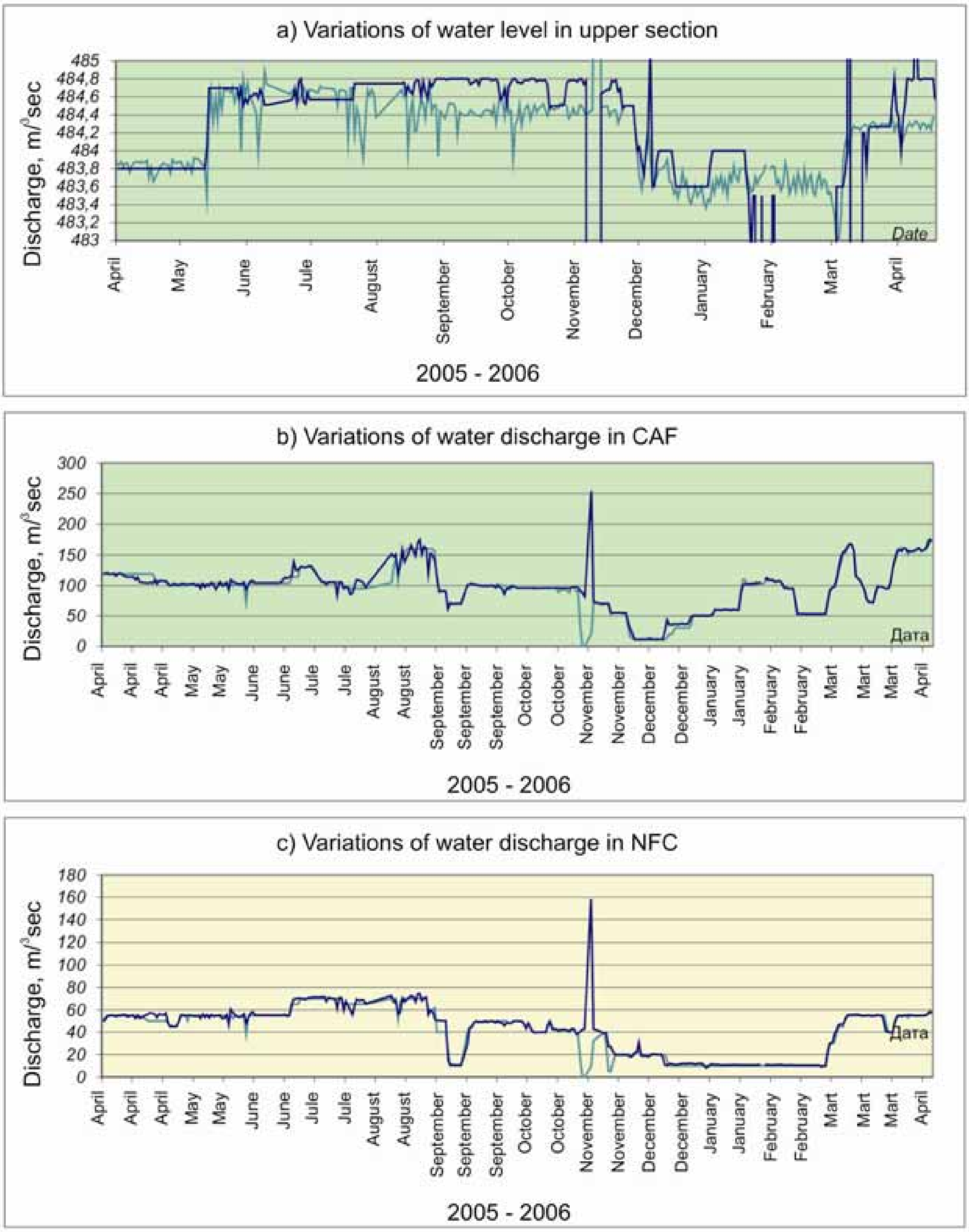



**Figure 5. 26 Operational Regimes of the Automation System of the Uchkurgan Hydroscheme in 2005 and 2006**

A maximum value of instantaneous deviations of an actual flow rate against the established value for automatic regulation of a flow rate in the NFC amounts to 11.2% and 1.77% in the AFC (during the transition period). Analyzing the automation system operation of the Uchkurgan Hydroscheme over the whole period of operation (5 years) shows that the following quantitative and qualitative indicators of water resources management were considerably improved:

- the stability of irrigation water supply through the NFC and FFC in the Fergana Valley was improved at the expense of introducing the system of automatic regulating of water levels and flow rates;
- the measurement accuracy of water levels, flow rates and water salinity, as well as a height of opening the gates of hydraulic structures was raised due to the introduction of the up-to-date technical means for measuring and accounting water resources;
- dataware and the quality of water record keeping was improved based on continuous computerized gathering, storing and processing data on water levels and flow rates;
- the efficiency and accuracy of water resources management were improved at the expense of speed-up of transferring and processing the information on technological processes and the decision-making process; and
- the rapidity of detecting and eliminating failure occurrence in the system equipment and hydraulic structures was increased.

It is necessary to note that the automation system of the Uchkurgan Hydroscheme has raised the O&M level, substantially facilitating activity of operational personnel and improving the quality of water distribution into the NFC and AFC. As a result, the conditions for monitoring the BWO “Syr Darya” and its territorial bodies’ activity were created based on the openness and accessibility to information for all stakeholders.

Taking into consideration advantages of the automation system, the project: “Automation of Water Distribution on Pilot Canals in the Frame of IWRM-Fergana Project and the BWO “Syr Darya” Structures” has been proposed as further development of the IWRM-Fergana Project and its tools. This project encompasses:

***The basin level:***

- the BWO “Syr Darya” structures;

***Pilot canals:***

- the Aravan-Akbura Canal (Kyrgyzstan);
- the South Fergana Canal (Uzbekistan); and
- the Khoja-Bakirgan Canal (Tajikistan).

**The project objective** is to put into practice the computer-aided system of regulating and operational monitoring of the water distribution process at the BWO’s structures and on pilot canals to ensure supplying of irrigation water to farmers in due amounts and proper time and to establish the system of monitoring of channel inflow, flow rates and water levels at the water-balance gauging stations and water intakes.

**A key task** of automation and monitoring is to establish the system of management and control of canal operation, which allows:

- to improve implementing the plan of water use;
- to create conditions for sustainable, uniform and equitable water distribution excluding unproductive water losses.

Achieving this objective will be provided based on the introduction of the SCADA system on the water intake and check structures, water-balance gauging stations, as well as at the expense of dispatching of all hydraulic structures under management, establishing telecommunications and computerization of transferring, processing and storing information. In addition, special observers who will be provided with communication means and vehicles will monitor the water-balance sites.

***Pilot canals to be subjected to automation have different sources of water supply:***

- the South Fergana Canal is fed from the Andijan Reservoir of over-year regulation;
- the Akbura River, flow of which is regulated by the Papan Seasonal-Storage Reservoir is the water source for the Aravan-Akbura Canal;
- the Khoja-Bakirgan Canal diverts water from the river of the same name with unregulated flow.

The existing situation in water distribution through irrigation canals and the stochastic nature of flow rates in streams impede uniform water delivery to consumers and meeting the established water use limits. Unproductive organizational water releases result from the inopportuneness and unreliability of information gathered at the gauging stations due to the lack or insufficient accuracy of measuring devices that are used for monitoring flow rates and water levels.

Automation of the main waterworks and the system of gathering information on the water-balance gauging stations and monitoring at the water-balance sites conducted by observers who will be provided with communication means and vehicles are envisaged for ensuring sustainable water distribution providing stable and uniform satisfaction of farmers' requirements.

***The system of managing the water distribution process: there are not differences of principle in the system of managing water resources on pilot canals; each republican system is represented by three levels:***

- *basin level* where the BWO "Syr Darya" and republican ministries of water resources carry out management functions. At this level, the ICWC establishes limits of water resources use for the irrigation systems and controls their realization;
- *level of the Basin Irrigation Systems Administration, Fergana Valley Main Canals Management Organization (Uzbekistan) and Provincial Water Management Organizations (Kyrgyzstan and Tajikistan)*. At this level, the plans of water use with allocating water resources per specific irrigation canals are approved taking into consideration the water use limits established and applications of farmers; and
- *level of the Main Canal Management Organization*, at this level, irrigation water distribution over ten-year periods in accordance with the approved plan is being implemented, as well as the monitoring and adjusting of water delivery every ten days, if necessary.

The main dispatching point (MDP) and water-balance sites with local dispatching points were established on each irrigation canal in the frame of operational water distribution system. The Central Dispatching Point (CDP) that is the central element of water distribution management along the canal was established at the Main Canal Management Organization.

**The principle of water distribution through irrigation canals:** a key principle of water distribution through irrigation canals is planned water use that bases on stable and equitable meeting of consumers' demands over the entire length of irrigation canals. Plans are drawn up by water resources management organizations based on applications submitted by water users and water use limits established by the Ministries. Water use plans are approved after joint reviewing by the Irrigation System Management

Organizations (or Provincial Water Management Organizations), Canal Management Organizations, Canal Water Committees and representatives of water users. Water use plans are the basis for plans of water diversion and delivery to consumers that are being drawn up every ten days and adjusted during the irrigation season depending on weather conditions, general water management situation in the river basin and applications of consumers.

**An extent of automation and dispatching of main hydraulic structures and the monitoring system: Headworks of the pilot irrigation canals are equipped with measuring devices of the SCADA system; sensors of water level at upstream and downstream of the structure and position of gates (an extent of their lifting) are installed at all check structures. Dispatching points at headworks are equipped with computers and the system of telecommunication that provides trouble-free communication with the central and local dispatching points and automatic transferring of information according to the established mode. The following components are automatically operating:**

- gates of headworks that maintain designated flow rates under fluctuating of water levels in the headrace channel;
- gates of spillways that are operated in accordance with water levels in the headrace channel;

All information registered by sensors is illustrated at the symbolic circuits; and the protection from emergencies (self-locking of gates, exceeding a maximum level, power cutoff, opening a power switchboard by unauthorized persons etc.) is envisaged.

***The SCADA system at the main structures includes the following equipment:***

- computers (hardware and software);
- programmable controllers;
- input and output modules;
- sensors of water level and position of gates; and
- radio stations with antennas.

**Secondary canal head gates** are equipped and operate similar to pilot main canals' headworks.

***Automation will be introduced on:***

- the South Fergana Canal – 10 main structures and Kirkidon Reservoir's structures (72 gates and 17 dispatching points in total);
- the Aravan-Akbura Canal – 3 main structures (17 gates and 7 dispatching points ); and
- the Khoji-Bakirgan Canal – 7 main structures (43 gates and 7 dispatching points).

**Four BWO "Syr Darya" structures** are also equipped with the SCADA system (46 gates and 5 dispatching points).

**Water-balance gauging stations** are equipped with the SCADA system (sensors of water level). The SCADA system at water-balance gauging stations includes the following equipment:

- programmable controllers; and
- input and output modules, sensors of water level and radio stations with antennas.

Information on water levels and flow rates is transmitted through radio communication to a local dispatching point (LDP) of a hydro-operational site (a hydro-unit) that operates this water-balance gauging station. The following gauging stations will be subjected to automation:

- South Fergana Canal – 10 gauging stations (one at the headworks, 9 at water-balance sites);
- Aravan-Akbura Canal – 4 gauging stations (one at the headworks, 3 at water-balance sites);
- Khoji-Bakirgan Canal – 3 gauging stations (one at the headworks, 2 at water-balance sites); and 7 dispatching points.

**Monitoring at water-balance sites. Objects of automation and computer-aided monitoring on the pilot irrigation canals do not exceed 10% of water distribution infrastructure; therefore, a key role in achieving sustainable and uniform water distribution along the entire length of irrigation canals to meet users' water demands belongs to observers at water-balance sites who monitor off-takes operation.**

For the purpose of efficient water resources management, the irrigation canals are subdivided into water-balance (hydro-operational) sites that are the primary level of management hierarchy. A local dispatching point that will be equipped with computer and telecommunication means was established at each water-balance site. A LDP receives information from main structures and water-balance gauging stations and has the staff of observers who monitors water distribution at all off-takes and water diversion by pumping units. Monitoring at water-balance sites is conducted based on visual read-out of information and its transferring to the LDP by observers via their individual radiophones, and data input into the computers by hand. Off-takes at water-balance sites are divided into two groups: "controllable off-takes" and "accountable off-takes." Off-takes (pumping units), unplanned opening or closing of which can considerably affect canal operation, refer to "controllable off-takes" and are characterized by the following parameters:

- within the SFC system, off-takes with a discharge capacity more than 100 l/sec;
- within the AAC and KBC systems, off-takes with a discharge capacity more than 10 l/sec;

Flow rates for such off-takes can be regulated during a ten-day period; and at the same time, flow rates of off-takes with a lesser carrying capacity are not being adjusted. All off-takes are "accountable ones." Water withdrawal is accounted using water-measuring devices; however, water diversion through small off-takes with a discharge capacity less than 5 l/sec is accounted according to their rated discharge capacity.

Water withdrawal by pumping units is calculated taking into account the number of pumping units (PU) under operation and their nameplate capacity and audited according to registrations of an energy meter.

**Table 5. 15 Structures under Monitoring**

| Irrigation canal | Number of off-takes | | Total water withdrawal | | Small pumping units (Q < 5 l/sec) | | |
|---|---|---|---|---|---|---|---|
| | Total | Including PU | Q, $m^3/s$ | % of $Q_{st}$ | Number | Q, $m^3/s$ | % of $Q_{st}$ |
| SFC | 162 | 67 | 92 | 92 | 68* | 3.89 | 2.95 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AAC | 62 | 5 | 28.8 | 87 | 108 | 0.54 | 2 |
| KBC | 46 | 4 | 32.6 | 80.2 | 14 | 0.07 | 0.2 |

* Off-takes with a discharge capacity less than 100 l/sec were included into the group of off-takes non-controllable during a ten-day period within the SFC system

The number of daily observations is established depending on the duration of daylight hours: during the growing season – four times a day, and during the off-vegetation period – three times a day. Time spent by an observer at one structure was estimated based on virtual evaluating duration of each elementary procedure:

- at off-takes: i) readout of an indication of a water-level staff installed in the headrace channel; ii) readout an indication of a water meter' staff and determination of a flow rate using the design chart; iii) transmitting data to a dispatcher; and iv) data recording into the field book;
- at the pumping units: i) visual definition of the number of pumps under operation; ii) reading indication of an energy meter; iii) transmitting data to a dispatcher; and iv) data recording into the field book.

Observers are provided with radio-telephones and vehicles (by mopeds, as expected). The number of observers was specified on the basis of a length of water-balance sites, number of off-takes, and normative working hours.

**Functional tasks of monitoring; reliability and exchange of information:** Efficient water distribution based on the proposed system of automation and monitoring should be grounded on reliable accounting of water resources. With that end in view, the IWRM-Fergana Project envisages calibration and metrological assurance of all main structures, water-balance gauging stations and re-attestation and issuing passports of water-measuring devices. The second condition is the efficient interaction of all levels of water management hierarchy. The IWRM-Fergana Project clearly specified functional tasks of participants of management and monitoring activity.

A dispatcher of the LDP is a primary level of gathering, processing and analyzing the incoming information. Data transmitted by observers allow evaluating the uniformity of water delivery to users at the water-balance site, adequacy of water supply against the plan and an amount of unproductive water losses. Key functional tasks of participants of the monitoring process are the following:

***Observers at water-balance sites:***

- strict implementing the dispatcher's instructions relative to flow rates of irrigation water delivery to users;
- monitoring and accounting flow rates of irrigation water delivery through all relevant off-takes and pumping units;
- monitoring and accounting side inflows and water releases through spillways;
- transmission of data on water levels and flow rates through off-takes, pumping units, water escapes and side inflows to a dispatcher of the LDP by a radiophone;
- implementing measurements in compliance with due time and sequence of observations;
- regular data recording into the field book;
- preventing intervention in gates' operation of off-takes by non-authorized persons; and
- safeguarding and maintenance of the flowing-through section of hydraulic structures, mechanical and water-measuring equipment.

***Dispatchers of the Local Dispatching Points (LDP):***

- adjusting flow rates established by the CDP for a ten-day period for all off-takes and pumping stations within the water-balance sites;
- gathering and checking information on actual flow rates at non-automated off-takes transmitted by observers via radiophones four times a day in the interactive mode;
- analyzing a daily balance of water resources at water-balance sites, evaluating the efficiency factor of a water-balance site and unproductive water losses;
- regular entering of monitoring data into the database; and
- calculating an average daily flow rate and discharge for each off-take at the hydro-operational site and water-balance gauging station and submitting this information in the form of reports to the CDP.

***Dispatchers of the Central Dispatching Points (CDP):***

- setting assignments for LDPs' dispatchers regarding flow rates at water-balance gauging stations and all off-takes;
- implementing the planned water delivery by means of instructions to the LDPs and recurrent control of flow rates and discharges over the past periods;
- an everyday reconciliation of reported and actual data on volumes of water delivery to water users with the DP of Basin Irrigation System Management Organization;
- a reconciliation of data between water-balance sites;
- analyzing the daily balance of water resources at water-balance sites and along the irrigation canal as a whole; and
- analyzing water losses and indicators of the water balance at water-balance sites and along the irrigation canal as a whole.

## The telecommunication system of the CDP and LDPs

***Irrigation canals are equipped with the telecommunication system with state-of-the-art facilities for data transmitting and voice-message reports that solves the following tasks:***

- reception and transmitting telemetric information, which is formed by the automation system established in the radio-communication units of the CDP, waterworks and water-balance gauging stations;
- voice radio-communication between the LDPs and observers of hydro-operational sites; and
- provision of the united information system of an irrigation canal based on the computerized network of transmitting, reception, processing and exchanging of information between the CDP and LDPs.

Under the project: "Canal Automation in the Fergana Valley", specifications are set for the following components:

- technological regime;
- analyzing and archiving of information;
- technical means;
- software;
- a telecommunication system; and
- mechanical equipment and power supply.

### Developing and implementing the project: "Canal Automation in the Fergana Valley"

It is planned to implement the project: "Canal Automation in the Fergana Valley" on the pilot canals in two stages and to complete all Works in 2008. At each stage, the project implementation schedule sets the following scope of works: i) the detailed design for each water-balance site; ii) equipment procurement according to the specifications; iii) construction works (cable laying, mounting of equipment, installation of devices and sensors etc.); iv) precommisioning; v) calibration testing, attestation, and commissioning of waterworks, gauging stations and water-metering facilities at off-takes; v) training of operational personnel; vi) software development for automation and dispatching. At the final stage it is planned to implement the following scope of works: i) developing a set of software for operative water distribution management along all main canals; ii) precommissioning of all the automation systems and training of operational personnel.

### The economic efficiency of the project: "Canal Automation in the Fergana Valley"

Indicators of the economic efficiency that resulted from analyzing of this project parameters are the following: i) investments – USD 1,545,000 funded by the SDC and USD 262,000 budgeted by the water management organizations of the republics; ii) operating costs – USD 332,000 and USD 377,360 prior to and after project implementation respectively; iii) annual net profit due to water savings amounts to USD 719,000 (115.27 million m3 at a water price of 0.006 USD/$m^3$); iv) the cost recovery – 6 years; v) the net present value – USD 2,477,000 and IRR = 32%. Results of economic analysis are given in Table 5.13.

**Table 5.16**
**Evaluating the Economic Efficiency of the Project: "Canal Automation in the Fergana Valley"**

| **Objects** | **Operating costs** ,000. *USD* | | **Investments** ,000. *USD* | | **Net profit** | | **Economic indicators** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **before** | **after** | **SDC** | **MAWR** | **Water volume** *mln.$m^3$* | **Cost** ,000. *USD* | **Cost recovery,** *years* | **NPV over 15 years** | **IRR , %** |
| **BWO „Syr Darya“** | 74 | 87.36 | 305 | 40 | 38.8 | 232.8 | **2** | **1039** | **59** |
| **SFC** | 131 | 155 | 725 | 117 | 63 | 378 | **7** | **1224** | **36** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **AAC** | 59 | 64 | 235 | 30 | 7 | 69.8 | **9** | **121** | **19** |
| **KBC** | 68 | 71 | 280 | 75 | 6.47 | 38.8 | **7** | **93** | **24** |
| **In total** | **332** | **377.36** | **1545** | **262** | **115.27** | **719.4** | **6** | **2477** | |

Based on results of the economic analysis of existing systems operation it can be noted that the introduction of the system of automation and monitoring of the water distribution process within the irrigation systems in Central Asian countries is the cheapest measure for water resources savings in comparing with other technical solutions such as canal lining or other measures preventing water seepage losses.

The small-scale enterprise "SIGMA" (Kyrgyzstan), whose production is comparatively cheap, simple for operation and accessible for procurement, taking into consideration available operational and servicing personnel in the region, was selected as the leading Contractor for constructing the system of automation and monitoring.

**By the mid of 2008, the following works were implemented in the frame of the project:**

***1) BWO structures:***

- The system of automation and dispatching (SAD) was installed at all planned waterworks and operates since June 2006. The system of automation and dispatching was timely put into pilot operation and now is ready for commissioning;
- The systems of data transmission based on the GPRS were installed on all planned structures. Time delay in data transmission from some structures (gauging stations on Uchkurgan HS and BFC) takes place;
- Specialists of the SSE "SIGMA" debug the system of data transmission installed at BWO waterworks; and
- In February 2007, the SDT at BWO structures was put in pilot operation.

***2) AAC structures:***

- Detailed design was completed; equipment of the system of automation and dispatching was installed at all planned waterworks;
- The system of data transmission based on radio communication was installed by the beginning of the growing season 2008; and
- The system of automation and dispatching and the system of data transmission with software for monitoring the water distribution process were put in operation in May 2008.

***3) SFC structures:***

- Mechanical components of main waterworks have been repaired;
- Power transmission lines to waterworks were constructed; and the dispatching points are under construction;
- The detailed design of the system of automation and dispatching (SAD) was completed;
- The detailed design of the system of data transmission (SDT) is in progress; the specifications for equipment are adjusted; and

- Equipment for the SDT was procured, and its assembling and debugging at the Andijan part of the SFC were initiated.

*4) KBC structures:*

- Rehabilitation of KBC structures funded by the Asian Development Bank are being completed;
- Mechanical components of main waterworks have been repaired;
- Power transmission lines to waterworks were constructed; and the dispatching points are under construction;
- The contract for implementing the Canal Automation Project has been prepared; and necessary agreements were signed;
- Realization of the SDT project was initiated and will be completed to the end of growing season;
- Project works related to installing the system of data transmission were initiated; and
- Monitoring of preparatory works is being conducted.

***The system of automation and monitoring of water distribution through irrigation canals allows:***

- enhancing the accuracy of measurements of water levels, flow rates and salinity, as well as opening gates of waterworks due to the introduction of the state-of-the-art tools for measuring and accounting water resources (measurement errors are decreased from 10% to 2%);
- improving the dataware based on computerized and continuous gathering, storing in memory and processing the observed values of water levels and flow rates;
- enhancing the operability and accuracy of water resources management by speeding up transmitting and processing operational information and the decision-making process;
- decreasing unproductive water resources use; and
- timely detecting and eliminating failures of the equipment of the management system and waterworks.

It is necessary to note that the systems of automation and dispatching installed at BWO “Syr Darya” structures have raised the level of O&M substantially facilitating activity of the operational staff and improving the quality of water distribution through main canals such as the SFC, Big Andijan Canal, Khakulabad Canal and Akhunbabaev Canal. At that, the conditions for the real system of monitoring by the BWO and its territorial bodies and receiving reliable information on water resources by all stakeholders were created.

## 5.6. Water Use Aimed at Enhancing Land and Water Productivity

**(Sh. Sh. Mukhamedjanov, S.A. Nerozin)**

At present, extremely excessive amounts of water are used for irrigation of crops over the whole territory of Central Asia. As a result, the environment is serious damaged. The world practice shows that introducing the state-of-the-art water-saving methods is feasible but without incentives for saving irrigation water these measures will be unsustainable. Increase in water productivity with simultaneous rising of crop yields and the application efficiency will be the sustainable solution under conditions of adequate operation of irrigation systems.

Under reforming the existing system of water use the special attention should be paid to a design carrying capacity of irrigation canal because there are not funds for their rehabilitation and increasing their operational capacity. An existing crop pattern was the basis for calculating the canal's parameters; therefore, it is necessary to select an alternative crop pattern that does not result in water delivery volumes exceeding the existing operational capacity of the canal under consideration.

Water allocation among water users being implemented by WUAs should base on the coordination of water demand with each water user, taking into account an overall capacity of irrigation systems. A crop pattern has to be planned based on selecting crops, irrigation of which is adequate to irrigation system's capacity according to timing, volumes and modes of water delivery. Therefore, the technical state of irrigation systems and maximum values of crop water requirement established for the given area should be carefully reviewed under reforming the water use practice.

Providing an optimal crop yield under minimal irrigation water consumption should be a criterion of water productivity rising. Irrigation systems' operation being coordinated at all levels and relying on the rate setting of water delivery that limits excessive use of irrigation water and establishes the water use discipline has to become a key mechanism of enhancing the irrigation water productivity under reforming the agricultural sector. Taking into consideration economic, social and political conditions in Central Asian countries, the first stage of reforming the agricultural and water sector aimed at enhancing irrigation water productivity must follow the following key provisions:

- Planning a crop pattern within the canal command area based on a carrying capacity of this canal;
- Selection of alternative crops, water requirement of which can be provided by the carrying capacity of the existing irrigation system;
- Planning the crop pattern and irrigation schedule based on the mutual agreement of WUAs and the Basin Irrigation System Administration;
- Legal guarantees to water users (under selecting crops), WUAs (under delivering irrigation water to water users) and the BISA, based on the carrying capacity of the existing irrigation systems;
- Transition towards paid water services as the pledge of WUAs existence and incentive for rational use of irrigation water; and
- Establishing the extension services focused on introducing the innovations in irrigated farming.

Taking into consideration above provisions, improvement of the irrigation water and land productivity is achieved covering the following directions:

1. monitoring a current productivity of water used for irrigation in the agricultural sector;
2. managing the agricultural practice to improve the water and land productivity using the methods that were developed taking into account the monitoring findings; and
3. managing the agricultural practice to achieve the sustainability of derived results and broad dissemination of the positive experience among water users.

**Evaluating the existing status of water use and irrigation water productivity at demonstration sites in individual farms**

In 2002, for monitoring irrigation water use, evaluating the actual water and land productivity, and developing the recommendations for enhancing the irrigation water productivity, 10 demonstration sites were selected in the frame of the IWRM-Fergana Project (within the command areas of pilot canals: Khoja-Bakirgan Canal in Soghd Province, South Fergana Canal in Fergana and Andijan provinces, and Aravan-Akbura Canal in Osh Province). Demonstration sites were selected and established in farms located along the upper, middle and lower parts of each pilot canal (Fig. 5.27). Each demonstration site was selected based on its representativeness for the whole command area of pilot canals. 10 demonstration sites that are representative for different altitudinal belts and climatic zones in the Fergana Valley were selected in whole (Table 5.17).

### General description of pilot objects

Regions of the Fergana Valley differ from each other by their altitudinal belts with specific soil and hydrogeological conditions (Table 5.18). A harsh continental climate is observed in this zone. Natural variations of climatic conditions over altitudinal belts are typical for piedmont regions. Overall climatic features are high summer temperatures and the dryness of air; there are sudden changes in daily and seasonal temperatures. Average daily temperatures in January range from -2.5° to +2°C; and an average monthly temperature in July is about 30°C. Annual distribution of temperatures and rainfalls depend on an altitude (an elevation above mean sea level). With increasing the altitude, the amount of rainfalls is also increasing but air temperatures are lowering. Precipitation falls mainly in winter and spring. Summer is arid; and there is not almost a fall of rain since July until September. Annual amount of precipitation ranges from 100 mm to 200 mm on the plain, and up to 450 mm in the piedmont zone.

Soils are the determinative factor under scheduling irrigations. In the growing season 2002, regional group's specialists have surveyed soils and micro-relief of each demonstration site. Soils differ from each other drastically not only in provinces but also in farms depending on the altitudinal belts of their location. A small depth of topsoil underlain by pebble with deep watertable is typical for most of farms in the project area (Table 5.18). Developing irrigation on these lands is complicated by the high soil permeability, ill-made land leveling and non-uniform wetting across irrigated fields. In Osh Province, all three demonstration sites are located in the zone with irregular topography, naturally creating problems for organizing irrigation.

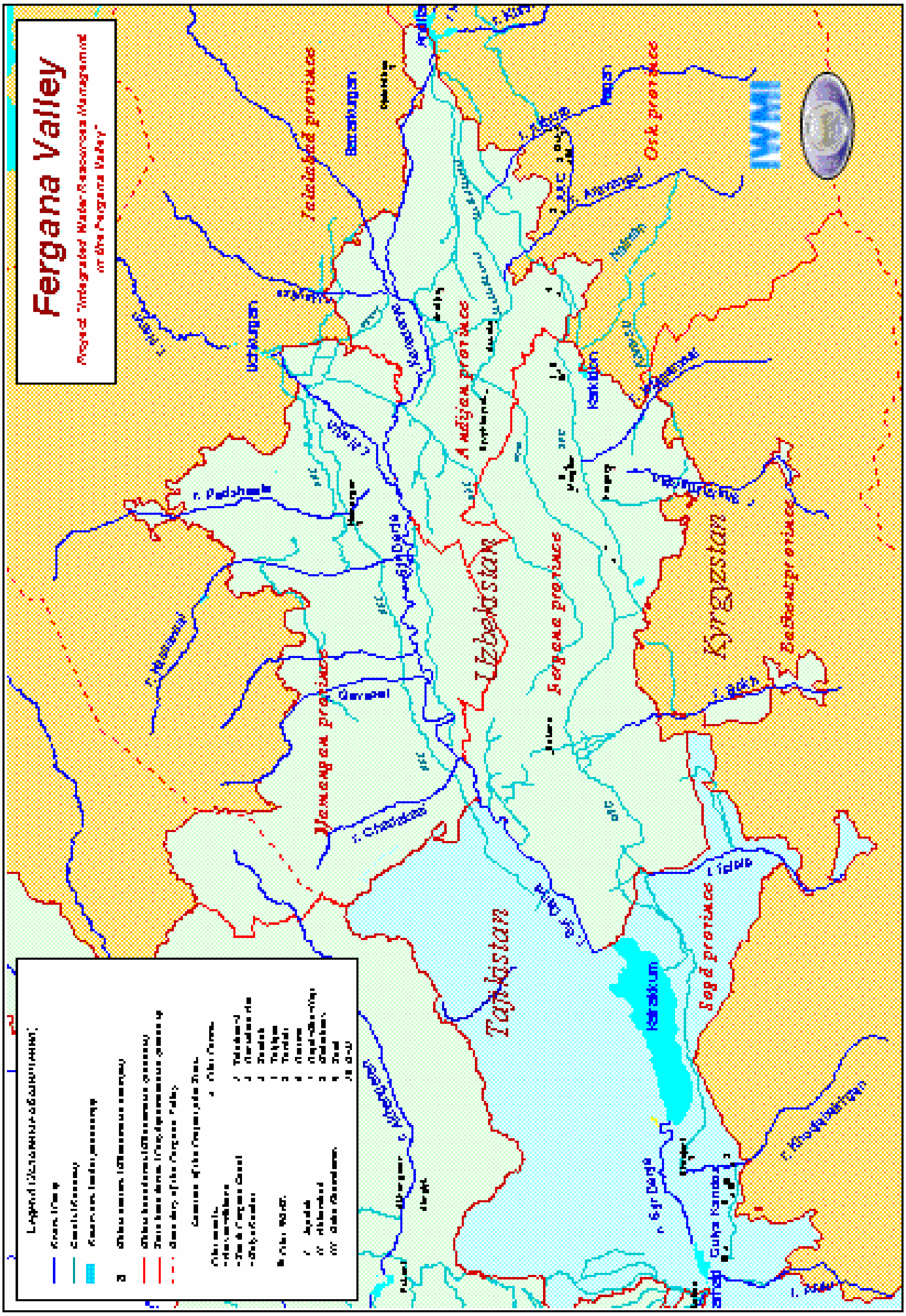



Figure 5. 27 The Fergana Valley: the Pilot IWRM-Fergana Project's Area

**Table 5.18**

**Distribution of Selected Farms over the Altitudinal Zones with Different Types of Soil-Forming Processes**

| Demonstration site | Altitudinal belt | Elevations | Description of soils and underlying layers | Hydrogeological conditions |
|---|---|---|---|---|
| **Osh Province** | | | | |
| PF «Sandyk» | Adyry[32] uplands | 500 to 800 m | Thick topsoil of loam and sandy loam | GWT>5 m |
| PF «Nursultan-Ali» | | | Stony loam underlain by pebble | |
| PF «Toloykon» | | | Stony sandy loam underlain by pebble | |
| **Andijan Province** | | | | |
| PF «Tolibjon» | Inter-adyry depressions | 400 to 500 m | Thick topsoil of sandy loam | GWT>5 m |
| **Fergana Province** | | | | |
| PF «Turdialy» | Inter-adyry depressions | 400 to 500 m | Thick topsoil of sandy loam | GWT = 0.5-1.0 m |
| PF «Nozima» | Sloping plain | up to 400 m | Thick topsoil of loam and clay loam | GWT = 1.0-1.5 m |
| PF «Khojalkhon-ona-Khoji» | Inter-adyry depressions | 400 to 500 m | Topsoil of sandy loam of 0.5 to 0.7 m underlain by pebble | GWT>5 m |
| **Soghd Province** | | | | |
| DF «Bakhoriston» | Inter-adyry depressions | 400 to 500 m | Thick topsoil of sandy loam | GWT>5 m |
| PF «Saed» | | | Topsoil of sandy loam of 0.5 to 0.7 m underlain by pebble | |
| DF «Samatov» | | | Topsoil of sandy loam of 0.5 to 0.7 m underlain by pebble | |

**DF – Dekhan farm**

**PF – Private farm**

[32] Low foothills bordering the Fergana depression

### Assessing impacts of the soil permeability and land surface slopes

Important indicators that need to be considered under designing an optimal furrow irrigation system and evaluating the application efficiency are an infiltration rate and an average slopes. In 2002, during the growing season, regional group's specialists have conducted field investigations to specify infiltration rates and slopes on demonstration fields (Table 5.19).

**Table 5.19 Slopes in Demonstration Farms**

| No | Farm | Longitudinal gradient | Cross gradient |
|---|---|---|---|
| 1 | DF "Samatov" | 0.028 | 0.0112 |
| 2 | PF "Sayed" | 0.025 | 0.0034 |
| 3 | DF "Bakhoriston" | 0.014 | 0.0088 |
| 4 | PF "Khojalkhon-ona-Khoji" | 0.012 | 0.0045 |
| 5 | PF "Nozima" | 0.003 | 0.0022 |
| 6 | PF "Turdialy" | 0.006 | 0.0012 |
| 7 | PF "Tolibjon" | 0.010 | 0.0168 |
| 8 | PF "Toloykon" | 0.045 | 0.0130 |
| 9 | PF "Nursultan-Aly" | 0.060 | 0.0110 |
| 10 | PF "Sandyk" | 0.055 | 0.0260 |

Topographic maps, which clear demonstrate the existing micro-relief by means of contour lines were plotted based on field topographic surveys. These data were included into a passport of each demonstration field and used for designing the optimal layout of field ditches, head ditches and furrows, as well as locations for installing water-metering devices.

The timing and irrigation rates substantially depend on effective available water in the soil. Deficit of effective available water points out the need of irrigation. Field investigations of soil infiltration rates have shown that soil permeability is high on all demonstration fields but especially where there is stony topsoil or topsoil underlain by pebble deposits. Tailwater[33] releases and overwetting of upper part of furrows are unavoidable in the zone with soils of high permeability where the field irrigation efficiency is the lowest one due to water losses related to percolation. According to the classification developed by N. Laktaev [5], project demonstration fields refer to the zone of steep and very steep slopes (0.01 to 0.04). The steepest slopes and high permeability of the soil are observed in farms in Osh Province (Table 5.20).

[33] Tailwater: Applied irrigation water that runs off the lower end of a field.

**Table 5.20 Location of Demonstration Sites**

| Province | District | WUA /DF | Private farm | Irrigated area of a farm, ha | Irrigated area of the DS, ha | Crop cultivated at the DS | Main Canal | Water sources |
|---|---|---|---|---|---|---|---|---|
| Osh | Aravan | WUA "Akbura" | Sandyk | 30.3 | 5 | Cotton | Aravan-Akbura | Akbura River |
| | Karasu | WUA "Japalak" | Nursultan-Aly | 6 | 0.9 | Spring wheat | | |
| | | WUA "Janaryk" | Toloykon | 16 | 4 | Winter wheat | | |
| Andijan | Bukak-bosh | Jura-Polvan | Tolibjon | 10 | 5.6 | Cotton | SFC | Kampiravat Reservoir |
| Fergana | Kuva | Navoi | Turdialy | 10 | 2.7 | | | |
| | Tashlak | Navoi | Nozima | 12 | 8 | | | |
| | Akhun-babaev | Niyazov | Khojalkhon-ona-Khojy | 10 | 5 | | | |
| Soghd | Gafur | DF "Bakho-riston" | Br. 2 | 133.3 | 12.6 | Cotton | Gulyakandoz | Khoja-Bakirgan River |
| | Rasul | Bobokham-damov | Sayed | 70.6 | 4.1 | | | |
| | | DF " Samatov" | Br. 21 | 126 | 6 | | | |

***Crop pattern in pilot private farms***

Crop patterns differ from each other over provinces located in the Fergana Valley. Cotton and wheat occupy about 40% and 30% of a total irrigated area respectively in Uzbek and Tajik part of the valley. In Osh Province, an irrigated area under cotton amounts only 7%, and most of irrigated farmland were sown with wheat (33%). Tobacco, corn and fruits are the most widespread crops according to their sown areas after wheat in this province. Crop patterns in private farms also usually correspond with crops prevailing in the province (Table 5. 21).

**Table 5.21 Crop Patterns in Provinces and Pilot Farms**

| No | Province/Farm | Crop pattern, % of irrigated area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Cotton | Grains | Alfalfa | Corn | Tobacco | Vegetables | Orchards | Truck crops | Others |
| | **Osh Province** | 8.10 | 31.5 | 5.5 | 10.1 | 6 | 7.99 | 5.9 | 13,9 | 10.9 |
| 1 | PF “Sandyk” | 29.7 | 16.5 | 6.6 | | 1.65 | 4.2 | 39.6 | | 1.75 |
| 2 | PF “ Nursultan-Aly” | - | 65 | 16.7 | 11.7 | - | - | - | - | 6.6 |
| 3 | PF “Toloykon” | - | 87.5 | - | - | - | - | - | - | 12.5 |
| | **Fergana Province** | 33.92 | 27.07 | 3.66 | 2.84 | | 1.48 | 9.58 | 21.45 | - |
| 4 | PF “Khojalkhon-ona-Khoji | 50 | | | | | | | | |
| 5 | PF “Nozima” | 100 | | | | | | | | |
| 6 | PF “Turdialy” | 50 | | | | | | | | |
| | **Andijan Province** | 38.56 | 26.92 | 2.62 | 0.45 | | 0.79 | 10.8 | 14.95 | 4.95 |
| 7 | PF “Tolibjon” | 50 | 50 | | | | | | | |
| | **Soghd Province** | 29.74 | 21.33 | 8.01 | 1.81 | 1.28 | 1.75 | 7.1 | 13.03 | 15.93 |
| 8 | PF “Sayed” | 65.82 | 17.69 | | 4.2 | - | 4.5 | 0.63 | | 7.15 |
| 9 | DF “Samatov” | 57.94 | 28.57 | 7.93 | 4.76 | - | 0.8 | - | - | - |
| 10 | DF “Bokhoriston” | 59.26 | 11.78 | 12 | 7.5 | - | 4.35 | - | 3.6 | 1.5 |

## Monitoring land and water use in selected private farms

Analyzing the actual irrigation practice has shown that considerable losses of irrigation water are observed in farms depending on soil and hydrogeological conditions, topography and the quality of land leveling. In some farms excessive irrigation water losses result from the incorrect selection of a furrow irrigation system and irrigation season duration. A protracted irrigation season (until October) is observed at all three demonstration sites in Soghd Province in Tajikistan. Irrigation on small plots with short furrows (a furrow length ranges from 68 to 98 m on demonstration fields) is typical for Soghd Province. Considerable irrigation water losses in the form of tailwater releases were observed in farms “Sayed” and “Bakhoriston”; and more efficient use of irrigation water takes place in the farm “Samatov.” There is a difference in irrigation water use resulted from the location of farms relative to the main canal. The farm “Bakhoriston” located along the upper part of the main canal with higher water availability uses more amounts of irrigation water than farms “Sayed” and “Samatov” located along the middle and tail part of the irrigation canal. Applying of greater irrigation rates in the farm “Bokhoriston”, due to soil conditions, results in considerable irrigation water losses owing to deep percolation.

**Table 5.22 Zoning of Demonstration Fields according to the Permeability of Soils and Slopes**

| Farm | Soil type | Topsoil depth, m | Underlying layer | Zone index/ Gradient | Zone index/ Infiltration Rate (m/h) |
|---|---|---|---|---|---|
| DF “Samatov” | Sandy loam | 0.5- 0.7 | pebbles | **I – the zone of steepest slopes** | C – average permeability |
| | | | | 0.028 | 0.0042 |
| PF “Sayed” | Sandy loam | 0.5- 0.7 | pebbles | **II- the zone of steep slopes** | A- the highest permeability |
| | | | | 0.025 | 0.036 |
| DF “Bakhoriston” | Loamy sand | 1.5- 2.0 | pebbles | **II - the zone of steep slopes** | A- the highest permeability |
| | | | | 0.014 | 0.0138 |
| “Khojalkhon-ona-Khoji” | Sandy loam | 0.5- 0.7 | pebbles | **II - the zone of steep slopes** | B - high permeability |
| | | | | 0.012 | 0.0102 |
| “Nozima” | Loam and clay loam | Thick topsoil | | **III – the zone of mild slopes** | A- the highest permeability |
| | | | | 0.003 | 0.0198 |
| “Turdialy” | Sandy loam | 1.5-2.0 | pebbles | **III - the zone of mild slopes** | B - high permeability |
| | | | | 0.006 | 0.0102 |
| “Tlibjon” | Sandy loam | Thick topsoil | | **II - the zone of steep slopes** | A- the highest permeability |
| | | | | 0.01 | 0.0198 |
| “Toloykon” | Sandy loam | 0.5- 0.7 | pebbles | **I - the zone of steepest slopes** | A- the highest permeability |
| | | | | 0.045 | 0.012 |
| “Nursultan-Aly” | Loam | 0.5- 0.7 | pebbles | **I - the zone of steepest slopes** | B– high permeability |
| | | | | 0.06 | 0.006 |
| “Sandyk” | Loam and sandy loam | Thick topsoil | | **I - the zone of steepest slopes** | A- the highest permeability |
| | | | | 0.054 | 0.0402 |

In Fergana and Andijan provinces of Uzbekistan, conditions for water applications are different at selected demonstration sites due to different soil and hydrogeological conditions. In some farms, incorrect selecting of the furrow irrigation systems namely the direction and length of furrows (294 to 525 m) and irregular irrigation water delivery results in high consumption of irrigation water since most of irrigation water was lost due to deep percolation.

In the farm “Turdialy”, water applications were conducted taking into account groundwater feeding (GWT up to 0.5 m) and using irrigation rates and intake rates in furrows (0.3 to 0.4 l/sec) that are optimal for these conditions. Water application in accordance with the water-saving mode on selected sites (irrigation only on those parts of the field where plants suffer from water deficit) was conducted in the farm “Tolibjon.” The farmer could use lesser water volume during the growing season if to exclude two first unjustified water applications with high rates (4,400 and 2,500 $m^3$/ha).

Managing of water applications is more complicated in all three farms in Osh Province due to the irregular topography and stony soils. Planned soil wetting is achieved at the expense of higher irrigation rates (private farms “Toloykon” and “Nursultan-Aly”). The most part of irrigation water delivered is forming the runoff from a field. More efficient use of irrigation water was observed in the farm “Sandyk” where shorter furrows and lesser inflow rates in furrows were utilized.

Field investigations of the irrigation technique along with agricultural practice have shown that there are problems in organization of water applications due to the high permeability of soils, ill-made land leveling, steep slopes, insufficient topsoil thickness and incorrect selection of the furrow irrigation system.

## Evaluating the efficiency of irrigation water use in private farms

Analyzing the monitoring data along with appropriate calculations shows that a major portion of irrigation water losses is caused by deep percolation rather than surface runoff. Actual irrigation water losses due to deep percolation in farms exceed normative ones. In some farms such as “Khojalkhon-ona-Khoji” and “Nozima”, irrigation water losses exceed normative ones two times (Table 5.23). In these farms, an application efficiency amounts to 40%. Deep percolation is unavoidable for most of farms where the high permeability of soils is observed and where ill-made land leveling takes place and too long furrows are in use. It is although necessary to note that some farms, having the same soil and hydrogeological conditions, irrigated their plots with minimum irrigation water consumption and small losses of water owing to deep percolation and surface runoff (DF “Samatov”, “Sandyk”, and “Turdialy”). Application efficiency in these farms is the highest one. DF “Samatov” provided this result based on use of short furrows and small inflow rates in furrows. The farm “Turdialy” has provided the high application efficiency as a result of effective accounting the feeding by groundwater under irrigation scheduling. Excepting these three farms, the application efficiency was quite low at other demonstration sites.

**Table 5.23 Basic Indicators of Irrigation Water Use at Demonstration Sites**

| Farm | $WR_{norm}$ | SR | | DP | | AE | $AE = \frac{(WR_{norm} - SR - DP)}{WR_{norm}}$ |
|---|---|---|---|---|---|---|---|
| | actual | norm | actual | norm | actual | actual | |
| | $m^3$/ha | % | % | % | % | % | |
| DF “Samatov” | 8266 | 13 | 10 | 12 | 20 | 70 | 0.70 |
| PF “Sayed” | 7343 | 17 | 21 | 20 | 20 | 59 | 0.59 |
| DF “Bakhoriston” | 12969 | 17 | 20 | 20 | 36 | 45 | 0.45 |

| Farm | $WR_{norm}$ | SR | | DP | | AE | $AE = \frac{WR_{norm} - SR - DP}{WR_{norm}}$ |
|---|---|---|---|---|---|---|---|
| | actual | norm | actual | norm | actual | actual | |
| | $m^3$/ha | % | % | % | % | % | |
| DF "Khojalkhon-ona-Khoji" | 16795 | 13 | 19 | 17 | 41 | 41 | 0.41 |
| DF "Nozima" | 6718 | 2 | 0 | 31 | 58 | 42 | 0.42 |
| DF "Turdialy" | 2145 | 10 | 5 | 12 | 11 | 84 | 0.84 |
| DF "Tolibjon" | 9510 | 17 | 13 | 20 | 29 | 58 | 0.59 |
| DF "Toloykon" | 5803 | 1,3 | 32 | 46 | 40 | 28 | 0.28 |
| DF "Nursultan-Aly" | 5120 | 5 | 18 | 27 | 31 | 50 | 0.50 |
| DF "Sandyk" | 6030 | 1 | 26 | 46 | 10 | 64 | 0.64 |

Where: $WR_{norm}$ – normative water requirement; SR – surface runoff; DP – deep percolation; and AE –application efficiency

**Table 5.24. Assessment of Actual and Planned Application Efficiency**

| Farm | Planned application efficiency | Actual application efficiency | Possible increase in the application efficiency, % |
|---|---|---|---|
| DF "Samatov" | 0.76 | 0.70 | 8 |
| PF "Sayed" | 0.63 | 0.59 | 6 |
| DF "Bakhoriston" | 0.63 | 0.45 | 29 |
| PF "Khojalkhon-ona-Khoji" | 0.70 | 0.41 | 41 |
| PF "Nozima" | 0.67 | 0.42 | 37 |
| PF "Turdialy" | 0.84 | 0.84 | 0 |
| PF "Tolibjon" | 0.63 | 0.59 | 6 |
| PF "Toloykon" | 0.53 | 0.28 | 47 |
| PF "Nursultan-Aly" | 0.68 | 0.50 | 26 |
| PF "Sandyk" | 0.64 | 0.64 | 0 |

### Evaluating the existing furrow irrigation systems on demonstration fields

A proper furrow irrigation system is a crucial element that ensures the high application efficiency. Existing furrow irrigation systems were studied on all project demonstration fields during the growing season 2002. As a result of these field investigations, three groups of furrow irrigation systems were distinguished taking into account soil and hydrogeological conditions and local topography:

Satisfactory furrow irrigation systems not requiring any improvements (DF "Samatov", DF "Bakhoriston", PF "Turdialy" and "Tolibjon");

Non-satisfactory furrow irrigation systems requiring the complete remodeling, including reducing a length of furrows and arrangement of additional field and head ditches (PF "Khojalkhon-ona-Khoji" and "Nozima"); and

Furrow irrigation systems on fields with irregular topography where only partial modifications are possible (PF "Sayed", "Toloykon", "Nursultan-Aly", and "Sandyk").

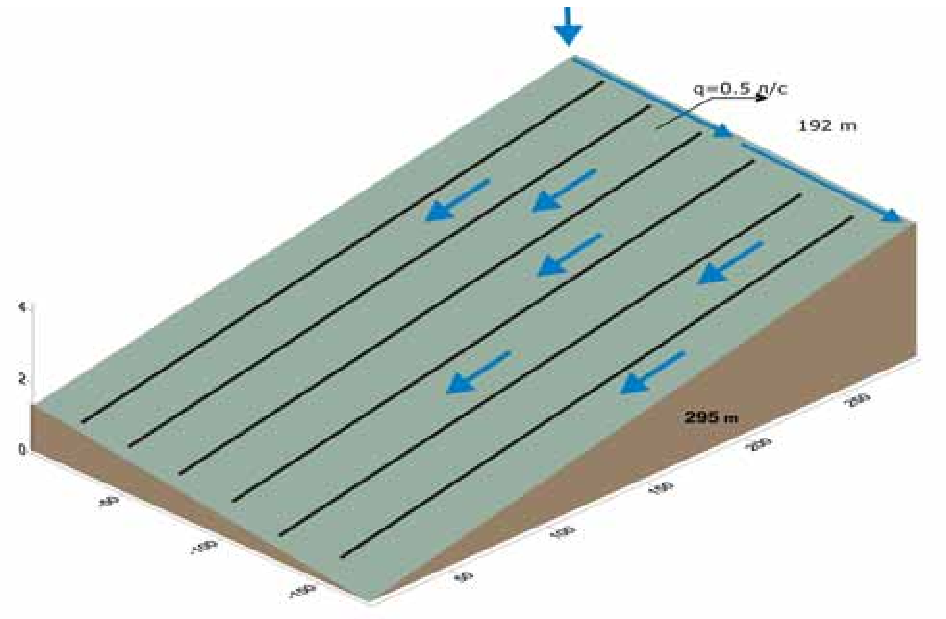



**Figure 5.28 Parameters of the Furrow Irrigation System in PF "Khojalkhon-ona-Khoji" (2002)**

Reducing a length of furrows and arrangement of additional field ditches were recommended for irrigated areas with shallow topsoil underlain by pebble. The length of furrows and division of the irrigated field into four irrigation units in DF "Samatov" can be considered as the most optimal solution. In DF "Bakhoriston", a flow rate in the irrigation canal should be adjusted (up to 40 l/sec instead of 80 l/sec) to be sufficient for irrigating two irrigation units on the field.

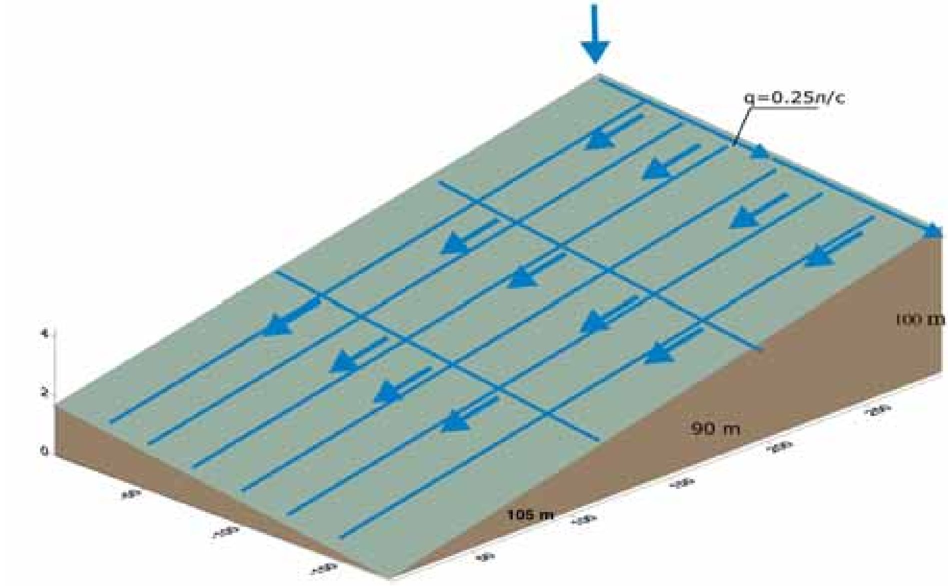



**Figure 5. 29 Parameters of the Furrow Irrigation System Recommended for PF "Khojalkhon-ona-Khoji" (2003)**

A key shortcoming in organization of water applications in the farm "Nozima" is the incorrect selection of furrow irrigation system under lacking of land leveling. In the farm "Tolibjon" water application is conducted on selected irrigation units within fields, taking into account actual crop water demands. It is important to study and develop this approach containing elements of water-saving methods.

Steep slopes, irregular topography and the high permeability of soils cause difficulties in organizing water applications in farms of Osh Province. The furrow irrigation system in all three demonstration farms should be modified by means of arranging additional field ditches. It is recommended to irrigate three sections of a field in turn: an upper section with a gentler slope; middle and lower section with steeper slopes.

### Assessment of the actual irrigation water productivity on the demonstration sites

To assess the irrigation water productivity we have analyzed and evaluated monitoring data on irrigation water use and agricultural practice on all demonstration fields during the growing season. In the process of comparative assessment of irrigation water use it was determined that actual irrigation water supply exceeds required volumes and obviously that rising of irrigation water productivity can be achieved at the expense of reducing the rate and numbers of water applications. The actual productivity of irrigation water ranges from 2400 to 4400 m3/ton in farms of Soghd Province (Figure 5.30). It is necessary to note that water applications in September and October are not effective and even reduce crop yields; therefore, the irrigation water productivity could be much higher without these irrigations and could make up 1900 to 2600 m3/ton. The highest water consumption per unit production is observed in the farm "Khojalkhon-ona-Khoji" (reducing the irrigation water productivity 2.5 times)

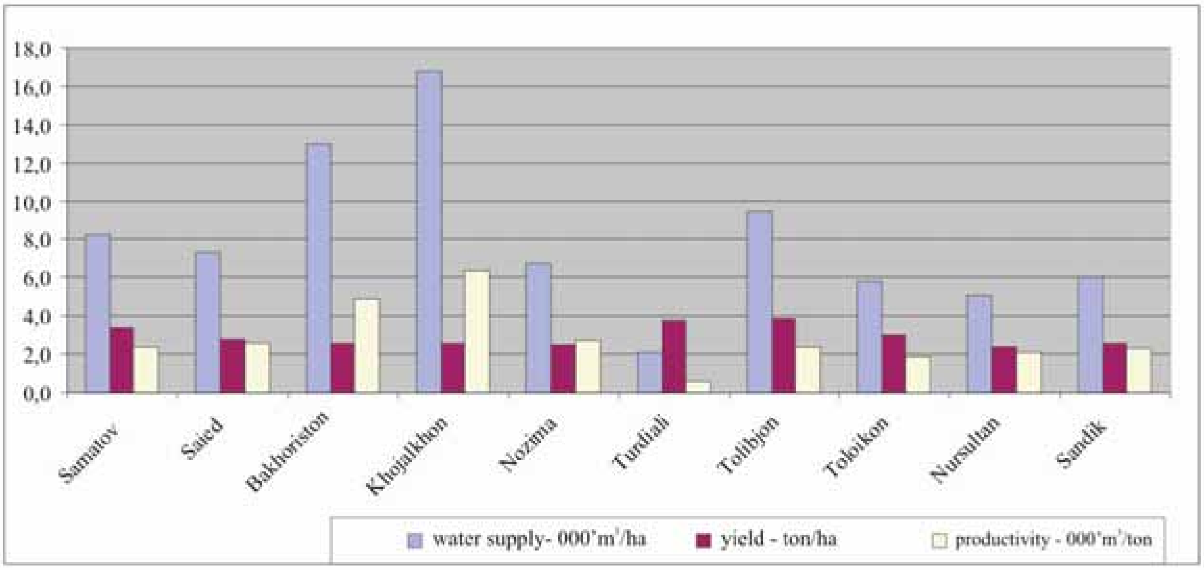



**Figure 5.30 Assessment of the Actual Irrigation Water Productivity**

Note: where Nf – an actual irrigation rate; PY- an actual crop yield; P- the irrigation water productivity.

The least consumption of irrigation water was observed in farms "Saed", "Samatov", "Sandyk", "Nursultan-Aly" and "Turdialy." The highest level of irrigation water productivity was achieved in the farm "Turdialy" (600 $m^3$/ton) as a result of effective water use and feeding by groundwater along with skillfully implementing the land treatment.

### Assessment of the potential irrigation water productivity

Apart from unproductive losses of irrigation water due to deep percolation and tailwater runoff from irrigated fields, reducing of irrigation water productivity is caused by losses of crop yield owing to organizational factors and different bottlenecks in the agricultural practice. Actual values of reducing crop yields caused by different factors were determined based on evaluating of the field monitoring data. Maximum losses of crop yield are caused by an insufficient content of humus in soils over all farms with the exception of the farm "Nozima." Losses of crop yields due to humus deficit amount to 30 to 40% in farms of Osh Province. This reason is also crucial for Soghd Province causing losses of crop yields up to 23%. In Andijan and Fergana provinces the content of humus in soils is higher than in Osh and Soghd provinces; and therefore losses of crop yields caused by this factor make up less than 10%.

Soil salinization is no less important a factor of reducing crop yields. Soils more affected by salinization are observed in farms "Khojalkhon-ona-Khoji", "Nozima" and "Nursultan-Aly" where losses of crop yield due to salinization make up 9 to 13%. Losses of crop yields caused by other factors are negligible. An assessment of the potential water productivity will be incorrect without reviewing losses of crop yields caused by factors related to agricultural practice and soil and hydrogeological conditions since under supplying irrigation water according to optimal timing and norms, the low indicators of irrigation water productivity can be received due to factors that have nothing to do with irrigation water. Therefore, the optimal gross irrigation rate and potential crop yield that was calculated for each demonstration field based on monitoring data were used for evaluating the potentially possible productivity of irrigation water. In case of eliminating step-down factors, a level of irrigation water productivity on project demonstration fields can be, on average, raised on 54% in Tajikistan, 52% in Uzbekistan, and 34% in Kyrgyzstan.

## Financial and economic indicators of the irrigation water productivity

A chief indicator of agricultural production efficiency is the profit from agricultural output, which depends from total production costs, amount of output and its realization. Total production costs and an amount of agricultural output depend on different factors and components of farming, including use of irrigation water.

Production costs in farms from tillage operations and until harvest and sale of output were studied and analyzed based on data of the monitoring on each demonstration field. Total production costs were calculated for each demonstration farm in the local currency based on data on scopes of works and their unit costs. For conducting the comparative assessment, the total production costs were converted to USD. Manual labor, fertilizers and machinery operation are main items of total production costs under cultivating cotton.

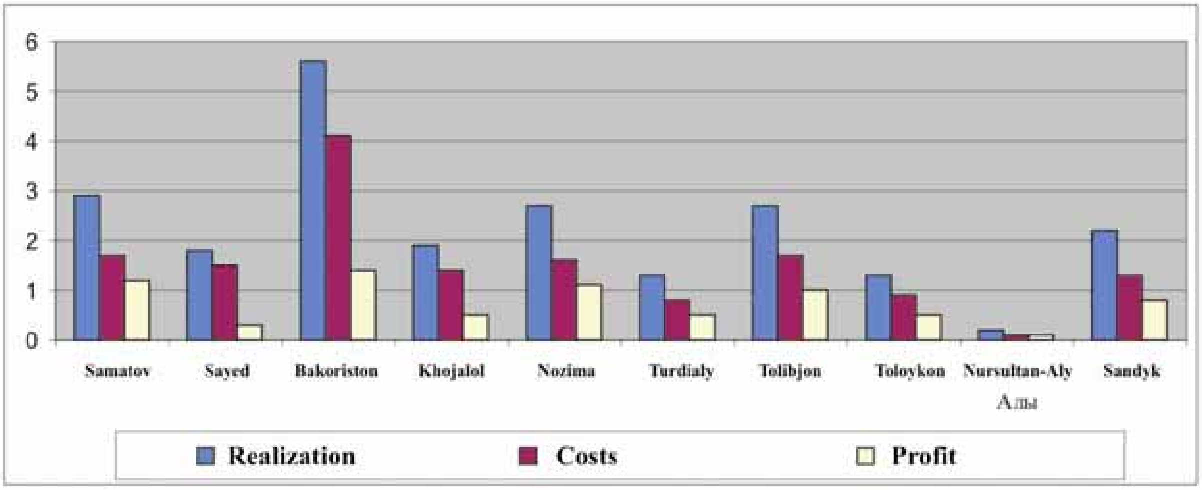



**Figure 5.31 Economic Assessment of Agricultural Production**

The economic assessment of irrigation water productivity was carried out on the basis of collected data on the profit from agricultural output and irrigation water volumes consumed on demonstration fields. Economic indicators of irrigation water productivity vary over the range of 0.02 to 0.26 \$/m3 over demonstration farms. The highest economic indicators of irrigation water productivity are observed in the farm “Turdialy” and the least ones in the farm “Khojalkhon-ona-Khoji.” An average economic productivity of irrigation water over all farms, without considering crop pattern, amounts to 0.06 \$/m3.

Evaluating the initial monitoring data has shown that the soil and hydrogeological conditions at selected demonstration sites in the Fergana Valley differ from each other drastically, causing different challenges for organizing water applications. The application efficiency at demonstration sites has mainly depended on soil properties, water availability, hydrogeological conditions, and selected furrow irrigation system. Monitoring of irrigation water use and agricultural practice allowed revealing the low efficiency of land and water resources use practically in all farms in three provinces of the Fergana Valley. Major causes of reducing the efficiency of irrigation water use are the following:

- unstable irrigation water availability in irrigation canals;
- lack of the plan of water use adequate to specific soil, climatic, and morphological conditions of irrigated farmlands;
- incorrectly selected furrow irrigation systems and their parameters; and

- low quality of land leveling and preparatory agricultural methods.

**Key indicators of the low efficiency of land and water resources use are the following:**

- considerable losses due to deep percolation;
- considerable tailwater runoff on irrigated fields;
- out-of-time implementing of some land treatment operations and their low quality;
- low application rates of potash and phosphate fertilizers or their complete lack; and
- ineffective methods of weed control and pest control;

Ununiform rates of water infiltration into soil over different parts of an irrigated field and along a furrow length, unsustainable water availability in irrigation canals, ill-made land leveling and incorrect selected furrow irrigation systems result in the considerable consumption of irrigation water during the growing season.

### 5.6.1 Management of Irrigation and Agricultural Practice Based on State-of-the-Art Technological and Engineering Methods for Achieving Efficient Use of Land and Water Resources and Sustainable Crop Yields at the Field Level

The monitoring conducted in 2002 for evaluating the productivity of irrigation water and irrigated farmland allowed revealing the existing status of irrigated farmland, private farms and irrigation water use in the Fergana Valley, as well as existing bottlenecks and opportunities for their eliminating. The monitoring data became the basis for developing the recommendations how to raise the efficiency of irrigation water and irrigated farmland use, how to enhance their productivity and how to improve the management methods in the agricultural sector. The models for irrigation scheduling adapted to conditions of each field were developed based on the analysis of baseline information. So-called agro-ameliorative passports that contain the baseline information on a field and the recommended furrow irrigation system along with recommended agricultural methods were developed for each demonstration site.

As a result of assessment and analyzing of irrigation water use at demonstration sites in 2002, major factors that affected the efficiency of water applications were revealed. In 2003, activity aimed at eliminating existing shortcomings in water application management and improving the efficiency of water application was undertaken. At that, the particular attention was paid to the following measures:

- **Layout of irrigated units:** each demonstration field, taking into consideration its topographic, soil and hydrogeological conditions, was divided into irrigated units with a length of furrows less than 100 m (an optimal length up to 70 m) by the system of longitudinal and lateral irrigation ditches;
- **Improving on-field irrigation water distribution** based on the subdivision into irrigated units: the sequence of irrigation with applying water-saving elements and rational use of irrigation water within a field (a decrease in water delivery into lower irrigated units in accordance with volumes of tailwater runoff from each furrow of an upper irrigated units), taking into consideration a micro-topography and soil texture of irrigated units; and
- Implementing water application in accordance with **terms and rates** calculated by the computer model based on information on actual soil water depletion and evaporation rates.

Implementing the planned measures was started since October-November because it was important to implement tillage in accordance with the developed recommendations during the autumn season. For the purpose of preparing fields for the irrigation season, division of fields into irrigated units was made in March-

April. For calculating terms and rates of water applications, daily field measurements of evaporation and soil water content were started in May.

### Comparative analyzing of irrigation water use to evaluate the water management at the demonstration sites

Analysis of data on irrigation water use has shown that during following years practically all farms have irrigated their plots using water application rates considerably lesser than in 2002. In addition, the number of water applications was reduced in many farms. Although this indicator cannot be considered as an indicator of saving water in the process of irrigation, at the same time, it has certain meaning relative to rational and effective use of irrigation water. For example, in May and June in 2003, farms "Toloykon" and "Norsultan-Aly", using recommendations based on modeling results that took into account actual data on soil water content and rainfalls, have implemented only one water application with a small rate against two water applications with the rate of 2000 $m^3$/ha in 2002. In this case, the reduction in the water application volumes took place according to both the number of irrigations and their rates. However, a different situation was observed in the farm "Tolibjon" where there were four water applications in 2002 and seven in 2003; and the reduction in the water application volumes in 2003 took place due to the reducing in irrigation rates.

In 2004, weather conditions considerably differed from those in 2003; and this fact has predetermined great changes in volumes of irrigation water supply and irrigation scheduling. Table 5.25 shows that in 2004 the irrigation requirements and volumes of irrigation water supply were increased in most of private farms; and some farms increased the number of water applications as well.

The most increase in irrigation water use was observed in the farm "Somatov" in Soghd Province and the farm "Toloykon" in Osh Province. The farm "Somatov" has used more irrigation water on 34% than was recommended. The farm "Toloykon" exceeded the normative volume of irrigation water use because of the first overrated water application in spring (3729 m3/ha) when the drought and high infiltration rates of dry soils in this farm did not allow irrigators to use small irrigation rates. Irrigation rates were adjusted during the following water applications in accordance with the estimated norms.

In farms "Bakhoriston", "Nozima", and "Nursultan-Aly", the increase in irrigation rates was observed only relative to 2003 and cannot be considered as mismanagement, because the Year 2003 is characterized by abundant rainfalls, most of which fell in May and June. The amount of precipitation during these months made up 46 mm in 2004 against 112 mm in 2003, or 660 m3/ha of additional replenishing of soil water content available for plants. The intensity of rainfalls allowed farmers to delay the first water application by 30 to 40 days and even more. As a result, most of farms have reduced the number of irrigations (by one or two) and the total volume of irrigation water supply into fields. The farms that cultivate wheat have managed with one water application in the spring period, as much as possible using wetting of soils by rainfalls. The farm "Nursultan-Aly" that has produced the output of wheat using only one water application (the irrigation rate of 2130 m3/ha) can be mentioned. In 2004, although this farm has increased the irrigation requirement up to 4393 m3/ha, however, it fits the estimated water requirement for this year (with the exception of small surpluses over water application rates). The beginning of irrigation of wheat since April and more intense irrigations in May and June were caused because of the droughty end of winter and the droughty beginning of May. The same can be mentioned regarding irrigation of cotton. Droughty spring did not allow farms to sow cotton using the natural soil water content. Some farms were forced to make irrigation to trigger germination in the beginning of April. Most of farms have used irrigations to trigger germination. Some farms, such as the farm "Turdialy", have made water application for land preparation and were forced to make irrigation to trigger germination due to the deficit of soil water content before the sowing campaign. As a result, the farm has used 1053 m3/ha for water application for land preparation in vain. Although, this farm has rationally used the feeding by groundwater and following the estimated irrigation schedule based on accounting actual soil water content and evaporation, used the irrigation rate less than in 2003.

The farms "Sayed", "Khojalkhon-ona-Khoji" and "Tolibjon" have used irrigation water in limits of volumes used in 2003. The farm "Khojalkhon-ona-Khoji" has slightly reduced the volume of irrigation water use mainly due to accurate implementing the recommendations on irrigation scheduling based on modeling. At the same time, the farm "Tolibjon" has reduced the volume of irrigation water use mainly due to the original water-saving method of water applications over local irrigation units (this method is described in the section devoted to water saving technologies in more detail).

Table 5.25 Basic Indicators of Irrigation Water Use at Demonstration Sites

| Farm | Number of water applications | | | Area, ha | | | Irrigation water supply per unit area (gross), $m^3$/ha | | | Tailwater runoff, $m^3$/ha | | | Irrigation water supply per unit area (net), $m^3$/ha | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 |
| 1 | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | |
| Samatov | 11 | 7 | 8 | 6 | 7 | 7 | 8,264 | 5,012 | 8,032 | 853 | 468 | 339 | 7411 | 4,545 | 7,693 |
| Sayed | 14 | 7 | 7 | 4.1 | 4.1 | 4.1 | 7,342 | 5,940 | 6,659 | 1,536 | 1,071 | 895 | 5807 | 4,869 | 5,763 |
| Bakhoriston | 8 | 7 | 8 | 12.6 | 12.6 | 4.6 | 12,968 | 7,643 | 8,815 | 2,483 | 1,557 | 1,361 | 10,485 | 6,086 | 7,454 |
| Khojalkhon-ona-Khoji | 10 | 8 | 7 | 5.6 | 5.6 | 5.6 | 18,804 | 12,525 | 10,305 | 3,173 | 3,173 | 2,342 | 15,631 | 9,351 | 7,962 |
| Nozima | 3 | 3 | 4 | 8 | 8 | 4.5 | 6,718 | 3,468 | 4,523 | 0 | 0 | 0 | 6,718 | 3,468 | 4,523 |
| Turdialy | 6 | 5 | 5 | 2 | 1 | 1 | 4,020 | 3,429 | 3,290 | 255 | 510 | 164 | 3,831 | 2,919 | 3,126 |
| Tolibjon | 4 | 7 | 7 | 5 | 5 | 5 | 9,399 | 5,925 | 5,761 | 1,208 | 468 | 1,485 | 8,191 | 5,457 | 4,275 |
| Toloykon | 2 | 3 | 4 | 4 | 2 | 2.5 | 5,803 | 4,569 | 5,495 | 1,855 | 606 | 1,666 | 3,948 | 3,963 | 3,829 |
| Nursultan | 2 | 3 | 3 | 0.9 | 1 | 1 | 5,120 | 2,130 | 4,393 | 942 | 418 | 1,200 | 4,178 | 1,712 | 3,193 |
| Sandyk | 5 | 5 | 5 | 5 | 5 | 5 | 6,030 | 5,540 | 6,236 | 1,554 | 1,170 | 1,139 | 4,476 | 4,370 | 5,097 |

### Assessment of the water use efficiency at demonstration sites

In 2003, the higher efficiency of irrigation water use in comparing with 2002 was observed (it was ranging from 0.53 to 0.83 i.e., on average, 65% of irrigation water delivered was used directly by plants). However, in 2004, the efficiency of irrigation water use was lower than in 2003, although maximum values in some farms were higher (Table 5.26).

For example, in farms “Nozima”, “Turdialy” and “Tolibjon” (Uzbekistan) and in the farm “Sandyk” (Kyrgyzstan), in comparing with 2002 and 2003, the growth of the efficiency of irrigation water use was observed. The efficiency of irrigation water use has reduced in all three farms in Tajikistan; although in two farms (“Sayed” and “Bakhoriston”) this reduction was negligible, within the allowable variations. Regarding some factors that affect the efficiency of irrigation water use (tailwater runoff from irrigated fields and irrigation water losses due to deep percolation), it is necessary to note that while volumes of tailwater runoff from irrigated fields were higher in 2004 than in 2003, they were lower than in 2002 and most likely reflect the losses of irrigation water inherent for the given soil and climatic conditions. In the farm “Samatov”, basic losses of irrigation water are related to deep percolation. The incorrect decision of this farm’s manager, who explained his actions by the specificity of cultivating cotton with long-staple fibers, consisted in applying higher irrigation rates without considering the soil and hydrogeological conditions (topsoil with the thickness not exceeding 0.7 to 1.0 m underlain by pebble). Overrated values of tailwater runoff from irrigated fields and irrigation water losses due to deep percolation were also observed in the farm “Khojalkhon-ona-Khoji” in Fergana Province of Uzbekistan and in farms “Toloykon” and “Nursultan-Aly” in Osh Province of Kyrgyzstan. In these farms, topsoil with the insufficient thickness underlain by pebble play a determinative role. High losses of irrigation water due to deep percolation on such soils are unavoidable, but they can be reduced by applying low inflow rates in furrows and simultaneous irrigation only on small irrigated units. However, at that, the problem of elongating a total time of water delivery into a field arises. As a whole, losses of irrigation water due to deep percolation and tailwater runoff from irrigated fields were close to the normative values in other farms. On average, the efficiency of irrigation water use was at the level of 52% in 2002, 66% in 2003, and 62% in 2004. These values show that the relative sustainability in irrigation water management was achieved.

### Assessment of irrigation water productivity at demonstration sites

In 2002, actual volumes of irrigation water supply in farms have exceeded the required volumes, and it became quite obvious that raising the irrigation water productivity can be provided only by reducing the number and rates of water applications. Monitoring at demonstration sites confirmed the correctness of conclusions made in 2002. Assessment of the irrigation water productivity based on the field monitoring has revealed considerable changes at each demonstration site in 2003. In 2004, members of the regional group and local experts organized field works, carefully following the methodological approaches developed in 2003 to achieve the sustainability of gained results. In 2004, according to the monitoring data, irrigation water consumption per unit output ranged from 0.7 to 3.6 $m^3$/kg; these values are lower than in 2003 (from 0.5 to 4.65 $m^3$/kg). In 2002, irrigation water consumption per unit output ranged from 1.14 to 7.12 $m^3$/kg (Table 5.27).

The comparative assessment of irrigation water consumption per unit output at project demonstration sites shows that in 2004, as a whole, most of farms have received the sustainable results relative to the results achieved in 2003, but farms “Samatov” in Soghd Province and “Toloykon” in Osh Province are an exception from them. The farm “Samatov” exceeded the normative irrigation water consumption per unit output by two reasons: the first one is overrated water applications, and the second one is a low productivity of cotton with long-staple fibers in comparing with common varieties. The farm “Toloykon” used the overrated irrigation water consumption under receiving high crop yield (4.5 ton/ha). Farms “Bakhoriston” and “Sayed” in Soghd Province, farms “Nozima”, “Turdialy” and “Tolibjon” in Fergana and Andijan provinces, and farms “Nursultan-Aly” and “Sandyk” in Osh Province used their resources as much as possible (Figure 5.32). In these farms, lesser values of irrigation water consumption per unit output have mainly obtained due to raising crop yields. Such farms as “Khojalkhon”, “Turdialy”, “Tolibjon” and “Sandyk” have raised crop yields using lesser volumes of irrigation water not only relative to 2002, but also relative to 2003. The efficiency of irrigation water use varies over the range of 0.29 to 1.4 kg/$m^3$ over demonstration farms in 2004. As a whole, the productivity has increased in most of demonstration farms, but such farms as “Somatov”, “Toloykon” and “Nursultan-Aly” had worse indicators than in 2003.

**Table 5.26 Comparative Assessment of the Efficiency of Irrigation Water Use**

| Farm | Irrigation requirement (gross – Nactual) | | | Losses due to tailwater runoff (TWR) | | | | | | Losses due to deep percolation (DP)** | | | | | | Ea= (Nactual - TWR - DP) / Nactual | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2002 | | 2003 | | 2004 | | 2002 | | 2003 | | 2004 | | 2002 | 2003 | 2004 |
| | $m^3/ha$ | | | $m^3/ha$ | % | $m^3/ha$ | % | $m^3/ha$ | % | $m^3/ha$ | % | $m^3/ha$ | % | $m^3/ha$ | % | | | |
| **Samatov** | 8,264 | 5,012 | 8,032 | 853 | 10 | 468 | 9 | 339 | 4 | 1628 | 20 | 674 | 13 | 2364 | 29 | 0.70 | 0.77 | 0.66 |
| **Sayed** | 7,342 | 5,940 | 6,658 | 1536 | 21 | 1071 | 18 | 895 | 13 | 1483 | 20 | 142 | 2 | 575 | 10 | 0.59 | 0.80 | 0.78 |
| **Bakhoriston** | 12,968 | 7,643 | 8,815 | 2483 | 19 | 1557 | 20 | 1361 | 15 | 4604 | 36 | 622 | 8 | 1588 | 18 | 0.45 | 0.71 | 0.67 |
| **Khojalkhon-ona-Khoji** | 18,804 | 12,525 | 10,305 | 3173 | 17 | 1980 | 16 | 2342 | 23 | 7635 | 41 | 3917 | 31 | 3683 | 36 | 0.43 | 0.53 | 0.42 |
| **Nozima** | 6,718 | 3,468 | 4,523 | 0 | 0 | 0 | 0 | 0 | 0 | 3903 | 58 | 1281 | 37 | 647 | 14 | 0.42 | 0.63 | 0.86 |
| **Turdialy** | 4,020 | 3,429 | 3,290 | 255 | 6 | 453 | 13 | 164 | 5 | 430 | 11 | 133 | 4 | 292 | 9 | 0.83 | 0.83 | 0.86 |
| **Tolibjon** | 9,399 | 5,925 | 5,761 | 1208 | 13 | 1685 | 28 | 1485 | 26 | 2679 | 29 | 631 | 11 | 634 | 11 | 0.59 | 0.61 | 0.63 |
| **Toloykon** | 5,803 | 4,569 | 5,494 | 1855 | 32 | 606 | 13 | 1666 | 30 | 2333 | 40 | 2040 | 45 | 1938 | 35 | 0.28 | 0.42 | 0.34 |
| **Nursultan** | 5,120 | 2,130 | 4,393 | 942 | 18 | 418 | 20 | 1200 | 27 | 1597 | 31 | 418 | 20 | 1404 | 32 | 0.50 | 0.61 | 0.41 |
| **Sandyk** | 6,030 | 5,540 | 6,236 | 1554 | 26 | 1170 | 21 | 1139 | 18 | 645 | 11 | 593 | 11 | 686 | 11 | 0.64 | 0.68 | 0.71 |

**Table 5.27 Comparative Assessment of Basic Indicators of Irrigation Water Productivity at Project Demonstration Sites**

| Farm | Irrigation requirement (gross – Nactual) | | | Losses due to tailwater runoff (TWR) | | | | | | Losses due to deep percolation (DP)** | | | | | | Ea= (Nactual - TWR - DP) / Nactual | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2002 | | 2003 | | 2004 | | 2002 | | 2003 | | 2004 | | 2002 | 2003 | 2004 |
| | $m^3$/ha | | | $m^3$/ha | % | $m^3$/ha | % | $m^3$/ha | % | $m^3$/ha | % | $m^3$/ha | % | $m^3$/ha | % | | | |
| **Samatov** | 8,264 | 5,012 | 8,032 | 853 | 10 | 468 | 9 | 339 | 4 | 1628 | 20 | 674 | 13 | 2364 | 29 | 0.70 | 0.77 | 0.66 |
| **Sayed** | 7,342 | 5,940 | 6,658 | 1536 | 21 | 1071 | 18 | 895 | 13 | 1483 | 20 | 142 | 2 | 575 | 10 | 0.59 | 0.80 | 0.78 |
| **Bakhoriston** | 12,968 | 7,643 | 8,815 | 2483 | 19 | 1557 | 20 | 1361 | 15 | 4604 | 36 | 622 | 8 | 1588 | 18 | 0.45 | 0.71 | 0.67 |
| **Khojalkhon-ona-Khoji** | 18,804 | 12,525 | 10,305 | 3173 | 17 | 1980 | 16 | 2342 | 23 | 7635 | 41 | 3917 | 31 | 3683 | 36 | 0.43 | 0.53 | 0.42 |
| **Nozima** | 6,718 | 3,468 | 4,523 | 0 | 0 | 0 | 0 | 0 | 0 | 3903 | 58 | 1281 | 37 | 647 | 14 | 0.42 | 0.63 | 0.86 |
| **Turdialy** | 4,020 | 3,429 | 3,290 | 255 | 6 | 453 | 13 | 164 | 5 | 430 | 11 | 133 | 4 | 292 | 9 | 0.83 | 0.83 | 0.86 |
| **Tolibjon** | 9,399 | 5,925 | 5,761 | 1208 | 13 | 1685 | 28 | 1485 | 26 | 2679 | 29 | 631 | 11 | 634 | 11 | 0.59 | 0.61 | 0.63 |
| **Toloykon** | 5,803 | 4,569 | 5,494 | 1855 | 32 | 606 | 13 | 1666 | 30 | 2333 | 40 | 2040 | 45 | 1938 | 35 | 0.28 | 0.42 | 0.34 |
| **Nursultan** | 5,120 | 2,130 | 4,393 | 942 | 18 | 418 | 20 | 1200 | 27 | 1597 | 31 | 418 | 20 | 1404 | 32 | 0.50 | 0.61 | 0.41 |
| **Sandyk** | 6,030 | 5,540 | 6,236 | 1554 | 26 | 1170 | 21 | 1139 | 18 | 645 | 11 | 593 | 11 | 686 | 11 | 0.64 | 0.68 | 0.71 |

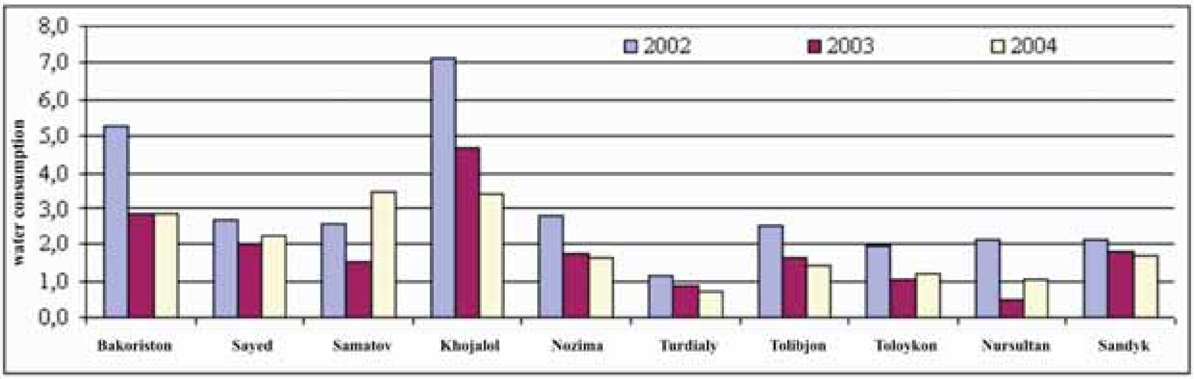



**Figure 5. 32 Irrigation Water Consumption for Crop Growing at Project Demonstration Sites**

Considerable differences in values of the irrigation water productivity over years were observed in the farm "Nursultan-Aly." In this case, abundant rainfalls in May and June in 2003 have played a key role in reducing irrigation water supply and raising the irrigation water productivity. Therefore, the irrigation water productivity observed in 2004 is more realistic for existing soil and climatic conditions; and the increase in the irrigation water productivity in 2003 should be considered as an exception to the rule. In 2004, the irrigation water productivity in this farm has increased two times relative to 2002. A general picture of changes in the irrigation water productivity over all demonstration farms is given in Figure 5.33.

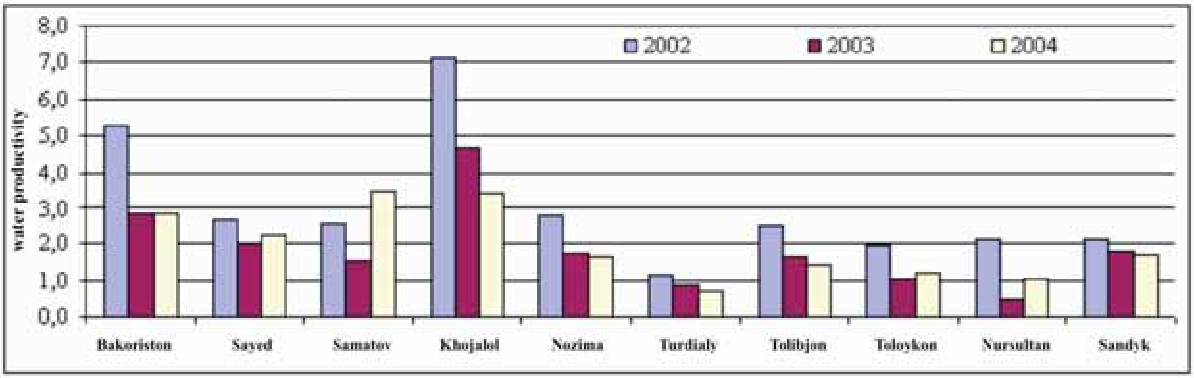



**Figure 5.33 Irrigation Water Productivity**

The comparative assessment of irrigation water use and crop yields has shown that most of farms have managed to raise the level of both the irrigation water productivity and crop yields. In 2004, the overall productivity over demonstration sites has raised by 21 to 135% relative to 2002, excepting the farm "Samatov" where the productivity has lowered by 25%. In comparing with 2003, trends over farms in 2004 are different, for example, in the farms "Sayed", "Khojalkhon-ona-Khoji", "Turdialy", "Nozima", "Tolibjon" and "Sandyk", the raise of the productivity was varying over the range of 2 to 54%, at the same time, in the farms "Samatov", "Toloykon", and "Nursultan-Aly", the productivity has lowered by 55%, 35% and 52% respectively. In 2004, the farm "Bokhoriston" has provided the practically same productivity that was achieved in 2003 (by 1.1% less). In 2003, the weather conditions along with special measures for setting the proper irrigation water supply rates have played a great role in achieving the high level of productivity in all farms. In 2003, the irrigation water productivity has increased by 35 to 95% relative to 2002 against the increase in crop yields by 4 to 54%. In 2004, the irrigation water productivity has increased by 16 to 83% relative to 2002 against the increase in crop yields by 11 to 72% (Table 5.27).

**Table 5.27 The Efficiency of Irrigation Water Use and Crop Yield Relative to 2002**

| Farm | Overall productivity, kg/m$^3$ | | | **Input into raising the productivity,% | | | |
|---|---|---|---|---|---|---|---|
| | | | | According to irrigation water use (relative to 2002.) | | According to the increase in crop yields (relative to 2002) | |
| | (P1) 2002 | (P2) 2003 | (P3) 2004 | IWP1 2003 | IWP2 2004 | ICY1 2003 | ICY2 2004 |
| Bakhoriston | 0.19 | 0.36 | 0.35 | 79 | 55 | 13 | 31 |
| Sayed | 0.37 | 0.49 | 0.45 | 77 | 51 | 21 | 44 |
| Samatov | 0.39 | 0.65 | 0.29 | 97 | 0 | 2 | 0 |
| Khojalkhon-ona-Khoji | 0.14 | 0.21 | 0.30 | 95 | 74 | 4 | 15 |
| Nozima | 0.36 | 0.58 | 0.62 | 100 | 69 | 0 | 21 |
| Turdialy | 0.88 | 1.14 | 1.40 | 56 | 37 | 37 | 51 |
| Tolibjon | 0.40 | 0.61 | 0.71 | 100 | 83 | 0 | 11 |
| Toloykon | 0.52 | 0.97 | 0.83 | 31 | 9 | 54 | 86 |
| Nursultan | 0.48 | 2.02 | 0.98 | 43 | 16 | 24 | 72 |
| Sandyk | 0.47 | 0.55 | 0.57 | 54 | 0 | 42 | 100 |

In 2004, six farms have improved their indicators of the productivity relative to 2003 (both in water saving activity and in raising crop yields). The farms “Sayed”, “Khojalkhon-ona-Khoji”, “Turdialy”, “Tolibjon” and “Sandyk” have obtained the reduction of irrigation water consumption. The farm “Bokhoriston” has achieved the productivity at the level of 2003. The farm “Samatov” has lowered the level of its productivity due to cultivating the low-yield variety of cotton with long-staple fibers. Farms “Nozima” and “Nursultan-Aly” have obtained the productivity that was close to the level of the year with average water availability in respect of both irrigation water use and crop yields, although their values in 2004 were lower than in 2003. The farm “Tloykon”, obtaining the maximum possible crop yield, has used overrated amounts of irrigation water during the first water application in spring affecting its overall productivity. Implemented measures allowed improving management of water applications and agricultural activity in the project demonstration farms. As a result, reduction of irrigation water supply on the field level, rising of yields of cotton and wheat, and the growth of the productivity of land and water resources have become possible (Table 5.28).

**Table 5.28. Indicators of Improving Agricultural Production Management**

| Indicators | Tajikistan | Uzbekistan | Kyrgyzstan | |
|---|---|---|---|---|
| | Cotton | Cotton | Cotton | Wheat |
| Reducing irrigation water supply | 33% | 34% | 17% | 40% |
| Raising crop yields | 18% | 21% | 25% | 64% |
| Raising the productivity | 62% | 69% | 52% | 96% |

Analyzing the obtained results over all farms during three years, it is possible to state a fact that the irrigation water productivity at the level of 2003 is rather sustainable.

## Comparative Assessment of Basic Economic Indicators of Agricultural Activity

Mineral fertilizers are one of key factors determining the level of the agricultural productivity; at that, not only the total amount of fertilizers applied to soils but also their qualitative composition (the content of macroelements) affects crop yields. Information on the amounts of nitrogen, phosphate and potash fertilizers applied to soils over the period of 2002 to 2004 is given in Table 5.26 (physical weights were converted into the amount of so-called active nutrients (AN) that allows presenting the extent of availability of nitrogen, phosphorus and potassium for crops N-P-K). A comparative analysis of the actual application of fertilizers shows that almost all farms have considerably increased the application of nitrogen fertilizers in 2004 in comparing with 2002 (the situation in the farm “Nursultan-Aly” has not changed). At that, an average indicator for all farms cultivating cotton made up 171 kg/ha of AN at the beginning of the project implementation and has increased up to 212 kg/ha of AN in the growing season of 2004. An appreciable growth in the amount of phosphate fertilizers applied to soils was observed: in 2002 – 31 kg/ha of AN, on average over farms; in 2003 – 153 kg/ha of AN; and in 2004 – 160 kg/ha of AN. Potash fertilizers were not being applied at all in 2002; and only in subsequent years, these fertilizers started to be applied at demonstration fields. Comparing the reached indicators in some farms shows that not all farmers apply the recommended rates of artificial fertilizers and do not use this substantial potential for raising crop yields. The comparative assessment of agricultural activity allows comparing the results of management of land and water productivity in 2002 (the year when farmers themselves managed their farms under passive participation of project specialists who only monitored and recorded all parameters of agricultural practice) and the results of agricultural activity in 2003 and 2004 when project specialists actively participated in the management process. Basic agricultural and economic indicators over the mentioned period (Table 5.18) confirm that management of agricultural production was considerably improved at the expense of applying the recommendations developed by the project specialists for demonstration fields, use of computer-simulated irrigation schedules, the increase in fertilizer rates applied to soils; use of the individual process charts, and improving the quality of agricultural operations.

Cotton productivity has increased in seven farms from 0.7 center/ hectare (PF “Sayed”) to 7.8 centers/ hectare (PF “Nozima”) in 2004 in comparison with the 2003 cotton yield.

Comparing the results obtained in 2004 with indicators of the initial phase of project activity (2002) is of special interest. All farms cultivating cotton (with the exception of the farm “Samatov”) have achieved the considerable rising of productivity; for example, in the farm “Turdialy” during two years the crop yield has increased by 10.8 center/ha, in the farm “Sandyk” by 7.2 center/ha, in the farm “Bakhoriston” by 6.5 center/ha, and in remaining farms the increase in cotton yields is ranging from 2.2 center/ha to 3.3 center/ha (as was mentioned, in the farm “Samatov” the crop yield has decreased due to cultivating of cotton with long-staple fibers). At the same time, the increase in grain crop production can also be marked: in the farm “Toloykon” for two years of integrated management the yield of winter wheat has increased by 15.8 center/ha and in the farm “Nursultan-Aly” by 18.6 center/ha. In comparing with 2002, the gross output has considerably increased on all demonstration fields due to the rise of crop yields and the substantial growth of purchasing prices of raw cotton. For instance, in the farm “Sandyk”, the cost of sold output from one hectare was by US$ 798 higher; by US$ 974 in the farm “Bakhoriston”; and by US$ 655 in the farm “Turdaily.” The most growth of gross output over the period under consideration was observed in the farm “Samatov” where additional 1369 US$/ha were obtained due to the high purchasing price for cotton with long-staple fibers (789 US$/ton).

**Table 5.29 The Application of Chemical Fertilizers at Demonstration Fields (2002 to 2004)**

| Farm | Nitrogen fertilizers (kg/ha of AN) | | | | Phosphate fertilizers (kg/ha of AN) | | | | Potash fertilizers (kg/ha of AN) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 |
| **«Turdaily»** | 220 | 190 | 280 | 225 | 170 | 0,0 | 60 | 100 | 30 | 25 | 0.0 | 25 |
| **«Talibjon»** | 220 | 230 | 156 | 350 | 170 | 0,0 | 125 | 50 | 30 | 0.0 | 0.0 | 0.0 |
| **«Nozima»** | 220 | 140 | 131 | 145 | 170 | 25 | 30 | 160 | 30 | 0.0 | 0.0 | 0.0 |
| **«Khojalkhon-ona-Khoji»** | 230 | 195 | 230 | 220 | 180 | 65 | 230 | 100 | 50 | 0.0 | 100 | 40 |
| **«Samatov»** | 200 | 160 | 170 | 250 | 180 | 125 | 210 | 240 | 50 | 0.0 | 0.0 | 21 |
| **«Sayed»** | 200 | 162 | 146 | 185 | 180 | 0,0 | 220 | 180 | 50 | 0.0 | 0.0 | 0.0 |
| **«Bakhoriston»** | 200 | 165 | 140 | 175 | 180 | 35 | 175 | 250 | 50 | 0.0 | 45 | 18 |
| **«Sandyk»** | 200 | 130 | 170 | 150 | 180 | 0,0 | 180 | 200 | 50 | 0.0 | 0.0 | 0.0 |
| **«Toloykon»** | 140 | 100 | 106 | 145 | 140 | 0,0 | 160 | 60 | 30 | 0.0 | 0.0 | 0.0 |
| **«Nyrsultan-Aly»** | 140 | 50 | 83 | 50 | 140 | 0,0 | 160 | 140 | 30 | 0.0 | 0.0 | 0.0 |

**Table 5.30 Comparative Assessment of Basic Agricultural and Economic Indicators Obtained on Demonstration Fields ( 2002 to 2004)**

| Farm | Nitrogen fertilizers (kg/ha of AN) | | | | Phosphate fertilizers (kg/ha of AN) | | | | Potash fertilizers (kg/ha of AN) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 |
| **«Turdaily»** | 220 | 190 | 280 | 225 | 170 | 0,0 | 60 | 100 | 30 | 25 | 0.0 | 25 |
| **«Talibjon»** | 220 | 230 | 156 | 350 | 170 | 0,0 | 125 | 50 | 30 | 0.0 | 0.0 | 0.0 |
| **«Nozima»** | 220 | 140 | 131 | 145 | 170 | 25 | 30 | 160 | 30 | 0.0 | 0.0 | 0.0 |
| **«Khojalkhon-ona-Khoji»** | 230 | 195 | 230 | 220 | 180 | 65 | 230 | 100 | 50 | 0.0 | 100 | 40 |
| **«Samatov»** | 200 | 160 | 170 | 250 | 180 | 125 | 210 | 240 | 50 | 0.0 | 0.0 | 21 |
| **«Sayed»** | 200 | 162 | 146 | 185 | 180 | 0,0 | 220 | 180 | 50 | 0.0 | 0.0 | 0.0 |
| **«Bakhoriston»** | 200 | 165 | 140 | 175 | 180 | 35 | 175 | 250 | 50 | 0.0 | 45 | 18 |
| **«Sandyk»** | 200 | 130 | 170 | 150 | 180 | 0,0 | 180 | 200 | 50 | 0.0 | 0.0 | 0.0 |
| **«Toloykon»** | 140 | 100 | 106 | 145 | 140 | 0,0 | 160 | 60 | 30 | 0.0 | 0.0 | 0.0 |
| **«Nyrsultan-Aly»** | 140 | 50 | 83 | 50 | 140 | 0,0 | 160 | 140 | 30 | 0.0 | 0.0 | 0.0 |

In 2004, the growth of output cost value (variable costs) related to some rise in the cost of means of production (costs of mechanized and manual labor, fertilizers, pesticides etc.) was observed in all demonstration farms with the exception of the PF “Khojalkhon-ona-Khoji.” A maximum increase in variable costs was fixed in Tajikistan: by 301.4 USD/ha (more than two times) in the farm “Samatov”; by 155.6 USD/ha in the farm “Sayed”; and by 270 USD/ha in the farm “Bakhoriston.” In 2004, the profitability of farms has substantially changed due to the rise in crop yields and the cost of gross output. For instance, the maximum income was observed in the farm “Samatov” (1298 USD/ha), exceeding the indicator of 2002 on 1067 USD/ha. The high profitability of agricultural activity was also provided in the farms “Bakhoriston” (878 USD/ha) and “Sandyk” (900 USD/ha), exceeding the indicators of 2002 on 705 USD/ha and 712 USD/ha respectively. Over the period under consideration, the least growth of gross income was observed in the farm “Nazima” (only 133 USD/ha). The rise of profitability in farms that cultivate winter wheat made up 279 USD/ha in the farm “Toloykon” and 274 USD/ha in the farm “Nursultan-Aly.” The similar correlation is observed regarding the net income obtained in farms, which has insignificantly changed (after deducting fixed costs from the gross income) and keeps the same trends inherent in the gross income.

## Basic Agro-Economic Indicators over Countries

The indicators of the efficiency of agricultural production mainly depend on the costs for raw materials and agricultural inputs. The data given in Table 5.31, to a large extent, reflects the agricultural policy and reforms conducted in countries that participate in implementing this project.

**Table 5.31 Average Financial Prices of Output and Basic Agricultural Inputs**

| Indicator | Uzbekistan | | | Kyrgyzstan | | | Tajikistan | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 |
| Purchasing prices of raw cotton ($/ton) | 140.7 | 213.2 | 250.7 | 151.3 | 476.0 | 343.9 | 162.7 | 353.0 | 370.0 |
| Price of water ($/000 m$^3$) | 0.0 | 0.0 | 0.0 | 0.58 | 0.83 | 0.98 | 1.36 | 2.73 | 2.06 |
| Land tax ($/ha) | 3.4 | 11.3 | 12.7 | 9.8 | 9.7 | 14.5 | 5.5 | 10.2 | 12.9 |
| Mechanized labor ($/machine-hour) | 2.7 | 2.5 | 2.0 | 5.8 | 6.8 | 3.2 | 2.8 | 2.1 | 2.9 |
| Manual labor ($/man-day) | 1.6 | 1.9 | 1.6 | 1.4 | 1.4 | 1.1 | 0.8 | 1.2 | 1.3 |
| Seeds ($/kg) | 0.35 | 0.51 | 0.48 | 0.15 | 0.31 | 0.25 | 0.13 | 0.16 | 0.21 |
| Selitra (ammonium nitrate) ($/ton) | 63.0 | 68.0 | 140.0 | 105.2 | 153.0 | 180.0 | 119.3 | 119.8 | 170.0 |
| Ammophos ($/ton) | 106.5 | 109.8 | 220.0 | 130.0 | 107.0 | 140.0 | 159.7 | 144.0 | 170.0 |
| Carbamide ($/ton) | 83.1 | 87.5 | 140.0 | 120.3 | 123.1 | 155.0 | 140.7 | 136.9 | 160.0 |
| Superphosphate ($/ton) | 25.3 | 33.7 | 61.0 | 70.5 | 72.6 | 70.0 | 87.4 | 89.2 | 90.0 |

For example, in Uzbekistan, the purchasing prices for cotton, wheat and rice are established by the government, and their production is subjected to the state order along with setting rates for agricultural inputs, irrigation water and machinery, as well as financing farmers through the "goal-oriented crediting" granted by the banks that are managed by the government in fact. There are free markets in Kyrgyzstan and partly in Tajikistan, but even here, the administrative control is kept doing harm because of numerous resellers. The table contains the actual prices used at demonstration sites.

Under analyzing the given prices it is necessary to take into account that a direct fee for irrigation water is not collected; and its cost is included into the agricultural land tax. As a general trend, it can be noted that the least prices of output and some agricultural inputs take place in Uzbekistan where at the expense of understated purchasing prices of agricultural output the government subsidizes and keeps the low level of prices of major agricultural inputs (relative to other countries). The land tax does not differ markedly over the countries and in 2004 made up 12.7 USD/ha in Uzbekistan, 12.9 USD/ha in Tajikistan, and 14.5 USD/ha in Kyrgyzstan. A tax on land over all countries in this region is calculated based on the level of taxation rates and a class of soil fertility. In Kyrgyzstan, the tax for allocation into the Social Fund that equals to 7.6 USD/ha is also collected. It is necessary to note that in comparing with 2002, the purchasing prices of cotton have considerably risen; and at present they are higher by 78% in Uzbekistan, by 127% in Kyrgyzstan and Tajikistan. The prices of nitrogen fertilizers are lower in Uzbekistan than in other countries since this state has four large factories for producing artificial fertilizers. In comparing with prices of 2002, the increase in manual labor cost in Tajikistan (on 0.5 USD/man-day) and irrigation water cost in Kyrgyzstan and Tajikistan can be noted.

**Table 5.32**
**Basic Agro-Economic Indicators of Cotton Production on Demonstration Fields (on average over countries)**

| Indicator | Country | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Uzbekistan | | | Kyrgyzstan | | | Tajikistan | | |
| | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 |
| Irrigation water use (ths.m$^3$/ha) | 8.7 | 6.3 | 5.97 | 6.1 | 5.5 | 6.23 | 9.52 | 6.2 | 7.80 |
| Price of irrigation water ($/ths.m$^3$) | 0.0 | 0.0 | 0.0 | 0.58 | 0.83 | 0.98 | 1.36 | 2.73 | 2.06 |
| Cost of irrigation water consumed ($/ha) | 0.0 | 0.0 | 0.0 | 3.54 | 4.61 | 4.90 | 12.9 | 16.9 | 15.67 |
| Average crop yield (ton/ha) | 3.09 | 3.13 | 3.62 | 2.86 | 3.06 | 3.58 | 2.88 | 2.96 | 2.81 |
| Gross output ($/ha) | 434.8 | 675.1 | 909.2 | 432.7 | 1458.0 | 1230.7 | 545.7 | 1025.6 | 1370.3 |
| Variable costs (production price) ($/ha) | 263.8 | 340.9 | 408.1 | 244.3 | 271.7 | 330.4 | 284.9 | 377.7 | 527.5 |
| Fixed costs ($/ha) | 12.5 | 26.4 | 33.3 | 23.2 | 19.4 | 19.4 | 43.3 | 11.3 | 14.7 |
| Gross income ($/ha) | 171.0 | 334.2 | 501.1 | 188.4 | 1186.3 | 900.3 | 170.8 | 646.9 | 842.8 |
| Net income ($/га) | 158.5 | 307.8 | 467.8 | 165.2 | 1166.9 | 880.9 | 127.5 | 635.6 | 828.1 |
| Irrigation water productivity | 49.9 | 137.5 | 189.3 | 70.9 | 263.1 | 197.5 | 47.8 | 164.5 | 175.7 |

| Indicator | Country | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Uzbekistan | | | Kyrgyzstan | | | Tajikistan | | |
| | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 |
| ($/ths.$m^3$) | | | | | | | | | |

Comparing of basic agro-economic indicators over the period of 2002 to 2004 allows evaluating the existing level of agricultural production and the extent of improving management practice on demonstration fields over the countries. Table 5.32 shows that in Uzbekistan, in 2004, the cotton yield made up 3.62 ton/ha against 3.09 ton/ha in 2002; 3.58 ton/ha against 2.86 in Kyrgyzstan; and remains practically at the same level in Tajikistan.

Costs related to irrigation water supply has somewhat increased due to rising price of water resources (on 0.40 USD/ths.$m^3$ in Kyrgyzstan and on 0.70 USD/ths.m3 in Tajikistan). Changes in purchasing prices of raw cotton conditioned the difference in gross income from output sold; the maximum cost of gross output is observed in Tajikistan – 1370 USD/ha against 545 USD/ha in 2002; in Kyrgyzstan – 1230 USD/ha against 432 USD/ha, and in Uzbekistan – 909 USD/ha against 434 USD. The maximum gross income was observed in Kyrgyzstan – 900 USD/ha (in Tajikistan - 842 USD/ha; and in Uzbekistan – 501 USD/ha). In 2004, high incomes on demonstration fields conditioned the essential increase in the economic productivity of irrigation water use; at that, irrigation water was used in the most productive manner in Kyrgyzstan where the income from consumed irrigation water amounted to 197 USD/ths.$m^3$ against 71 USD/ths.$m^3$ in 2002; at the same time, in Tajikistan this indicator was 175 USD/ths.m3 against 47 USD/ths.m3 in 2002; and in Uzbekistan – 189.3 USD/ths.$m^3$ against 49.9 USD/ths.m3 in 2002.

### Agro-Economic Indicators of Agricultural Production on Demonstration Fields under Purchasing Prices of Agricultural Output Averaged over Countries

In 2004, key economic indicators of agricultural production on demonstration fields were calculated based on the existing financial prices in the republics i.e. actual prices of output, agricultural inputs, taxes etc. were used. In order to assess prospective incomes from the agricultural production and actual irrigation water productivity on the indicator fields, it is possible to carry out the economic analysis, using purchasing prices of agricultural output averaged over the republics (Table 5.30). Such an analysis, with focusing on unit economic prices, allows separating effects of the existing agricultural policy in different countries from the real production indicators.

We have taken an average price over the republics in 2004 that was equal to 350 USD/ton as the unit price of raw cotton; at the same time, variable costs, volumes of consumed irrigation water, and crop yield are the real values obtained on demonstration fields. Under such an approach, the best agro-economic indicators are observed in farms with the rational practice of water use and high crop yields. The farm “Turdaily” had the maximum gross and net incomes under averaged purchasing prices – 1159 USD/ha and 1087 USD/ha respectively; three farms “Tolibjon”, “Sandyk”, and “Khojalkhon-ona-Khoji” also provided the high indicators of profit ranging from 762 USD/ha to 971 USD/ha. The farm “Samatov” where a cotton yield was only 20 centner/ha and many errors in water management were made during the growing season had the lowest indicator of profitability.

The productivity and efficiency of irrigation water use also varied over the farms. Under ranging the demonstration fields according to these indicators, the first rank was given to the farm “Turdialy” where the economic productivity made up 489.4 USD/ths.m3 and economic efficiency of irrigation water use was equal to 352.3 USD/ths.$m^3$. High indicators of irrigation water use were also observed in farms “Tolibjon” and “Nozima” where the irrigation water productivity made up 249.1 USD/ths.$m^3$ and 215.2 USD/ths.m3 respectively. The maximum production profitability, reflecting the ratio of net profit to gross output, is observed in the farms “Khojalkhon-ona-Khoji” and “Sandyk”(about 0.72 $/$); and low levels of production profitability were revealed in the farms “Nozima”, “Sayed”, and “Bakhoriston” (0.54 to 0.49 $/$). Maximum values of the efficiency of investments that is calculated as the ration of gross income to variable costs were observed in the farms “Sandyk” (2.79 $/$) and “Khojalkhon-ona-Khoji” and minimum values in the farms “Samatov” (0.91 $/$) and “Bahoriston” (1.02 $/$).

**Table 5.33 Basic Agro-Economic Indicators of Cotton Production under Conditions of Single Purchasing Price of Raw Cotton (2004)**

| Farm | Nitrogen fertilizers (kg/ha of AN) | | | | Phosphate fertilizers (kg/ha of AN) | | | | Potash fertilizers (kg/ha of AN) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 |
| «Turdaily» | 220 | 190 | 280 | 225 | 170 | 0,0 | 60 | 100 | 30 | 25 | 0.0 | 25 |
| «Talibjon» | 220 | 230 | 156 | 350 | 170 | 0,0 | 125 | 50 | 30 | 0.0 | 0.0 | 0.0 |
| «Nozima» | 220 | 140 | 131 | 145 | 170 | 25 | 30 | 160 | 30 | 0.0 | 0.0 | 0.0 |
| «Khojalkhon-ona-Khoji» | 230 | 195 | 230 | 220 | 180 | 65 | 230 | 100 | 50 | 0.0 | 100 | 40 |
| «Samatov» | 200 | 160 | 170 | 250 | 180 | 125 | 210 | 240 | 50 | 0.0 | 0.0 | 21 |
| «Sayed» | 200 | 162 | 146 | 185 | 180 | 0,0 | 220 | 180 | 50 | 0.0 | 0.0 | 0.0 |
| «Bakhoriston» | 200 | 165 | 140 | 175 | 180 | 35 | 175 | 250 | 50 | 0.0 | 45 | 18 |
| «Sandyk» | 200 | 130 | 170 | 150 | 180 | 0,0 | 180 | 200 | 50 | 0.0 | 0.0 | 0.0 |
| «Toloykon» | 140 | 100 | 106 | 145 | 140 | 0,0 | 160 | 60 | 30 | 0.0 | 0.0 | 0.0 |
| «Nyrsultan-Aly» | 140 | 50 | 83 | 50 | 140 | 0,0 | 160 | 140 | 30 | 0.0 | 0.0 | 0.0 |

An agro-economic assessment of the efficiency of agricultural production (Table 5.34) allowed making conclusion about the level of production management in private farms in Kyrgyzstan, Tajikistan, and Uzbekistan.

**Table 5.34 Efficiency of Agricultural Inputs Use on Demonstration Fields**

| Republic | Land use efficiency | | | Investment efficiency | | | Water use efficiency | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2002 ($/ha) | 2003 ($/ha) | 2004 ($/ha) | 2002 ($/$) | 2003 ($/$) | 2004 ($/$) | 2002 ($/ths.m$^3$) | 2003 ($/ths.m$^3$) | 2004 ($/ths.m$^3$) |
| Uzbekistan | 171 | 334 | 01 | 0.65 | 0.98 | 1.23 | 50 | 137 | 189.8 |
| Kyrgyzstan | 188 | 1186 | 900 | 0.77 | 4.37 | 2.77 | 71 | 263 | 197 |
| Tajikistan | 171 | 647 | 843 | 0.60 | 1.71 | 1.60 | 48 | 164 | 175 |
| **On average** | **176** | **722** | **748** | **0.70** | **2.35** | **1.87** | **56** | **188** | **187** |

The land use efficiency that is characterized by a profit per a unit area (ha) has increased four times over the republics, on average; the investment efficiency that is calculated as the ratio of gross income to production costs has risen more than three times; and the water use efficiency also increased more than three times – all these facts allowed making conclusion about substantial raising the level of production management in private farms, the increase in the land and water productivity, as well as the farmers' profitability.

### 5.6.2 Water-Saving Methods Used on Project Demonstration Sites

One of the IWRM principles is the introduction of water-saving methods under using irrigation water. Initially, project specialists were planning to introduce water-saving technologies for solving the problems of raising the irrigation water productivity. The methodology of irrigation management in itself contains the elements of economical use of irrigation water in the field. First of all, we would like to show how the methodology developed by the regional group solves water-saving issues. A key indicator of saving water resources is the information on volumes of water withdrawal. Without information about how much irrigation water is delivered into a field it is difficult to plan economical use of irrigation water. At the same time, the lack of knowledge on real timing and rates of water applications that take into consideration the soil and climatic conditions also does not allow us to evaluate the extent, within which we can save irrigation water in the field.

In 2002, the system of water measurement and record keeping was established in each pilot farm and on its demonstration fields by the beginning of the growing season. Information on irrigation water supply and surface runoff, which was being transmitted from each demonstration field allowed us to evaluate the baselessness and nonuniformity of irrigation water delivery during the growing season. Irrigation by overrated norms at the initial stage of plant growth under providing water application for land preparation took place in farms.

Assessment of the existing practice of irrigation water use in 2002 in comparing with the computer-simulated irrigation schedules prepared for each demonstration site based on field investigations of their soil and climatic conditions allowed us to determine the potential opportunities for saving irrigation water. A size of excessive irrigation water supply against the normative amounts was determined for each field. Apart from studying irrigation rates, shortcomings in organization of water applications were specified; for example, use of too long furrows with a high inflow rate results in considerable losses of irrigation water due to deep percolation and large tailwater runoff from a field. The individual furrow irrigation systems that allow to provide efficient management of water application and to use irrigation water rationally were elaborated for demonstration fields in private farms "Khojalkhon-ona-Khoji", "Nozima", and "Turdialy." In 2003 and 2004, after introducing the recommended furrow irrigation systems, the farms have reduced the volumes of irrigation water use: by 33 to 45% in the farm "Khojalkhon-ona-Khoji"; by 15 to 18% in the farm "Turdialy"; and by 33 to 48% in the farm "Nozima." Apart from a new furrow irrigation system, the farm "Turdialy" has used the water-saving technology that allows taking into account the upward feeding of the aeration zone by groundwater.

The furrow irrigation systems were upgraded in the farms "Sayed", "Bakhoriston" and "Sandyk." Although, the existing furrow irrigation systems in these farms had an optimal length of furrows, but, as a whole, they were arranged without detailed considering the soil pattern and slopes of irrigated fields resulting in considerable losses of irrigation water due to deep percolation and tailwater runoff from fields. As a result, water application rates were, first of all, fixed in these farms; and the uniform wetting of soils was provided by organizing water applications on the irrigated units that were specified taking into account the soil pattern and slopes. At that, the following saving of irrigation water was reached: in the farm "Sayed" - 2% in 2003 and 19% in 2004; in the farm "Bokhoriston" – 41% in 2003 and 32% in 2004 "Sandyk" – 8% in 2003 and 17% in 2004 (Table 5.35). In the farm "Sandyk", we asked the farmer to put special attention to the difference in soil infiltration rates in the upper part of his field with thick topsoil and in the middle part of the field where outcrops of pebble take place. It was necessary to separate out these plots and to irrigate them separately. Prior to adjusting management of water applications, the farmer used furrows 70 to 100 m long but did not take into account the difference in a texture of soils in upper and middle parts of the field; as a result, overwetting of soil and overgrowth of cotton in the upper part and deficit of soil water content and backwardness of cotton in the middle part were observed.

Management of the farm "Tolibjon", having the experience of using the efficient method of water applications on local irrigated units, did not pay attention to economical use of irrigation water. The project has supplemented the furrow irrigation system employed by the farmer with the system of water measurements and record keeping and setting of irrigation water rates. Project specialists consider that this technology has the great potential for rational and efficient use of irrigated water, which was seldom applied in the region and requires certain experience and skill for its use. A backbone of this technology consists in the subdivision of a field into small irrigated units by arranging longitudinal and lateral irrigation ditches and in conducting subsequent water applications only on those parts of the field where the need of plants in water arises, independently from their location. The first water application is conducted according to the method widespread among the experienced farmers and irrigators in this region. This method allows reducing flow rates due to redistribution of irrigation water between an upper irrigated unit and a next irrigated unit, and owing to managing of water application within each irrigated unit.

**Table 5.35 Basic Indicators of the Water Saving Practice on Project Demonstration Sites**

| Farm | Nitrogen fertilizers (kg/ha of AN) | | | | Phosphate fertilizers (kg/ha of AN) | | | | Potash fertilizers (kg/ha of AN) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 | Recommended rate | 2002 | 2003 | 2004 |
| «Turdaily» | 220 | 190 | 280 | 225 | 170 | 0,0 | 60 | 100 | 30 | 25 | 0.0 | 25 |
| «Talibjon» | 220 | 230 | 156 | 350 | 170 | 0,0 | 125 | 50 | 30 | 0.0 | 0.0 | 0.0 |
| «Nozima» | 220 | 140 | 131 | 145 | 170 | 25 | 30 | 160 | 30 | 0.0 | 0.0 | 0.0 |
| «Khojalkhon-ona-Khoji» | 230 | 195 | 230 | 220 | 180 | 65 | 230 | 100 | 50 | 0.0 | 100 | 40 |
| «Samatov» | 200 | 160 | 170 | 250 | 180 | 125 | 210 | 240 | 50 | 0.0 | 0.0 | 21 |
| «Sayed» | 200 | 162 | 146 | 185 | 180 | 0,0 | 220 | 180 | 50 | 0.0 | 0.0 | 0.0 |
| «Bakhoriston» | 200 | 165 | 140 | 175 | 180 | 35 | 175 | 250 | 50 | 0.0 | 45 | 18 |
| «Sandyk» | 200 | 130 | 170 | 150 | 180 | 0,0 | 180 | 200 | 50 | 0.0 | 0.0 | 0.0 |
| «Toloykon» | 140 | 100 | 106 | 145 | 140 | 0,0 | 160 | 60 | 30 | 0.0 | 0.0 | 0.0 |
| «Nyrsultan-Aly» | 140 | 50 | 83 | 50 | 140 | 0,0 | 160 | 140 | 30 | 0.0 | 0.0 | 0.0 |

## 5.7 Conflicts Resolution: Types of Conflicts and Mechanisms of Their Resolution at the WUA's Level

The availability of efficient mechanisms for settling conflicts and disputes that arise in the process of WUA's activity is one of chief preconditions for sustainable operation of a WUA. In case of their belated resolution, conflicts can result in slowdown of development and even disintegrating of WUAs. The mechanisms of conflict resolution available in Central Asian countries, both as formal ones in the form of the national legislative instruments and informal ones based on customs and traditions of local nations, which do not contradict the national legislation in force play an important role under settling conflicts and disputes.

Various types of disputes that can arise in the process of WUA's activity are described below. A special attention was put on formal and informal mechanisms of dispute resolution that existed on the territory of the Fergana Valley; and the guidelines on involving the alternative bodies for dispute resolution, taking into consideration the national legislations in force, were developed.

### 5.7.1 Conflicts and Disputes among Water Users, between Water Users and WUAs, and between WUAs and Water Management Organizations

As known, water is life. Therefore, no wonder that many various conflicts at all levels of the water management hierarchy and between all stakeholders can arise in the process of water allocation. There are many definitions of the term "conflict."[34] Here, the term "conflict" means a contradiction that arises between individuals or groups in the process of mutual activity related to water allocation due to different interests, lack of understanding and consensus [28].

Since the Soviet times, there is kept an exclusively negative attitude to the word "conflict", although it also contains the positive elements since the progress is impossible without the collision of interests ("struggle of opposites"). It is necessary to consider a conflict as an indicator that points out the presence of problems without the settling of which there is no way for further development.

***Parties of conflicts:***

- Farmers – water users;
- Water Users Associations (WUAs), co-operative farms (CF);
- Water management organizations (at the level of the river basin, province, administrative district or irrigation system);
- Governmental audit and supervision organizations (water inspectorate, land inspectorate, environment inspectorate).

**Types of conflicts**

*By nature:*

- Between individuals;
- Between an individual and a group (between a chief of the WMO and his personnel);
- Between groups.

[34] The Big Soviet Encyclopedia: "Conflict is a collision of opposite interests, views, aspirations, serious disagreement resulting in a struggle."

***By the composition of Parties (groups):***

- Between water professionals (WMOs) of neighboring countries, provinces, districts and irrigation systems;
- Between the WMO and WUAs (co-operative farms);
- Between WUAs (CFs);
- Between the WUA and farmers; and
- Between two or a few farmers.

***By the level of intensity:***

- Conflict of the low level;
- Conflict of the mid-range level;
- Conflict of the high level (Box 1).

***Causes for conflicts:***

- Non-compliance with provisions of the Agreement on irrigation water delivery;
- Nonuniformity of irrigation water delivery to water users along the canal;
- Irregular irrigation water delivery to water users (the daily and ten-day period changes in a canal water level);
- Lack of irrigation water delivery during the growing season due to the emergency on the canal;
- Lack of irrigation water delivery during the off-vegetation period for domestic needs of water users;
- Cut-off of power supply and time-out in operation of pumps;
- Uncertainty in ownership of off-take: organization in the book of which an off-take was registered; or in case of this certainty, a non-agreement of water users to pay for water losses at this off-take;
- Overestimated (underestimated) amounts in the applications for irrigation water submitted by water users;
- Ill-timed setting of water limits by the BISA;
- Inaccurate and unreliable data of water distribution monitoring;
- A low level of collecting fees for water services of the Canal Administration;
- Deteriorating the land conditions caused by irrational water use in neighbor farms;
- Uncertainty in sizes of irrigated area and crop pattern;
- Unauthorized tie-in into discharge pipelines of the pumping stations;
- Unauthorized water diversion from the irrigation canal (theft);
- Unauthorized construction of a new off-take;
- Illegal use of the water protection zone (WPZ) by local population;
- Polluting of the WPZ and water in the canal by local population;
- Others.

The abovementioned only gives occasion for water conflicts. However, profound reasons for water conflicts mainly lie in water governance (Chapter 4). Our experience shows that the view, according to which key reasons of water sector's problems are traditionally related only to technical aspects, is prevailing up to now. Thinking in such a way means "not to see the wood for the trees." From the point of view of followers of this approach, for example, a major cause of conflicts lies in deteriorating of material logistics of the water management organizations resulting in the following:

- Poor communication of the Canal Management Organization with hydro-operational sites, pumping stations and water users;
- Deficit of spare parts and construction materials;
- Lack of water-metering devices;
- Sudden shutdown of pumping stations and pump units due to cut-off of power supply (the instability of flow rates and water levels, the need in water releases, possible water overflows etc.); and
- Lack of vehicles for hydro-operational sites' personnel.

It is necessary to remind this approach's followers while the metering facilities were always at the filling stations, now they became more perfect, we cannot allege that petrol is always filled without fraud. Not in the least underestimating merits of the "engineering" approach, it is necessary to note that at present the understanding that this problem is sooner institutional than technical one is rising. The institutional approach's advantage is that it does not require large investments and aimed not only at settling conflicts but also their prevention.

As shown, there are various types of conflicts and reasons for them. There are accordingly different mechanisms for their resolution. We have considered informal (no legal) mechanisms of conflict resolution under water distribution at the level of main canals in the water sector of Central Asian countries[35].

Conflicts management assumes employing the following set of mechanisms (instruments) that can be systematized according to the next directions:

- Forecast of potential conflicts;
- Developing the preventive measures to prevent conflicts;
- Response to the incipient conflict; and
- Conflict resolution.

The due attention was put to all above directions in the frame of the project, but major emphasis was placed on developing the preventive measures to prevent conflicts. Instead of continually extinguishing "fire" of repetitive conflicts it is necessary to eliminate the profound reasons for water conflicts. Therefore, one of major aspects of IWRM-Fergana's activity is the implementation of institutional reforms including the introduction of principles of public participation and establishing WUAs based on hydro-geographical approaches (Chapter 4). Case studies of some conflicts that took place on the pilot canals are given in boxes below.

[35] In case of the impossibility to reach consensus, the legal procedures including arbitrage should be used but they require more time, finance and efforts in order to reach civil or another liability of one of parties. The practice of water allocation shows that, due to abovementioned reasons, either the formal mechanisms of conflict resolution in the water sector of the CAR do not work (as a rule, a case does not reach the judicial trial) or an judgment of court is not fulfilled. For example, the administration of the KBC went to the law because the WUA "Zerafshan" did not pay for water delivery services. The judgment of court was for benefit of the administration of the KBC (the WUA must pay for water services in terms established by the court), but the WUA "Zerafshan" did not execute the judgment of court, and the administration of the KBC continues to deliver water to this WUA.

| ***Box 1. Conflict on the border between countries*** |
|---|
| There is the lateral "Kyrkyz-Aryk" upstream of the water intake into the Karkidon Feeding Canal (KFC) from the Andijan part of the SFC. Along its upper section, water from this canal is used by Kyrgyz water users; along the middle section by Uzbek water users; and along the tail section again by Kyrgyz water users. Due to the expansion of irrigated areas along the upper section of this canal, deficit of water for irrigation was experienced by water users along the middle and tail sections. The conflict situation was temporary solved when water for irrigation was delivered through two pumping stations to Uzbek water users from the SFC and to Kyrgyz water users from the KFC. However, in 2007, the conflict has arisen much more intensive (the conflict of the high intensity level: attempts of taking of hostages, destroying of waterworks etc.). |

| ***Box 2. Conflict between provinces*** |
|---|
| The SFC. Gauging Station 4 "Polvantash." The border between Andijan and Fergana sections of the SFC. It was revealed that the administration of the hydro-operational site has concealed the information on return water inflow from the territory of Andijan Province with a flow rate up to 3 m3/sec. This water was used for mercenary ends. When there was not return water inflow from the Andijan part of the SFC, the administration of the hydro-operational site made a lot of noise about insufficient delivery of irrigation water from Andijan Province. After complete replacement of the administration of hydro-operational site "Polvantash", the conflict situation was temporary settled. However, the recurrence of conflicts has suggested that the nature of conflict was exclusively related to personalities only at first glance. It has become clear that both parties of this conflict were found with "their hands in the cookie jar" - the representatives of Andijan Province have withdrawn water in excess, and at the same time, the representatives of Fergana Province have concealed the information on additional water in the canal due to return water inflow. The conflict was settled after transition towards water resources management based on hydro-geographical principles and establishing the SFC Administration. |

| ***Box 3. Conflicts between administrative districts*** |
|---|
| 1. In the tail part of the SFC in Fergana Province, upstream of Balance Gauging Station 8, two pumping station located on the territory of Altyaryk District (PS "Fayziabad" with a capacity up to 3 m3/sec and PS "Povulgon" with a capacity up to 1 m3/sec) pump water from the SFC for irrigating lands in Fergana District (joint water use). Water conflicts between Altyaryk and Fergana districts took place in all cases of insufficient water delivery into the tail part of the SFC. Disputes were settled based on the trade-off approach by means of shutdown of one, two or all pump units of first or second pumping station. Sometimes it was impossible to put into operation pump units of the PS "Povulgon" due to water shortage in the tail part of the SFC. From time to time, conflicts again arose, showing that deep-rooted problems were not being solved and put off for the future. The conflict situation was mitigated by means of transferring the hydro-operational site "Fayziobad" under management of the SFC Administration.<br><br>2. There are traditional conflicts between the upstream hydro-operational site "B. Gofurov" and the downstream hydro-operational site "D. Rasulov" of the KBC, as well as between hydro-operational sites "Karasu" and "Aravan" of the AAC. The introduction of inter-district water rotation on the KBC has mitigated the conflict between districts, but not settled it completely; therefore, dozens of water users were forced to put padlocks on gates of waterworks and to watch operation at the upper end of this site to deliver water to the lower end. The conflict was settled by means of establishing the KBC Administration and the AAC Administration and transition towards management based on hydro-geographical principles. At present, there is not the need to put padlocks and to organize watching on the KBC. There is not also the need in the interference of local authorities in water allocation issues: "now akims have not headache…." |

***Box 4. Conflict on small transboundary rivers***

A tail flow of the Aravansay River fell into the SFC and then was conveyed to the Kyrkydan Reservoir. For a number of reasons, including the replacement of the administration of Aravan District in Kyrgyzstan, the Aravansay River's flow was redirected to the Shakhristansay River in bypass of the SFC.

The conflict was settled after the interference of the SFC WC. In the course of negotiations, Uzbek water specialists have reminded (it turns out the Kyrgyz party did not know about this fact) that, according to the Agreement on Water Sharing, 13% of the Aravansay River's flow accumulated in the Kyrkydan Reservoir can be used by Kyrgyz party. At present, without obstructions, the Aravansay River's flow comes in the SFC and then is accumulated in the Kyrkydan Reservoir. It is not difficult to understand the significance of this conflict resolution, taking into consideration that last years there is not the outflow of water from the Andijan Reservoir for its delivering to the associated water users.

***Box 5. Conflicts between the Canal Administration and WUAs***

1. The AAC command area. The WUA has submitted the evidently underestimated applications for irrigation water, planning to supply (sale) water stolen from the canal to local farmers.

This conflict is settled at the sessions of the Board of the AAC's Canal Water Committee.

2. The KBC command area. Due to the low level of fee collection for water services, the KBC Administration was forced to stop water delivery to some WUAs – debtors. The level of fee collection has risen but the conflict was not completely settled due to deep-rooted reasons of external water governance.

3. The AAC command area. Areas of pumped irrigation that are not planned to be irrigated due to high cost of electric power were included into the plan of water use. The conflict was discussed at the general meeting of WUAs, but was not still settled. It is planned to discuss this conflict at the general meeting of the Water User Council of the AAC with participation of representatives of the AAC Administration and the BISA.

4. The SFC command area. Decision-making regarding water delivery to the WUA "Akbarabad" was insufficiently well-timed. The conflict was settled based on the decision of the SFC CWC's session enabling the WUA "Akbarabad" to sign the agreement on irrigation water supply directly with the SFC Administration.

***Box 6. Conflict between the Canal Administration and local authorities***

A high-ranking official gave instructions to open gates of one check structure on the SFC to deliver extra volumes of water to the tail part. Personnel of the Canal Administration were refusing to execute these instructions for a long time, understanding the consequences of these actions. When they executed this order, abrupt breaking of the flow occurred. A water level suddenly dropped in front of this check structure; and the emergency situation was created downstream of the check structure. This is the example of adverse interference of the local authorities' chief, but there are also positive examples. However, the point is that the participation of representatives of local authorities and other economic sectors should be ensured in another manner.

For preventing and settling such conflicts, including cross-sectoral conflicts (agriculture, hydropower generation, water supply, ecology, industrial needs etc.) the Councils of Canal Water Committees with the participation of representatives of local authorities and other economic sectors should be established. At that, direct water users that consume or use water resources (hydropower stations, irrigation sector, water-supply companies) participate in activity of the CWC Council through their representatives in the CWUC, and representatives of indirect water users (local authorities, nature protection organizations etc.) are directly included in the CWC Council.

| ***Box 7. Conflict between the Canal Administration and the HPS's Administration*** |
|---|
| Two small hydro-power stations (HPS) were built on the SFC. HPS 1 does not usually inform about executing maintenance works related to cleaning the trash-racks of intake chambers; and, as a result of the manipulation with gates, flow rates in the canal fluctuate resulting in the conflict situation due to reducing water delivery to its tail part by 3.0 m3/sec, and for rehabilitation of the stable regime of flow rates three hours are needed as minimum.<br><br>Due to sudden power cutoff or reducing of voltage in the power network, the automation system of HPS 2 automatically close the intake gates of diversion canal. As a result, a flow rate at this section of SFC is increasing up to 20 m3/sec, and the canal operates under the emergency regime since its carrying capacity is insufficient for such flow rates. |

| ***Box 8. Conflict between the Canal Administration and the management of PS*** |
|---|
| Sudden power cutoffs cause hitch of pumping stations (PS) often resulting in damage of electric motor shafts and electric motors themselves. The Pumping Station Management Organization bears considerable material losses. At the same time, pumping station's shutdown results in increasing a flow rate in the canal up to 10 m3/sec and its emergency operation. The conflict situation arises since there are not communication with the PS and any possibility to inform about an incident in timely manner.<br><br>The managers of HPSs and power supply companies of Andijan and Fergana provinces were invited on the CWC SFC meeting. A representative of HPS assured the members of CWC SFC and Canal Administration that they are ready to inform the CA personnel at hydro-operational sites in timely manner about the situations causing changes in the canal's operational regime. Representatives of provincial power supply companies did not attend the meeting. The CA and BISA sent the letters to power supply companies, local authorities and the national MAWR with appropriate information and calculations of the amount of damage of pumping stations. Some progress in settling the conflict was reached: there were not sudden power cutoffs in 2005. |

| ***Box 9. Conflict between the Canal Administration and farmers*** |
|---|
| Water users divert water beyond established limits using siphons, small pumps, new off-takes etc. Such conflicts are caused by, on the one hand, the incompetence of farmers and, on the other hand, the WUA's weakness: through ignorance or due to the fact that the issue is not solved at the WUA level, water users themselves try to divert water from the main canal and conflict with the CA.<br><br>Our analysis has shown that for preventing such conflicts it is necessary to enhance works related to establishing WUAs based on hydro-geographical principles and participatory water management at the lower level of hierarchy, as well as to improve the efficiency of joint activity of the CWUC at hydro-operational sites and Councils of WUAs. |

Thus, the most typical situation for water management organizations that were established based on the administrative-territorial principle is the arising of conflicts "head - tail" on borders of the republics, provinces, districts, and small transboundary rivers (STR). At the same time, water users located along the tail parts of irrigation canals persistently suffer from water deficit. Each upstream water user aspires to take irrigation water as much as possible without any concern about the situation of downstream water users. Therefore, it is difficult for water professionals to deliver water (especially in dry years) to the tail section of canal. Transition towards introducing the hydro-geographical principle on the pilot canals at once provided the following results: conflicts on borders of administrative territories (on the borders between Andijan and Fergana provinces, Karasu and

Aravan districts, as well as between districts "B. Gafurov" and "D. Rasulov") were mitigated or practically eliminated (Boxes 2 to 4).

For settling and preventing other types of conflicts the appropriate instruments were created: Councils of WUAs, Boards of the CWUC, and Boards of the CWC. The analysis conducted has shown that the considerable part of disputes is caused by the misunderstandings and incorrect notions resulted from the low level of:

- available information on the water distribution process; and
- the transparency of decision-making.

There are grounds to think that the joint work of the CA with Councils of WUAs, Boards of the CWUC, and Boards of the CWC will facilitate preventing conflicts because all stakeholders are involved into the decision-making process, in the course of which the mutual understanding is growing and the misunderstandings disappear.

The Arbitration Commissions were provided for within the listed bodies, but since their activity was not properly organized, the boards of the CWUC and the CWC themselves settle conflicts. In particular, the participation of the members of SFC CWC in the conflict resolution on the KFC (Box 1, 5, and 8) was quite useful. Here, the following instruments for conflict management were used:

- Organizing the dialogs of conflict parties:
  - to define the essence of the conflict;
  - to identify the interests of conflict parties;
  - to specify the opportunities for conflict resolution; and
  - to reach the agreements on procedures for conflict resolution and settling other possible differences;
- Organizing the training seminars with the participation of conflict parties to rise the level of knowledge and awareness of problems related to water governance and management and to provide the consensus;
- Strengthening the composition of Board of the KFC CWC by involving the representatives of conflict parties (in particular, water professionals and water users of Aravan District);
- Installing the boxes for collecting complaints and suggestion of water users in the CA offices;
- Organizing the reception days by chairmen of the CWUC and the CWC;
- Providing the diaries for record keeping the conflict situations and disputes; and
- Holding the sessions of Boards of the CWUC and CWC to solve the issues related to preventing and settling the conflict situations.

Owing to above activity, the conflict on the KFC was settled. In addition, at the sessions of the SFC CWC the decisions for settling difficulties between the SFC Administration and BISA ("Sokh-Syr Darya" and "Naryn – Kara Darya") related to timing and limits of water supply for off-takes from the SFC were made.

Of course, there cannot be any assurance that conflicts on the KFC will never repeat since the process of water resources management at this site is very complicated. There is only the hope that, under the active work of the Board of KFC CWC, which has the powers to make operating decisions, the search of compromises will be speeded up, preventing the development of disputes into conflicts of the mid-range or high level of intensity.

At present, in the frame of this project the most topical activities, from the point of view of settling and preventing water conflicts, are the following:

- Promoting activity of Boards of the CWUU and CWC;
- Establishing the Boards of the CWUU and CWC and organizing of their activity; and
- Formation of the Arbitration Commissions within the CWUU, CWC and WUAs and organizing of their activity with involvement of women and wise elders into these commissions.

Establishing the WUGs is the important measure to prevent conflicts between farmers. Finally, it is necessary to remind that water conflicts eventually results from the growth of water demand; and reducing water demand will greatly facilitate settling existing problems. It is anything but a secret that a considerable potential for reducing water demand exists in Central Asia. The IWRM-Fergana project promotes activity aimed at revealing and enabling this potential.

One of the most important conditions for WUA sustainable operation is the available mechanisms for settling disputes and conflicts arisen in the process of WUA activity. In case of their belated resolution, conflicts can result in slowdown of development and even disintegrating of WUAs. The mechanisms of conflict resolution available in Central Asian countries, both as formal ones in the form of the national legislative instruments and informal ones based on customs and traditions of local nations, which do not contradict the national legislation in force play an important role under settling conflicts and disputes.

Various types of disputes that can arise in the process of WUA's activity are described below. A special attention was put on formal and informal mechanisms of dispute resolution that existed on the territory of the Fergana Valley; and the guidelines on involving the alternative bodies for dispute resolution, taking into consideration the national legislations in force, were developed. An attitude to the term "conflict" should be careful since this word can frequently be associated with the antagonism and brutality. According to the traditional perception of people of the former USSR, the meaning of the word "conflict" is "almost war"; and, therefore, this word antagonizes many people, who on the question about conflicts usually answer that "there are not conflicts."

The Big Soviet Encyclopedia gives the following definition of the word "conflict": "A conflict is a collision of opposite interests, views, aspirations, and serious disagreements resulting in a struggle." Certain time is needed to reach the perception of this word existing in the contemporary western world, namely "a conflict is the conscious incompatibility of targets: one party considers intentions of another party as harmful ones for own interests."

It is often difficult to realize the nature, type and reasons for local conflicts without understanding the nature of social dynamics. Sometimes the conflicts arise due to ethnic differences, relations within a clan/family, social inequality; sometimes they arise due to a struggle for power, but more often owing to the tangle of all these circumstances. Many people, in bounden duty, follow their "leader" and reluctantly express own views and opinions. At the same time, people prefer not discussing conflict situations with outsiders; and often they do not know how to discern an imminent conflict and how to prevent it.

In the Fergana Valley, water relations among water users within WUAs, between water users and WUAs, and between WUAs and water management organizations are accompanied by the conflicts and disputes that are caused by the following circumstances:

- non-compliance with the agreements signed by water users and WUAs in respect of the schedule and amounts of irrigation water supply and other services granted by WUAs;
- non-compliance with the agreements signed by water management organizations and WUAs;
- infringement of the established schedule of water use by a WUA members (unauthorized water diversion and construction of additional off-takes on the irrigation canals without permission, etc.);
- deteriorating the irrigated farmland conditions of WUA members due to non-compliance with the agreements signed by WUAs and the PHAE and by water users and WUAs;
- damaging of crops or irrigated plots of water users by WUA personnel or neighbor farmers due to careless O&M of on-farm water infrastructure;

- non-fulfillment by WUA member his duties provided for by the WUA's Charter;
- infringement of the WUA member's right to participate in decision-making at the general meeting;
- labor disputes between the WUA administration and its personnel;
- non-compliance with the agreement signed by water user not being a WUA member and the WUA in respect of irrigation water supply and other services granted by WUAs; and
- disputes between water users.

Disputes between WUAs and water management organizations can arise during the irrigation season due to unsettled matters relative to the following aspects:

- changes in volumes and time of irrigation water delivery to a WUA;
- considerable daily deviations from planned water levels in the canal;
- ill-founded reducing the volume of water supply by the Canal Administration to WUAs at the expense of use brackish return water being formed on the WUA's territory;

Water delivery to a WUA or WUGs can be adjusted due to the interference of local authorities of different levels, for example, a provincial or district administration, resulting in disputes and dissatisfaction of water users and WUA personnel. Of course, disputes and conflicts related to water delivery and distribution should be reviewed only under the presence of appropriate documents (a water supply registry, a statement of the case, etc.).

### 5.7.2. Analyzing the Existing Mechanisms for Settling Disputes and Conflicts between Water Users, between Water Users and WUAs, between WUAs and Water Management Organization Coupled with National Legislations in Force in the Fergana Valley

The legislations of all countries in the Fergana Valley, starting from the constitutional regulations and regulations of the civil law and procedural legislation, provide for the opportunity for legal remedy of infringed rights in the process of ownership relations and non-pecuniary relations. The legislations also provide for the mechanisms and detailed procedures of the pre-trial inquiry, preparation and judicial trial, legal decision and appeal against a sentence in accordance with the appellate jurisdiction or review proceedings.

In accordance with the national legislations and WUA Charters, disputes and conflicts between WUA members and the WUA Board can be investigated by the Arbitration Commission of the WUA, the Arbitration Commission of the Canal Water Committee, Aksakals' Courts that were established in the framework of the local administration, and the WUA Controlling Department under the Ministry of Agriculture and Water Resources (was established only in the MAWR in Kyrgyzstan).

The WUA Arbitration Commission may examine all issues related to activity of a WUA and its members, as well as the disputes with water users not being members of the WUA but having contractual relations with the WUA. The issues related to relations of a WUA and the water management organization can be examined by the Arbitration Commission under the Canal Water Committee, members of which are the representatives of water management organization and WUA. Their joint work represents the mechanism that prevents the conflict situations. *In case of the non-agreement of one of conflict parties with a judgment of the Arbitration Commission of a WUA or the Canal Water Committee regarding recovering damages, the case may be tried by the competent court according to established legal procedures.*

Aksakals play a crucial role in settling arisen conflicts. They, as a rule, evaluate those or other incidents and form the public opinion. Their interference in the examination of those or other disputes between WUA members and a WUA or between a WUA and the water management organization, as well as between water users would mitigate the social tensions and stop further development of disputes.

The proposed ways for settling disputes and conflicts without the reference to the judicial authorities have an advantage of fast consideration and resolution and the lack of large financial expenditures that take place under the reference to the judicial authorities. Mechanisms of conflict resolution were considered taking into account the specificity of legal systems in the neighboring countries in the Fergana Valley.

## The Kyrgyz Republic

The judicial system in Kyrgyzstan was established in line with the Constitution of the Kyrgyz Republic. The judicial system consists of the Constitutional Court that executes the constitutional legal procedures and the system of courts of general jurisdiction that execute the criminal procedure, civil trial, and administrative proceedings. In addition, there is the system of arbitration tribunals that execute the public justice in the field of economic relations between economic entities, institutions, and organizations independently from the patterns of ownership and types of economic activity.

The intermediate courts and aksakals' courts are also active in Kyrgyzstan, which consider economic disputes and conflicts in case of reference to them. There are the established procedures for reference to the courts, judicial trial, judgment of court and its execution, as well as the procedures for appealing against a sentence and review proceedings.

The participation of natural persons and legal entities in the civil process and arbitration proceedings is accompanied by the execution of documents under drafting of which the existing legislation and law enforcement practice should be taken into account. In accordance with the existing national legislation, abovementioned types of disputes can be settled by the following entities:

***A number of the disputes between WUA members and the WUA can be examined by the Arbitration Commission of the WUA.***

Under the mutual agreement of parties, the disputes can be considered and settled in the aksakals' courts and in courts of general jurisdiction. The interpersonal conflicts of WUA members can be settled in the same way. In accordance with the Law "On Aksakals' Courts" passed in the Kyrgyz Republic, *the aksakals' courts can examine the documents on disputes and conflicts submitted by the following bodies:*

- local courts for civil cases;
- courts; public prosecutors, investigatory powers with the court order (the documents on criminal cases that were closed for applying the measures of community-based correction in accordance with the procedural criminal law); and
- the appropriate governmental bodies responsible for the control of administrative infringements of the law using the procedures provided for in the Administrative Code.

The aksakals' courts can also try cases according to the written requests of citizens (under the agreement of parties) to resolve the ownership and family disputes for the purpose of conciliating the parties. The aksakals' courts are not competent to deal with the cases, for which there is already adjudication or penalty under administrative law, as well as for which the aksakals' court decision was already made within its competence. After adjudicating the guilt of persons brought to trial, the aksakals' court can give judgment for executing one of the following punishments:

a) to pronounce a warning;
b) obligation to adduce the public excuse to an injured party;
c) to pronounce the public disgrace;
d) obligation of a party at fault to pay the damages;
e) monetary penalty at the rate up to three minimum salary established according to the legislation of the Kyrgyz Republic or forced public works;

If necessary, the aksakals' court has the right to transfer a case to the investigatory powers and court. The aksakals' court has to inform the body (an executive officer) that sent the case within 10 days about measures of community-based correction imposed on the persons who committed administrative infringement of the law. This court does not have the right to pass judgment that disparages the self-respect of people.

*Disputes due to financial payments should be considered in the general jurisdiction court in accordance with established judicial procedure, in case of disagreement of one of the parties and if one of the parties is a citizen.* When parties are legal entities or citizens having the status of an individual entrepreneur gained according to the legitimate procedure, an arbitration tribunal (arbitration[36]) investigates such cases. An arbitration tribunal can also investigate disputes between WUAs and the water management organization regarding the payment terms for services, ill-timed payments and related penalty fees. At the same time, they have the opportunity to reach the consensus through bringing the matter before the Arbitrage Commission of the Canal Water Committee.

*The legislation of Kyrgyzstan also provides for the procedure for adjudication in the extrajudicial bodies – in the arbitration (arbitration tribunal), in accordance with the law "On Arbitration in the Kyrgyz Republic."* Unless otherwise agreed by the parties or the law, provisions of this law are used under transferring a dispute case, in which one party or both parties are citizens, to the arbitration.

An action proceeding related to the compensation of damaging WUA members' crops or irrigated plots due to ill-fulfilled O&M of irrigation systems in WUAs should be considered in the general jurisdiction court, if one of the parties is a natural person (a citizen) and in the arbitration if the parties are the legal entities or one of the parties is a citizen - an individual entrepreneur. Labor controversies between the WAU administration and its personnel can be considered in the general jurisdiction courts. However, the extrajudicial procedure for such controversies in the WUA Arbitration Commission is also possible by mutual consent of parties.

## The Republic of Tajikistan

The judicial authority in the Republic of Tajikistan is being exercised by means of the constitutional, civil, criminal, arbitration and administrative legal proceedings. The legal procedures for proceedings are specified in the laws of the Republic of Tajikistan. The judicial system of the Republic of Tajikistan consists of the Constitutional Court, Supreme Court, Supreme Economic Court, Military Court, Court of Gorno-Badakhshan Autonomous Province, as well as provincial, district and city courts and the courts of arbitration of the Gorno-Badakhshan Autonomous Province, other provinces and Dushanbe City.

The Supreme Economic Court of the Republic of Tajikistan is the major judicial body that decides economic controversies and other cases, exercises the judicial review according to the code of practice and interprets the matters of jurisprudence.

*Some types of controversies, mentioned in the first section, can be resolved by the territorial civil courts and economic courts.* Economic proceedings are regulated by the economic code of practice of the Republic of Tajikistan.

[36] Arbitration is a proceeding in which a dispute is resolved by an impartial adjudicator whose decision the parties to the dispute have agreed will be final and binding.

*In Tajikistan, proceedings and deciding the specific economic controversies are possible in the intermediate court (arbitration) established for treating such cases.* The procedures for proceedings and deciding the specific economic controversies are specified by the Regulations No 426 dated May 15, 1997 was approved by the Majlisi Milliy (National Assembly) of the Republic of Tajikistan.

### The Republic of Uzbekistan

The judicial system of the Republic of Uzbekistan consists of: i) the Constitutional Court, Supreme Court, and Supreme Economic Court; ii) Supreme Civil and Criminal Courts of the Republic of Karakalpakstan; iii) provincial and Tashkent City's civil and criminal courts; iv) inter-district and district (city) civil courts and district (city) criminal courts; v) military courts; and vi) courts of arbitration of the Republic of Karakalpakstan and provincial and Tashkent City's courts of arbitration.

The Supreme Court of the Republic of Uzbekistan is the supreme body of judicial authority in the field of civil, criminal and administrative legal proceedings. The Supreme Court of the Republic of Uzbekistan has the right of supervision over the judicial practice of Supreme Civil and Criminal Courts of the Republic of Karakalpakstan, provincial, city, district and military courts. The Supreme Court of the Republic of Uzbekistan treats the cases as the trial court and exercises the judicial review. The cases that have been treated by the Supreme Court of the Republic of Uzbekistan as the trial court can be treated by as the court of cassation or according to the appellate process.

*The Supreme Economic Court of the Republic of Uzbekistan is the supreme body of judicial authority in the field of economic legal proceedings.* The Supreme Economic Court of the Republic of Uzbekistan has the right of supervision over the judicial practice of the economic court of the Republic of Karakalpakstan, and provincial and Tashkent City's economic courts. The Supreme Economic Court of the Republic of Uzbekistan treats the facts of cases as the trial court and exercises the judicial review and the appellate process.

*All types of abovementioned controversies can be resolved by the territorial civil courts and economic courts.*

Proceedings are regulated by the civil code of practice and the economic of code of practice of the Republic of Uzbekistan. *In Uzbekistan, proceedings and deciding the specific economic controversies are possible in the intermediate court (arbitration) established for treating such cases.*

### 5.7.3. Recommendations and Proposals on Developing Additional Legal Instruments for Dispute Resolution in Fergana Valley's Countries

Alternative methods of dispute resolution that do not require considerable financial expenditures and organizational efforts in comparing with judicially deciding the economic controversies exist in many developed countries along with the judicial procedure of economic dispute resolution. An arbitration tribunal is the kind of the institute of alternative methods for settling the economic controversies and, according to its nature, presents the extrajudicial body. *The principles of voluntariness and confidentiality to the body that decides essentially their controversies are the basis for forming and activity of arbitration tribunals.* These principles are reflecting not only the right of parties to treat an arisen dispute in the arbitration tribunal but also the right to participate in forming a composition of the arbitration tribunal, specifying the procedure for adjudication and dispute resolution.

***An arbitration tribunal is the non-governmental court; therefore it does not possess the tools to enforce the execution of its decisions.***

In Kyrgyzstan, the arbitration tribunals are active since 2001. The fact of passing the law "On the Arbitration Tribunals in the Kyrgyz Republic" confirms that the process of developing and strengthening the institute of arbitration tribunals for settling economic controversies in the national agrarian sector acquires the dynamic nature. The legislations of Tajikistan and Uzbekistan provide for the possibility to treat economic controversies in arbitration tribunals.

Beyond question, the arbitration tribunal has a number of perceived potential advantages over the judicial proceedings.

*Firstly,* the arbitration is often faster than litigation in court. When parties refer to the court they should potentially follow three formal procedures, including appeal and supervision procedures. An arbitration tribunal is the only instance that provides a final and binding decision.

*Secondly,* judges of the arbitration court are appointed by the government, at the same time, the dispute parties have the opportunity to select arbitrators of an arbitration tribunal from the proposed list. Moreover, this list can include not only legal professionals but also arbitrators with an appropriate degree of expertise (economists, financial officers, engineers etc) who are capable to examine the crux of economic disputes.

*Thirdly,* an arbitration tribunal can be cheaper and more flexible for businesses, since it is not necessary to go through three instances as in case of the arbitration court.

***And finally fourthly, there are less potential conditions for corruption in an arbitration tribunal.***

In case of real conflict situations and disputes, there are formal and informal mechanisms for their resolution at the farm level, for example, the aksakals' court legalized in Kyrgyzstan. Aksakals (wise and respected elders) always stood high in population's esteem in Central Asian countries.

Aksakals' courts are the community-based and self-government institutions that are voluntarily established on the basis of election procedures and aimed at the decision of cases, which were submitted to them according to the procedures established by the court, public prosecutor, departments of home affairs and other governmental bodies and their officials in accordance with the national legislation in force. Aksakals' courts are formed from the elders or other citizens who have gained the indisputable prestige, in line with the resolution of citizens' assemblies held in administrative units or according to the resolution of another self-government institution on the territory of villages, settlements and towns.

*Taking into consideration that the national legislations of Uzbekistan and Tajikistan provide for an opportunity to transfer the cases related to commercial and economic disputes to the arbitration tribunals, it would be expedient to entrust the aksakals' courts with deciding these cases*. A procedure of pre-trail in the aksakals' courts being applied in Kyrgyzstan is recommended to disseminate over Tajikistan and Uzbekistan as the model procedure.

The law of the Kyrgyz Republic "On Water Users Associations" provides for the need in Regulatory Department for monitoring WUAs' activity. The Department of Water Resources of the Kyrgyz Republic was entrusted with executing such functions by the appropriate governmental decree. This department should have a sufficient influence on the water authorities and WUAs and has to be the mediator settling their disputes related to water resources management.

The similar regulatory departments for monitoring WUAs' activity would be necessary to establish under the Ministries of Agriculture and Water Resources of Tajikistan and Uzbekistan for resolution of the following disputes:

- between WUAs and the water management organization;
- between WUA's members and a WUA over the matters of rights and duties of parties; and
- between a WUA and water users not being the members of a WUA over the matters of water services.

The recommended mechanisms for settling the different disputes between water users and WUAs, WUAs and the WMO, water users and relevant authorities are given in the table below.

| No | Type of dispute | Dispute resolution bodies | | | |
|---|---|---|---|---|---|
| | | WUA Arbitration Commission | Arbitration Commission of the Canal Water Committee | Aksakals' Courts (under the local authorities) | Regulatory departments under MAWR xx) |
| **1** | **2** | **3** | **4** | **5** | **6** |
| **1** | Non-compliance with provisions of the Agreement on irrigation water delivery and other water services signed by water users and a WUA | v | | v | v |
| **2** | Non-compliance with provisions of the Agreement signed by the Water Management Organization and WUAs | | v | | v |
| **3** | Breach of the established schedule of water use by a WUA member (unauthorized water diversion, unauthorized construction of a new off-takes etc.) | v | | v | |
| **4** | Deterioration of irrigated farmland conditions of WUA members due to inactivity or insufficient activity related to O&M of irrigation and drainage systems: | | | | |
| | • WUA | v | | | v |
| | • Inter-farm drainage network | | v | | v |
| **5** | Violation of WUA members' rights on the compensation in case of damaging of crops or irrigated plot due to ill-made O&M of on-farm irrigation and drainage systems | | | | |

| No | Type of dispute | Dispute resolution bodies | | | |
|---|---|---|---|---|---|
| | | WUA Arbitration Commission | Arbitration Commission of the Canal Water Committee | Aksakals' Courts (under the local authorities) | Regulatory departments under MAWR xx) |
| 1 | 2 | 3 | 4 | 5 | 6 |
| | | v | | | v |
| 6 | Non-fulfillment of duties provided for in the WUA Charter by a WUA member regarding timely payments for water services; careful use of equipment and machinery belonging to a WUA ; reimbursing expenditures related to repairing or replacement of parts of equipment and machinery belonging to a WUA and damaged due to ill use and maintenance | v | | | |
| 7 | Violation of WUA members' rights related to his participating in the decision-making process in a WUA: to vote at the general meeting of a WUA, to discuss and form the agenda of the general meetings, to use services granted by a WUA, to propose candidates for election to the management bodies of WUA; and to be elected to these bodies. | v | | | v |
| 8 | Interpersonal conflicts | v | v | v | |
| 9 | Labor disputes between WUAs and their personnel | v | | | |
| 10 | Non-compliance with provisions of the Agreement on irrigation water delivery and other water services signed by water users not being WUA's members and a WUA, as well as problems related to the | | | | |

| No | Type of dispute | Dispute resolution bodies | | | |
|---|---|---|---|---|---|
| | | WUA Arbitration Commission | Arbitration Commission of the Canal Water Committee | Aksakals' Courts (under the local authorities) | Regulatory departments under MAWR xx) |
| **1** | **2** | **3** | **4** | **5** | **6** |
| | compensation of damages | v | | | v |
| **11** | Changes in volumes and time of irrigation water delivery within a WUA | | v | | v |
| **12** | Considerable daily deviations from planned water levels in the canal in the process of water use in a WUA | | v | | v |
| **13** | Ill-founded reducing the volume of water supply by the Canal Administration to WUAs at the expense of use brackish return water being formed on the WUA's territory | | v | | v |
| **14** | Disputes due to the interference of local authorities of different levels into WUA water supply (or the group of WUAs) and separate farms (or the group of farms): | | | | |
| | • District administration | | v | | v |
| | • Provincial administration | | v [x)] | | v |
| **15** | Disputes between water users | v | | v | |

[x)] with the participation of a representative of the BISA

[xx)] at present, they are active in Kyrgyzstan and Tajikistan

Disputes due to the interference of provincial administration into the matters of irrigation water supply should be considered by the Canal Water Committee with the participation of dispute parties and under involving a representative of the Basin Irrigation System Administration (BISA).

If the parties cannot reach the consensus in the dispute under consideration they may transfer this case for proceedings at law into the economic court or common law court.

To prevent disputes between water users themselves, between water users and WUAs, and between WUAs and water management organizations it is necessary:

- to install water-measuring devices at water users' off-takes;
- to draw up the scientifically-grounded plan of water use for a WUA as a whole and for each farm – WUA's member prior to the beginning of water applications;
- to enhance governmental and community-based monitoring of irrigation water use;
- to create the environment of transparency and public awareness of activity of governmental water management bodies and water users associations;
- to improve and upgrade irrigation and drainage systems of different levels; and
- to conduct the training seminars for WUA personnel and farmers, from time to time, considering the topics related to the water use practice; water, land and civil legislation; integrated water resources management with involving water users into the water resources management process.

***How the recommendations for resolving the water disputes and other controversies are being practically implemented?***

These matters are described below by way of the case study of the pilot WUA "Akbarabad." In the growing season of 2007, the managers of five private farms brought their complaint to the Kuva District Office of Ministry of Agriculture and Water Resources and the Arbitration Commission of WUA "Akbarabad" about insufficient volumes of water delivered by this WUA for irrigation of cotton. The Arbitration Commission has established facts that water delivered for irrigation of cotton was used by farmers for irrigating secondary crops, an area of which was planned as 20% of the area under cereal crops for this dry year against 80% in the average year. Nevertheless, farmers have irrigated all their areas under secondary crops and caused the water stress of cotton. Farmers were notified about the gross violation of water use rules.

WUA's personnel with the assistance of the public have established facts that the farms "Isomidinov" and "Gulirano" practiced unauthorized water diversion from the WUA canal. The formal report about these violations was drawn up by the WUA personnel; and this document was brought to the WUA's Arbitration Commission. The WUA's Arbitration Commission decided to reduce irrigation water delivery to some farms and temporarily to suspend irrigation water delivery to these farms. In addition, the administration of WUA "Akbarabad" has addressed to the Provincial Water Inspectorate with its request to penalize the farmers who violate the irrigation schedule established for the irrigation canal "RP-1". By the resolution of the Provincial Water Inspectorate, these farmers were penalized in accordance with the established procedure.

Private farms having the state order for cotton and wheat were debtors of the WUA. The WUA, which has the right in accordance with the Charter to suspend granting its services when it members do not pay for services in timely manner, is going on with the notification about their arrears. In the case under consideration, farmers were informed that water services of the WUA will be discontinued if they will not pay off debts in the established terms.

According to the farmers' complaint, under distributing water through the WUA canals "Akbarabad-2" and "RP-1", the volumes of water delivered to private farms were two times less against their applications and the planned volumes of water use. A reasonableness of this complaint was established in the course of field audit; and by the decision of the WUA Council and administration, managers of hydro-operational sites who breached the procedure of water use were deprived 50% of their monthly bonus.

The private farm "Malika" brought its complaint to the Kuva District Office of Ministry of Agriculture and Water Resources (KDO MAWR) about the lack of irrigation water delivery by the WUA. The commission consisting of representatives of the KDO MAWR, District Association of Private Farmers, Arbitration Commission, Council and administration of the WUA "Akbarabad" has established that in 2007, the private farm "Malika" did not conclude the agreement on water delivery with WUA at all. After concluding the agreement on irrigation water supply between the WUA and the private farm, water delivery to this farm was started.

The private farm "Sayfutdinov" brought its complaint to the Council and Arbitration Commission of the WUA "Akbarabad" with the information that over the period of 6 to 10 August this farm had to receive irrigation water by a flow rate of 50 l/sec according to its application and the plan of water use. However, the private farm "Mamatkhon" during two days (7 to 8 August) practiced unauthorized water diversion from the canal by a flow rate of 30 l/sec, resulting in the dispute between these two farms. The Council and Arbitration Commission of the WUA "Akbarabad" have resolved this conflict situation: the private farm "Sayfutdinov" has received the planned volumes of irrigation water; and the private farm "Mamatkhon" was strictly notified that in case of repeated unauthorized water diversion from the canal it will be penalized. Thus, private farms and WUAs address not only to the WUA's Arbitration Commission but also to the Provincial Water Inspectorate and WUA Council and administration to resolve arisen disputes related to water use.

Figures 5.34, 5.35, and 5.36 give the trends of different types of disputes arisen in pilot WUAs "Akbarabad" (Uzbekistan), "Zerafshan" (Tajikistan) and "Japalak" (Kyrgyzstan) that were treated by WUA's Arbitration Commissions over the period of 2005 to 2007.

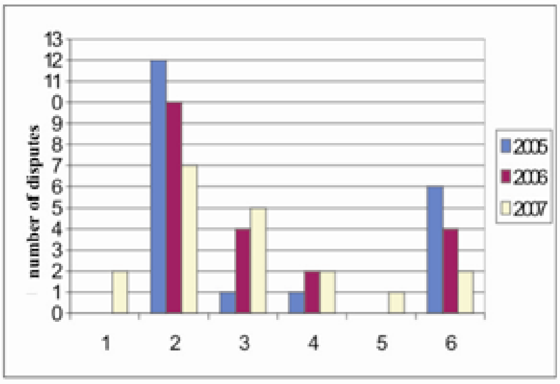



**Figure 5.34 Trends of Disputes Resolution in the Arbitration Commission of the WUA "Akbarabad" (2005 to 2007)**

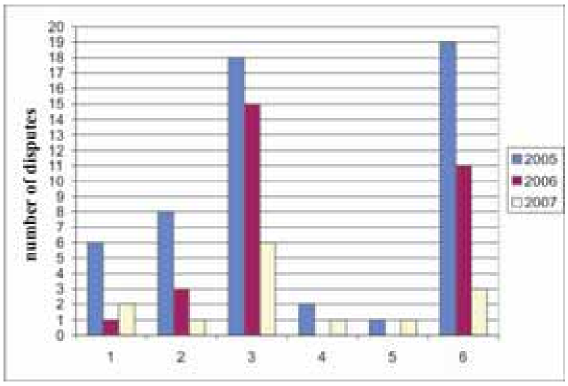
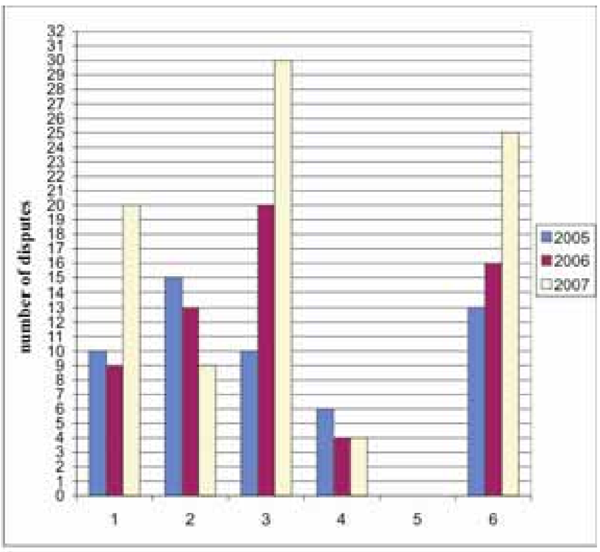



**Figure 5.35. Trends of Disputes Resolution in the Arbitration Commission of the WUA "Japalak" (2005 to 2007)**




**Types of disputes:**

1 – breach of irrigation water delivery;

2 – breach of the water use plan;

3 – ill-timed fees;

4 – labor disputes;

5 – relations with non-members of a WUA;

6 – relations between water users.

**Figure 5.36 Trends of Disputes Resolution in the Arbitration Commission of the WUA "Zerafshan" (2005 to 2007)**

Diagrams show that each WUA has own “painful points” that require those or other efforts in order to resolve and eradicate them and how WUAs managed to do this. There are trends of appreciable reducing the number of disputes in the pilot WUAs “Akbarabad” and “Japalak.”

As regards the pilot WUA “Zarafshan,” the increase in the number of disputes related to breaches of irrigation water delivery, violations of water use rules by water users, and ill-timed fees for water services of the WUA is observed here. This fact may be, to a large degree, explained by the process of increasing the number of water users in the WUA. Dispute resolution by the Arbitration Commission with involving the interested parties is the factor of stabilizing the general situation in the WUA that promotes strengthening the discipline of water users and WUAs in different fields of their activity.

## 5.8. Financial and Economic Instruments

**(V.A. Dukhovny, M. M. Pinkhasov)**

Financial and economic mechanisms are the most important tools for supporting the activity and development of any economic sector or enterprise. At that, the efficiency of their activity mainly depends on how these mechanisms were correctly selected and used. Undoubtedly, this refers to the water sector in the field of both operation and development including new construction, rehabilitation, nature protection and other aspects. At the same time, in the water sector these mechanisms also play an important role of regulating water demand and promoting the saving of water resources.

Unfortunately, during the Soviet period the economic mechanisms and financial system have suffered from the certain one-sided approach. The governmental financing of the water sector at all levels of the water resources management hierarchy up to the farm level did not create the incentives for saving water and funds. While under planning and constructing water infrastructure, the system of economic indicators (“a profit against costs” and “cost recovery” that are similar to such indicators as the NPV and IRR in the western practice) was used for evaluating the feasibility of constructing those or other waterworks, the method of “planning based on reached results”, with some corrections depending on development trends in the national economy, has dominated in the field of O&M. Economic indicators were mainly used under designing and very rarely under evaluating the reached results, basically under auditing. Insufficient attention to the actual efficiency of construction, inability to use completely economic mechanisms in the process of O&M, the lack of record keeping of financial responsibility of water users under different conditions, ignoring of the environmental profits and losses have resulted in many shortcomings of water resources management in the former Soviet Union including Central Asian republics. At the same time, the level of financial support of the water sector was considerably higher.

In spite of the lack of the integrated mechanism of planning operational costs and investments in the practice of water management and financial organizations, the upgraded system of standards on O&M of irrigation and drainage systems has provided better financial status of the water sector.

Trends of technical and economic indicators of the water sector in three Central Asian countries (Uzbekistan, Kyrgyzstan and Tajikistan) over the last twenty years (in the Soviet period since 1987 until 1991 and in the post-Soviet period since 1992 until 2006) are given in the table below.

This table shows that in the Soviet period the government spent considerable funds for O&M and development of water infrastructure (from 200 to 325 USD/ha) under the ration of O&M and investments into development of water infrastructure – 39.2% and 60.8% respectively, on average.

After independence, abrupt drop in new construction and even reducing irrigated areas took place in Kyrgyzstan and Uzbekistan, which were accompanied by drastic reducing of operational costs – by 60% in Uzbekistan, ten times in Kyrgyzstan, and a few times in Tajikistan. However, the indicators of Uzbekistan do not reflect the fact that expenditures for power make up about 70% of all operational costs; although formerly they did not exceed 20%. A situation related to capital investments much worse; since investments in developing water infrastructure were reduced in many times.

**Table 5. 36 Technical and Economic Indicators of the Water Sectors in Central Asian Countries**

| No | Indicator | Units | Averaged over the periods: | | | |
|---|---|---|---|---|---|---|
| | | | 1987 to 1991 | 1992 to 1996 | 1997 to 2001 | 2002 to 2006 |
| | ***Uzbekistan*** | | | | | |
| 1. | Irrigated area | 000' ha | 4141.9 | 4219.4 | 4228.9 | 4209.3 |
| 2. | Total water withdrawal | billion.m3 | 48.2 | 52.4 | 52.8 | 56.4 |
| | Including for irrigation | billion.m3 | 42.1 | 46.1 | 46.3 | 48.8 |
| | % of total water withdrawal | | 87.3 | 88.0 | 87.7 | 86.5 |
| 3. | Expenditures for the water sector, in total | mln. USD | 1347.7 | 413.5 | 333.9 | 389.1 |
| | Including O&M of water infrastructure | mln. USD. | 527.7 | 410.7 | 322.3 | 321.4 |
| | For development | mln. USD. | 820 | 2.8 | 11.6 | 67.7 |
| | **Indicators per unit area (ha)** | | | | | |
| | Water withdrawal for irrigation | 000' $m^3$/ha | 10.2 | 10.9 | 10.9 | 11.6 |
| | Expenditures for the water sector | USD/ha | 325 | 98 | 79 | 92.4 |
| | Including O&M of water infrastructure | USD/ha | 127 | 97.3 | 76.2 | 76.4 |
| | For development | USD/ha | 198 | 0.7 | 2.8 | 16.0 |
| | ***Kyrgyzstan*** | | | | | |
| 1. | Irrigated area | 000' ha | 434 | 414 | 405.5 | 401.6 |
| 2. | Total water withdrawal | mln. $m^3$ | 4936.5 | 4882.3 | 3676.6 | 3632.7 |
| | Including for irrigation | mln. $m^3$ | 4694.0 | 4673.5 | 3536.1 | 3512.3 |
| | % of total water withdrawal | | 95.1 | 95.7 | 96.2 | 96.7 |
| 3. | Expenditures for the water sector, in total | mln. USD | 87.2 | 41.7 | 2.61 | 4.88 |
| | Including O&M of water infrastructure | mln. USD | 87.2 | 22.4 | 1.97 | 4.18 |
| | For development | mln. USD | – | 19.3 | 0.64 | 0.7 |
| | **Indicators per unit area (ha)** | | | | | |
| | Water withdrawal for irrigation | 000' $m^3$/ha | 10.8 | 11.3 | 8.7 | 8.7 |

| No | Indicator | Units | Averaged over the periods: | | | |
|---|---|---|---|---|---|---|
| | | | 1987 to 1991 | 1992 to 1996 | 1997 to 2001 | 2002 to 2006 |
| | Expenditures for the water sector | USD/ha | 200.9 | 100.7 | 6.5 | 12.2 |
| | Including O&M of water infrastructure | USD/ha | 200.9 | 54.1 | 4.9 | 10.4 |
| | For development | USD/ha | – | – | 1.6 | 1.8 |
| ***Tajikistan*** | | | | | | |
| 1. | Irrigated area | 000' ha | 667.2 | 678.2 | 676.5 | 690.2 |
| 2. | Total water withdrawal | mln. $m^3$ | 11128 | 11014 | 11159 | 11179 |
| | Including for irrigation | mln. $m^3$ | 10190 | 10184 | 10237 | 10147 |
| | % of total water withdrawal | | 91.6 | 92.5 | 91.7 | 90.8 |
| 3. | Expenditures for the water sector, in total | mln. USD | 148.4 | 9.56 | 12.68 | 53.5 |
| | Including O&M of water infrastructure | mln. USD | 45.1 | 6.82 | 12.68 | 53.5 |
| | For development | mln. USD | 105.3 | 2.74 | 0 | 0 |
| | **Indicators per unit area (ha)** | | | | | |
| | Water withdrawal for irrigation | 000' $m^3$/ha | 15.3 | 15.0 | 15.1 | 14.7 |
| | Expenditures for the water sector | USD/ha | 222.4 | 14.1 | 18.7 | 77.5 |
| | Including O&M of water infrastructure | USD/ha | 67.6 | 10.1 | 18.7 | 77.5 |
| | For development | USD/ha | 157.8 | 4.0 | 0 | 0 |

[*)] Data of the project «CAREWIB» without accounting investments into the hydropower sector and urban and rural water supply

It can be mentioned that in the post-Soviet period, the budget allocation for the water sector was considerably reduced in all three countries, but especially in Kyrgyzstan and Tajikistan where a fee for water use was introduced. The table reflects the expenditures at the expense of the national budgetary funds.

At present, financing of the water sectors in Uzbekistan, Tajikistan and Kyrgyzstan has different sources depending on the resources to pay for water in the agricultural sector. The national budget is the major source of financing the water sector in the Republic of Uzbekistan. Here, additional sources of financing are the payments being received by the water management organizations for their services to water users, WUAs or other customers related to repairing irrigation and drainage systems or other works in the course of O&M of water infrastructure.

Nowadays, substantial additional sources of financing the water sector in Kyrgyzstan and Tajikistan are the payments for water services to agricultural customers.

The current financing of the water sector in the Republic of Uzbekistan is linked with the pricing policy in respect of major crops (cotton and wheat) cultivated under the state order with purchasing prices that are considerably lower the real market prices. In other words, the established prices (under state orders) include "free of charge" water services.

***However, the existing system of financing the water sector in the Republic of Uzbekistan does not allow:***

- to establish the mechanism of economic relations between water management organizations and water users and to stimulate saving of financial and water resources;
- to attract water users' funds for financing the water management interventions and to enhance the mutual liability of water suppliers and water consumers under implementing their duties;
- to establish the national water market as a key factor of redistribution of water resources from low-effective water users to high-effective ones and to create the mechanisms of overall and personal incentives of water users and water professionals in saving water; and
- to develop economic incentives for improving the environmental situation under using water resources.

*Moreover, the lack of the efficient encouragement mechanism of rational use of allocated funds for financing water-related interventions is also the shortcoming of the existing system of financing*. At present, in the system of financing O&M of the public water infrastructure, a share of payments for electric power together with a personnel salary makes up about 80%, and a share of repairing works is only about 20%. Such financing takes place under the current technical status of water infrastructure when a design operational life of 70% waterworks (especially, pumping stations) was exceeded 1.5 to 2 times.

Most of waterworks needed to be reconstructed, and consequently considerable investments are needed for implementing these interventions that are quite capital-intensive. Of course, all these issues should be solved not only by introducing water charging but also by providing the governmental support in the form of direct participation in financing the water sector and establishing the system of preferential crediting and taxation.

The all above said refers to the irrigation network within the former on-farm irrigation system. In the past, financing of the former on-farm irrigation and drainage systems (now serviced by a WUA) at the expense of farms was considerably lesser than financing the inter-farm irrigation and drainage systems by the government (about two times). At present, a share of the WUA's budget for these purposes makes up a negligible amount (from \$2.5/ha to \$7/ha). Issues of financing WUAs are one of major aspects of the economic mechanism, which will be described below.

### *The foreign experience of water charging*

There is not the overall approach for setting up the payment rates for different categories of water users in the world practice. Practically everywhere, water charging is based on reimbursement of expenditures related to water withdrawal, transportation and distribution among water users, as well as is the factor facilitating the improvement of water resources management and use in the national interests. Water sector's expenditures can be reimbursed in different ways:

- payment for volumes of consumed water;
- payment for water use per an accounting unit (per a person, irrigated hectare etc.);
- payment for water overuse against established limits;
- payment for water pollution;
- sale of water rights (payment for a license);

- a tax that includes a fee for water and water services; and
- a joint-stock right for water.

Practically everywhere, the highest payments for water are observed in the industrial and water supply sectors where a share of water sector's expenditures related to water services is completely paid for. Agricultural water users are in the preferred position because of the government subsidies covering expenditures of the water sector. In developing countries, where the introduction of water charging is at the initial stage, the encouraging arrangements for agricultural water users are being applied in the form of:

- liberalization of agricultural output markets;
- preferential crediting of farmers;
- preferential taxation; and
- involving water users in works that are related to maintaining water infrastructure on the paid base.

The government is completely financing (sometimes with use of local budget funds and financial input of water users) development of the water sector, large-scale construction of water infrastructure and land reclamation works. The following principle general statements can be mentioned:

- most of countries set up a water price for industrial and municipal use taking into account the self-repayment of the systems plus a certain profit share;
- most of countries have introduced the block-incremental system of pricing[37] when *a payment is minimum* for limited normative water consumption, but with the progressive growth of water prices under increasing of water consumption; and
- rural and municipal water supply is mainly self-supporting. Only water supply through the kilometers-long water pipelines can be exception. In this case, the government subsidizes part of expenditures.

A level of subsidies mainly depends on population incomes and institutional types of organizations that supply water and maintain the irrigation systems. According to the review of the International Commission on Irrigation and Drainage (ICID), in 1997, organizations that operate in the water sector all over the world were represented by governmental organizations (44%), community-based organizations (23%), private companies (6.7%) and joint-stock companies (13.5%). Therefore, most of large-scale water infrastructure is mainly maintained at the expense of national budgets; at the same time, some governmental and municipal participation is observed in maintaining smaller waterworks being the private or mixed ownership. On average, the cost of 1m$^3$ of water in the water supply systems in the developed countries ranges from \$2/m$^3$ to \$13/m$^3$. Payments of water users and governmental subsidies under financing investments and operational costs in the water sector are given in Table 5.37.

[37] The tiered block rate schedule

**Table 5. 37 Shared Financing of Investments and Operational Costs in the Water Sector, %**

| Country | Investment for water sector development | | Operational costs | |
|---|---|---|---|---|
| | Government | Water users and municipalities | Government | Water users and municipalities |
| Spain | 70 | 30 | 50 | 50 |
| France | 50 | 50 | 0 | 100 |
| Canada | 75 | 25 | 50-70 | 30-50 |
| Japan | 100 | 0 | 0 | 100 |
| the USA | 70 | 30 | 50 | 50 |

Table 5.37 shows that a share of the governments ranges from 50% to 100% for investments; and correspondingly a share of water users makes up 25-50%. As regards the operational costs, the governments bear 50 to 70% of expenditures or all operational costs are repaid by water users and municipalities (France and Japan). Indicators typical for some countries are given below:

***Israel***: under an average production cost of water in the public company "Mehorot" that equals to $0.35/m$^3$ to $0.40/m$^3$, the differentiated water tariffs are applied: for drinking and municipal needs – $1/m$^3$; for industrial needs – $0.60/m$^3$, and irrigation needs – $0.19/m$^3$. Water use in excess of the established limits is being penalized at the rate of tenfold tariff. The government subsidizes the public company "Mehorot" at the rate $0.20 per each cubic meter of water delivered to the agricultural sector.

***The USA***: the water tariffs for municipal and industrial water consumers vary from $40 to $2500 per 1000 m3. At the same time, water tariffs for agricultural water users amount to from $19 to $120 per 1000 m3. As a whole, the government spends about $ 1 billion for supporting the water sector including $500 million of subsidies allocated to the US Bureau of Reclamation. The going public of water rights and sale of water stocks are widespread in the USA in the recent years along with an abrupt growth of their price. The practice of the North Colorado Agricultural Water District in Colorado can be an example. In 1980, one stock that provides the right of eternal receiving one acre-foot of water has cost about $1000; in 1990, its cost has raised up to $15,000; and in 2000, its cost has reached $20,000. At the same time, water prices differ drastically over the states and even over counties.

**Canada:** CAD 5.3 billion38 from the federal and municipal budgets are subsidized into the water sector, including CAD 2.2 billion for O&M and CAD 3.1billion for development and rehabilitation. Water deliveries for irrigation are paid as a constant fee per one hectare in production. Owners of irrigated farmland pay CAD 110 per one hectare in production, on average.

***Spain:*** a payment for urban municipal water supply amounts to $0.75/m3; rural water supply - $0.25/m3; industrial water supply up to $2/m3; and water supply for irrigation from $0.02/m3 to $0.20/m3. Irrigation and rural water supply are subsidized by the government through its participation in maintenance of river basin organizations and through the municipalities.

[38] CAD – Canadian dollar

***Developing countries:*** in accordance with the review jointly prepared by the World Bank and Asian Development Bank, a share of payment for irrigation amounts to only 5% of revenue in Nepal; 6% in Pakistan; 8% in Indonesia; 9% in Thailand; and up to 26% in the Republic of Korea. There is the typical example of China, where while the industrial sector pays from $0.06/m3 to $0.10/m3, the irrigation sector only $0.008/m3 to $0.015/m3 under gravity irrigation and up to $0.02/m3 under pumped irrigation. Chinese economists consider that the payment for water shouldn't exceed 2 to 4% of gross annual revenue.

**At present, the situation in the agricultural sector in Central Asian countries is the following:**

*Two types of payment for water were established in Kazakhstan:*

1. in the form of a tax on each used cubic meter of surface water resources (payment for a resource) - Kaz Tiyna 3.02/m3[39] or $0.00021/m3;
2. in the form of services granted by water management organizations to the agricultural sector – Kaz Tenge 148.65 per 1000 m3 or $0.00105/m3.

*In Kyrgyzstan, the payment for water by agricultural water users is differentiated over seasons: B*

- during the growing season - Kyr Som 30 per 1000 m3 or $0.00069/m3; and
- during the off-vegetation period - Kyr Som 10 per 1000 m3 or $0.00023/m3 (as of 1.01.1999).

**Collected fees cover about 40% of O&M costs and a remaining part is subsidized by the government.**

*In Tajikistan* the payment for 1 $m^3$ supplied to agricultural consumers amounts to Diram 0.6 or $0.00205/$m^3$; for industrial use – Diram 1.2 or $0.00415/$m^3$ (as of 1.01.2004). Expenditures related to pumped irrigation are covered at the expense of budgetary funds - $16/ha, on average.

*In Turkmenistan* the payment for water delivered to industrial enterprises and other water users amounts to Manat 28.8/$m^3$. A coefficient of 1.7 is used in case of lifting water for irrigation. Water for irrigation is free of charge within established limits for water use. Water use in excess of the established limits is paid at the rate of threefold tariff.

Introducing the system of water charges has facilitated reducing volumes of water use by 10% in Kazakhstan, 21% in Kyrkyzstan, and 6% in Tajikistan. The main principles of water charging should be the following:

- incentive water pricing to achieve more efficient water use by water users;
- establishing the free market prices of agricultural output, enabling water users to be capable to pay for water services;
- enhancing the responsibility of water management organization for water delivery to water users in proper volumes and in a timely manner; and
- equipping the irrigation systems with advanced water measurement devices for monitoring flow rates.

[39] The national currency

***The following options and phases of the introduction of water charging are possible:***

- transition towards water charging is implemented simultaneously over the whole country. In this case, the thorough preparation of legal documents and the irrigation network that should be equipped with all necessary off-takes and gauging stations and matching of the prices of major crops (cotton and wheat) with the system of water charges are needed; and
- phased transition towards water charging, employing the block-incremental (tiered) system of water charges.

The backbone of block-incremental system of water charges consists in arranging three blocks of tariffs for water services:

***The first block**:* a tariff for water supply (per 1 m3) according to the rates corresponding to the advanced technology of water use or, in case of irrigation, according to the rates necessary to meet biological needs of crops. This kind of tariffs (the first block) established for agricultural water consumers has to be covered by the government at the first transition stage because of the difficult economic situation of agricultural producers and the existing policy of pricing in the agricultural sector.

***The second block*****:** a higher tariff rate for the amounts of water used in excess of biological needs of crops but within the established limits of water use.

***The third block**:* the highest tariff rate for the amounts of water used in excess of the established limits of water use. Tariffs of this block can be also considered as a penalty for water use exceeding the established limits; and a size of water charges should stimulate water users towards saving water, including the introduction of state-of-the-art irrigation methods. The penalties for unproductive discharges of irrigation water and unauthorized water diversion from the irrigation canals have to be also considered here. The system of penalties for the wasteful way of water use may be effective only when the size of penalty will be "painful" for the water user's budget. The system of penalties should also cover the issues related to water pollution.

As was mentioned before, in most countries all over the world, the payment for water use is established based on partial or complete reimbursing the operating costs taking into consideration the capability of water users to repay these costs.

## Principles of Establishing Tariffs for Water Services

***Tasks to be solved under transition towards water charging:***

1. Developing the mechanism of financing the water sector and land reclamation projects based on the market principles and parallel establishing the basis for sustainable operation and development of the water sector;
2. Forming the economic relations in the frame of the water sector that create the enabling environment and direct and indirect incentives for saving all resources and reducing unit costs under water governance, O&M and development of water infrastructure; and
3. Water charges as the incentive and priority for saving of water and water resources conservation.

*Pricing of water and land reclamation services*

In the water sector under establishing the mechanism of pricing, it is necessary to differ the following:

- the price of water as a renewable natural resource;
- cost of services related to water delivering and distribution;
- operating costs for O&M of drainage systems;
- costs for both simple and extended reproduction of the water sector and its assets;
- costs for compensation (or prevention) of damage possible under different kinds of water use, especially in the environment sector; and
- difference in costs for land reclamation activity on lands belonging to different natural fertility classes.

## *The pricing factors and the state policy*

Undoubtedly, the natural aridity affects water demand in Central Asian countries. At the same time, the state policy predetermines the tendencies of developing the water sector and hence forming water deficit (or its absence).

The former USSR's policy aimed at developing the irrigated farming to meet the national needs in raw cotton and also the development of the Central Asian region oriented on production of raw materials have resulted in the man-made deficit of water resources, although the integrated development aimed at profound processing the total output of the agricultural sector (as, for example, in Japan or South Korea) would prevent the arising of this deficit. In addition, target investments and the protectionist policy in the water sector (as in the USA and other developed countries all over the world) have created the large-scale water complex consisting of costly engineering irrigation and drainage systems that were not designed to be self-supporting. Most of these systems built in recent years had quite low economic indicators. Hence there are complexities that should be taken into consideration under transition towards water charging, namely: diversity of systems being built over the centuries that at present are rehabilitated and developed, creating the extreme differentiation of production costs and water productivity, as well as causing the complicated consequences of different social and ecological factors.

At that, it is necessary to keep in mind that investments for forming capital assets were made in the different periods (during tsarist and Soviet periods and nowadays in the period of transition towards the market economy).

The introduction of water charges requires pricing of water, which, to a considerable extent, depends on operational costs for O&M of water infrastructure, however, nobody never asked and does not ask now whether water users agree with a price of supplied water or not. Hence, sometimes we face the systems where costs for water supply are higher than the increase in water productivity. However, the government compels the land users to participate in maintaining and developing the irrigation practice to solve social problems related to the employment and supplying foodstuffs to the population.

At present, there are considerable differences in approaches to the problem of financing the water sector in different countries: in Turkmenistan, the government completely finances the national water sector; in Kazakhstan, Kyrgyzstan and Tajikistan, water users cover mainly O&M costs. The position of Uzbekistan is quite cautious for the time being, although water charging was introduced in all economic sectors with the exception of irrigated farming.

**Table 5.38 Financial Input of the Governments and Water Users in O&M of Irrigation Canals, %**

| # | Country | Government | | | | | Water users | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2003 | 2004 | 2005 | 2006 | 2007 | 2003 | 2004 | 2005 | 2006 | 2007 |
| 1 | Kyrgyzstan(Som) | 16 | 25 | 36 | 19 | 45 | 84 | 75 | 64 | 81 | 55 |
| 2 | Tajikistan (Somoni) | | 10 | 11 | 12 | 9 | | 90 | 89 | 88 | 91 |
| 3 | Uzbekistan (Sum) | | 100 | 100 | 100 | 100 | - | - | - | - | - |

Shares of governments and water users in financing O&M of the former inter-farm systems (now the systems that serve several WUAs) are given in Table 5.38. It is obvious that 90% of financing O&M of irrigation systems in Tajikistan is incurred by water users, and as a result, the farms hardly cover these considerable expenditures that amount to 16% of their revenue. In Kyrgyzstan, a share of the government varies from 16% to 45% and cannot provide the sustainability of financing.

***Models of tariffs for water services***

There are three kinds of tariffs for water services:

- volumetric tariff (per cubic meter of delivered water);
- fixed-area tariff (per a hectare under irrigation); and
- combined two-part tariff (per cubic meter of delivered water and per a hectare under irrigation).

The method of volumetric pricing has three options: i) a fixed price that is independent of a volume of water consumption; ii) a subside price that is reducing with the increase in a volume of water consumption; and iii) an incremental price that is rising with the increase in a volume of water consumption. The last option is usually used under conditions of water deficit (California, some regions of India)

One of options of the incremental tariff for water is a penalty for water used in excess of the established limits of water use.

***Factors Conditioning the Pricing***

In principle, there are not considerable divergences in factors of pricing, but some aspects should be kept in mind:

- changes in water availability over years that require establishing the insurance fund;
- it is obligatory to take into account water as a resource under establishing the mechanism of water charging if a task of reproduction of water resources is set or under assessing a new investment project;

- a tariff should take into account depreciation in case of simple reproduction (it is necessary to keep in mind that sometimes under the current economic policy the depreciation rates are erroneously underestimated resulting in depreciation of the water sector's assets);
- assessment of repairing costs under calculating tariffs should be made according to the norms rather than actual data (it is necessary to keep in mind that the policy of pricing on the basis of the reached level is always fraught with deteriorating the existing status of O&M); and
- assessment of normative profit.

Analysis of changes in annual water availability is based on evaluating the variability of water availability from year to year under relatively stable water demand in both the agricultural sector and other economic sectors. Under establishing tariffs for water delivery, calculating the cost of water delivery is made for a year with the 50% water availability. Therefore, a cost of water delivery will be different in years with different water availability. For example, in years with 75%, 90%, and 95% water availability, a cost of water delivery will be higher because a volume of water supply will be lesser and a level of conditionally-constant flow rates will not change with the alteration of water supply volumes.

To provide the sustainability of the water sector it is necessary to take into account this factor in the price model in the form of the insurance fund. A size of the insurance fund is computed according to the following procedure: a sum of conditionally-constant costs per 1 m3 of water supplied at off-takes is calculated and then multiplied by a value of the deficiency in water supply in a dry year in comparing with a year with mean annual water availability.

As known, under conditions of budgetary financing of the water sector, depreciation charges on capital assets were not being assigned. Under water charging and the need in reproduction of capital assets due to the self-repayment of costs, depreciation charges on capital assets are assigned. However, prior to specifying depreciation charges, it is necessary to receive evidence that the cost of capital assets corresponds to its real value. This can be done by means of reappraising capital assets.

In Kyrgyzstan the water management organizations have assumed 8% of water services costs as a scheduled profit under establishing tariffs. Prior to transition towards water charging this value of the scheduled profit can be accepted.

Without sufficient justification many specialists propose to assume a scheduled profit as 12% of costs of production. However, any percentage of a scheduled profit with respect to a production cost of water services will be disputable if to proceed from the assumption that the extended reproduction of irrigation and drainage assets will be provided at the expense of sectoral incomes. A high capital intensity of construction of new waterworks and water reservoirs, development of virgin lands, and rehabilitation of irrigation and drainage systems all over the world has forced the governments to subsidize the water sector even under conditions of developed infrastructure and high productivity.

***Pricing for water services should base on optimal satisfaction of requirements inherent in transition towards water charges:***

- a paying capacity of water users;
- stimulating of the public perception of water resources and water infrastructure as personal property, as well as of the responsibility for their sustainable development; and
- enabling environment for introducing the market mechanisms.

Pricing for water services should also base on the fact that a normal price provides for the "normal water quality." If a water quality does not meet primary standards, water price should be reduced. Under certain conditions it is necessary to pay "incentive bonuses" to water consumers for using brackish water i.e. drainage water, water abstracted from drainage tube-wells etc.

As yet, *three hierarchical levels can be distinguished in the framework of water management organizations.*

**Level I** – the inter-republican level: Basin Water Organizations (BWO) "Syr Darya" and "Amu Darya" that assess water resources forming within the basins and distribute them among consumers in the aggregated manner (for different economic sectors) through republican and provincial water authorities. Expenditures at this level can be referred to the category of water charge "payment for a resource", and have not to be taken into account in tariffs for water services being granted to water users.

**Level II** – the national level: water allocation to provincial water authorities taking into account local water sources. Under establishing differentiated tariffs for each province, expenditures related to water services are aggregated in the manner that allows referring part of expenditures incurred at the inter-provincial level to the municipal budget in proportion to water volumes diverted by this province.

**Level III –** the level of intra-basin systems and canals where the finite output of the national economic sectors is produced under using services on conveying and distribution of water, land reclamation and repairing water infrastructure.

**Models of tariffs for water services** can be presented as follows.

*For non-agricultural water users, a water price ($S_{nau}$) can be computed using the following formula:*

$$S_{nau} = \frac{\sum U_w + \sum C_f + \sum P_p}{W_{tlwu}} + P \text{ , Sum/m}^3, \qquad (5.1)$$

where:

| | |
|---|---|
| $\sum U_w$ | = total annual operational costs of the water sector related to water supply, Sum; |
| $\sum C_f$ | = insurance fund, Sum; |
| $\sum P_p$ | = profit per water volume supplied, Sum; |
| $W_{tlwu}$ | = total limit of water use, m3; |
| P | = amount for extended reproduction per 1m3, Sum/m3. |

The total annual operational costs of water management organizations ($U_w$) related to water supply are made up of costs at all existing hierarchical levels and represent the sum of annual costs including a salary of personnel, social insurance tax and unemployment insurance tax, expenditures related to network cleaning, power supply, depreciation charges on capital assets (for full replacement), a sum of capital and running repairs, transportation costs and other expenditures.

*A one-part (volumetric) tariff for agricultural water users ($S_{ir}$) can be computed using the following formula:*

$$S_{ir} = \frac{\left(\sum U_w + \sum Cf\right) * K_{li} + \sum U_{lr} + \sum P_{wu}}{W_{ILW}}, \text{ Sum/m}^3, \qquad (5.2)$$

where:

| | |
|---|---|
| $K_{lr}$ | = share of the limit for irrigation that equals to the ratio of $W_{lwi}$/ $W_{lio;}$ |
| $\sum U_w$ | = total annual costs of the water sector, Sums; |
| $W_{lwi}$ | = limit of water withdrawal for irrigation, $m^3$; |
| $\sum U_M$ | = total annual costs of water management organizations for ameliorative works, Sums; |
| $\sum P_{wu}$ | = normative profit of agricultural water users, Sums; |
| $W_{lio}$ | = limit for irrigation at off-takes of water users, $m^3$. |

Models of tariffs for water services being granted to different water users can be considered according to different options.

*Let us consider a two-part tariff for agricultural water users. The first part represents a payment for each hectare under irrigation, and the second part is a payment for each cubic meter of water delivered.*

*The first part* includes only costs related to land reclamation constituent with an appropriate share of profit; and *the second part* represents all other price-forming constituents with an appropriate share of profit.

***I. Formula for computing a payment for each hectare under irrigation:***

$$S_{ha} = \frac{\sum C_{lr} + \sum P_{lr}}{\omega}, \text{ Sum/ha}, \qquad (5.3)$$

where:

| | |
|---|---|
| $\sum C_{lr}$ | = total costs related to land reclamation constituent (a prime cost); |
| $\sum P_{lr}$ | = profit related to land reclamation constituent; |
| $\omega$ | = irrigated area, ha |

***II. Formula for computing a payment for each cubic meter of water delivered:***

$$S_{m^3} = \frac{(\sum O + \sum C_f) * K_{ir} + \sum P}{W_{wli}}, \text{ Sum/m}^3, \qquad (5.4)$$

where:

| | |
|---|---|
| ∑Oв | = total operational costs related to water supply, Sum; |
| ∑Cф | = insurance fund related to water supply, Sum; |
| Kпр | = share of the limit for irrigation; |
| ∑P | = profit related to water supply, Sum; |
| $W_{wli}$ | = amount of water limit for irrigation, $m^3$. |

Reimbursement of costs related to water supply to consumers can be provided according to the following proposed way. Covering costs by agricultural water users should be linked with the opportunity to sell their output at free market prices. In addition, agricultural water users should have the opportunity to cover their costs related to irrigation water supply and land reclamation activity at the expense of their incomes being gained under conditions of the financial sustainability.

The case study of the SFC demonstrates the results of establishing tariffs for water services using the proposed models for two options. According to undertaken assessment for the SFC command area, a water price under computing according to the one-part tariff model amounts to 6.65 Sum/m3 ($0.0051/$m^3$); and under computing according to the two-part tariff model, the first part (*a payment for each hectare under irrigation*) amounts to 4,984 Sum/ha and the second part (*a payment for each cubic meter of water delivered*) makes up 5.98 Sum/ha. In the case when the crop water requirement amounts to 7,500 $m^3$/ha, the costs related to irrigation water supply per unit area (ha) makes up $38.25/ha (7.500 $m^3$/ha * $0.0051/$m^3$).

**Table 5. 39**

**Computing the Tariffs for Irrigation Water Supply and Land Reclamation Works for the SFC Command Area**

| No | Indicator | Unit | Amount | Design formula, notes |
|---|---|---|---|---|
| 1 | Irrigated area served by the SFC | 000' ha | 85.5 | |
| 2 | Total annual limit of water supply (in a year with mean annual water | mln.$m^3$ | 841.06 | $W_{tot} = W_o + W_{industry}$ |

| No | Indicator | Unit | Amount | Design formula, notes |
|---|---|---|---|---|
| | availability) | | | |
| | including: water for irrigation | mln.m$^3$ | 641.06 | $W_o$ - volumes of water for irrigation according to established limits for water use |
| | water for industrial needs | mln.m$^3$ | 200.0 | $W_{industry}$ - volumes of water for industrial needs according to established limits for water use |
| 3 | Share of irrigation water supply | – | 0.762 | $K_{ws} = \frac{W_o}{W_{tot}}$ |
| 4 | Capital assets in the SFC system without drainage facilities | mln.Sum | 24,657.7 | Shares of the BISAs “Syr Darya-Sokh” and “Naryn-Karadarya” BDSA for the FV, Andijan Reservoir, PSA of Fergana and Andijan provinces |
| 5 | Capital assets of drainage systems in the SFC command area | mln.Sum | 1,165.6 | Share of PHAE in Fergana and Andijan provinces |
| 6 | Total capital assets of irrigation and drainage systems in the SFC command area | mln.Sum | 25,823.3 | P.4 + P.5 |
| 7 | Total costs of the irrigation sector (TCIS), including: | mln.Sum | 4,247.7 | TCIS = OC + $DC_M$ = 2768.2 + 1479.5 |
| | operational costs | mln.Sum | 2,768.2 | |
| | depreciation charges | mln.Sum | 1,479.5 | $DC_M$ = 24657.7 * 0.06 = 1479.5 |
| 8 | Total costs of the drainage sector (TCDS), including: | mln.Sum | 394.54 | Share of PHAE in Fergana and Andijan provinces |

| No | Indicator | Unit | Amount | Design formula, notes |
|---|---|---|---|---|
| | operational costs | mln.Sum | 324.6 | |
| | depreciation charges | mln.Sum | 69.94 | DC = 1165.6 * 0.06 = 69.94 |
| 9 | Conditionally -variable costs of the water sector in the SFC command area | mln.Sum | 1276.16 | CVC = power + cleaning = 1217.76 + 58.4 = 1276.6 |
| 10 | Conditionally -constant costs of the water sector in the SFC command area | mln.Sum | 2,971.5 4 | P.7 – P.9 = 4247.7 – 1276.16 = 2971.54 |
| 11 | Insurance fund | mln.Sum | 445.73 | IF = P.10 * 0.15 = 2971.54 * 0.15 = 445.73 |
| | including a share of irrigation systems | mln.Sum | 399.64 | $SI_o$ = 445.73 * 0.762 = 339.64 |
| 12 | Profit related to the irrigation constituent | mln.Sum | 258.94 | Pi = P7 * 0.762 * 0.08 = 4247.7 * 0.762 * 0.08 = 258.94 |
| 13 | Profit related to the land reclamation constituent | mln.Sum | 31.56 | P.8 * 0,08 = 394,54 * 0,08 = 31,56 |
| 14 | Costs of the land reclamation constituent taking into account the profit | mln.Sum | 426.1 | P.8 + P.13 = 394.54 + 31.56 = 426.1 |
| | ***Water tariffs*** | | | |
| 15 | **One-part tariff for irrigation and land** | Sum/$m^3$ | 6.65 | $S_{ir} = \frac{(\sum U_w + \sum Cf) * K_{li} + \sum U_{lr} + \sum P_{wu}}{W_{ILW}}$ |

| No | Indicator | Unit | Amount | Design formula, notes |
|---|---|---|---|---|
| | **reclamation** | | | $$S_{ir} = \frac{(4247.7 + 445.73) * 0.762 + 426.1 + 258.94}{641.06} = 6.65$$ |
| 16 | **Two-part tariff for irrigation and land reclamation:** | | | |
| | - a tariff part that reflects a payment for each hectare under irrigation | Sum/ha | 4,984 | $$S_{ha} = \frac{\sum C + \sum P_{lr}}{W_o} = \frac{394.54 + 31.56}{85.5} = 4984$$ |
| | - a tariff part that reflects a payment for each cubic meter of water delivered | Sum/m$^3$ | 5.98 | $$S_{m^3} = \frac{(\sum O + \sum C_f) * K_{ir} + \sum P}{W_{wli}}$$ $$S_{m^3} = \frac{(4247.7 + 445.73) * 0.762 + 258.94}{641.06} = 5.98$$ |

In respect of reimbursing the expenditures related to water supply of consumers the following can be proposed:

Covering costs by agricultural water users should be linked with the opportunity to sell their output at free market prices. In addition, agricultural water users should have the opportunity to cover their costs related to irrigation water supply and land reclamation activity at the expense of their incomes being gained under conditions of the financial sustainability. The international practice shows that water fee usually makes up 5% of gained profit.

Let us review the potential of private farms that grow different crops to pay for water under the conditions of irrigated farming in the SFC command area and the assumption that water fee makes up 5% of profit. Data on the crop profitability and capabilities of the private farms in the SFC command area to pay for water under average and maximum crop profitability are given in Table 5.40.

**Table 5.40**

**Assessing the Capability of the Private Farms in the SFC Command Area to Pay for Water**

| No | Crop | Crop profitability, $/ha | | Water fee, $/ha | Capability to pay, $/ha | |
|---|---|---|---|---|---|---|
| | | Average | Maximum | | Average | Maximum |
| 1 | Cotton | 150 | 420 | 38.25 | 7.5 | 21 |

| No | Crop | Crop profitability, $/ha | | Water fee, $/ha | Capability to pay, $/ha | |
|---|---|---|---|---|---|---|
| | | Average | Maximum | | Average | Maximum |
| 2 | Cereal crop | 160 | 500 | 38.25 | 8.0 | 25 |
| 3 | Orchards | 700 | 1200 | 38.25 | 35 | 60 |
| 4 | Vineyard | 1510 | 2200 | 38.25 | 75.5 | 110 |

The table shows that the capability to pay for water at the rate of $38.25/ha occurs under average profitability of orchards and vineyards when 5% of profit make up from $35/ha to $60/ha and from $75.5/ha to $110/ha respectively.

Now let us consider the expenditures of the pilot WUAs (the IWRM-Fergana Project) and profitability of farms serviced by these WUAs (Table 5.41).

**Table 5. 41**

**Trends of Costs per Unit Area in WUAs and Farmers' Profits (2003 to 2006), $/ha**

| Indicator | Year | | | |
|---|---|---|---|---|
| | **2003** | **2004** | **2005** | **2006** |
| ***Uzbekistan*** | | | | |
| WUA expenditures | 3.2 | 3.3 | 4.3 | 4.7 |
| Farming's profitability | 48.6 | 48.4 | 88.3 | 107 |
| WUA expenditures as percentage of profit, % | 6.6 | 6.8 | 4.9 | 6.3 |
| ***Kyrgyzstan*** | | | | |
| WUA expenditures | 2.14 | 2.44 | 8.95 | 2.83 |
| Farming's profitability | 365.2 | 401.0 | 302.4 | 288.5 |
| WUA expenditures as percentage of profit, % | 0.6 | 0.7 | 2.95 | 1.0 |
| ***Tajikistan*** | | | | |
| WUA expenditures | 3.5 | 2.13 | 3.43 | 4.49 |
| Farming's profitability | 207.4 | 32.9 | 106.8 | 27.2 |
| WUA expenditures as percentage of profit, % | 1.7 | 6.5 | 3.2 | 16.5 |

As shown, in Uzbekistan, farmers pay for WUA's services up to 5 to 7% of net profit; and according to the world experience this is quite realistic. In Kyrgyzstan, the overall payment of water users to WUAs and WMOs amounts to 5 to 6% of net profit, and this is also rather reasonable. There are absolutely unrealistic payments in Tajikistan (fees collected by WUAs have reached 15% of farms' net profit). However, this payment percentage from net profit is a result of low average revenues of farms serviced by WUAs – 100 to 200 $/ha (only in Kyrgyzstan – 300 to 400 $/ha).

Average and maximum water productivity that was reached on project demonstration fields (Table 5.25) shows that it can be risen without special investments only due to implementing good agricultural practice (the increase in productivity of cotton and wheat almost two times, and correspondingly the growth of net profit up to 420 to 500 $/ha). This means that an average acceptable fee for services of WUAs and WMOs can be at the level of 21 to 25 $/ha in the case of a fee at the rate of 5% from gained profit. A higher fee is possible if the same approach is employed for orchards and vineyards. Here, an acceptable size of fees can be increased up to 60 to 110 $/ha.

***What conclusions can be done based on this analysis?***

- The government should fix the limiting fee for services of WUAs and WMOs at the rate of 5% of net profit. This fee of farmers, first of all, covers the WUAs' operational costs;
- The government should encourage farmers in every possible way in order to reach higher productivity and profit, and for this purpose to finance O&M of inter-farm water infrastructure providing sustainable agricultural production. In line with the growth of irrigated farmland productivity and profit, the government will start to reduce its share of financing; and
- WMOs have to conclude the agreements with WUAs, and the latter with farmers, which should include the provisions with strict requirements to provide the compliance with the irrigation schedules.

### Creating material incentives for water management organizations and water users associations

Matters of creating material incentives for water management organizations (WMOs) and WUAs are quite topical, keeping in mind that water is scarce natural resource. At that, supplying of water to water users in proper time and in proper volumes with appropriate quality requires considerable investments and operational costs. As was mentioned, water supply for irrigation of one hectare in the SFC command area requires about 40 $/ha only for running costs.

***What measures should be stimulated?***

1. Encouraging the water-saving practice, first of all, in WUAs and private farms should be considered as the most important issue. For this purpose, the special funds ("Water-Saving Fund") should be established in the framework of WMOs and WUAs. Inpayments due to use of water in excess of the allowed maximum should be deposited into this fund in the WMO, and then water users who saved a part of water supplied according to the limits of water use should receive a bonus at the expense of this fund, i.e. the WMO transmits money to the WUA's account to give this bonus that is equivalent to payment for unused water volumes according to established tariffs.
2. As far as the reclamation of irrigated farmland is one of major factors of the increase in water and land productivity, it is necessary to encourage personnel of WUAs and the Hydro-Ameliorative Expedition to improve soil and hydrogeological conditions in farms serviced by WUAs for enhancing the crop productivity. Incentive criteria should be agreed with farmers and WUAs, for example, such criteria as shifting irrigation lands from the category of heavy and medium saline lands into the category of slightly and non-saline lands; lowering watertable and the level of groundwater salt content; improvements in drainage network operation; and rise of crop yields.
3. Well-organized service of water users by WUAs can be characterized by uniform water distribution over private farms in accordance with the established irrigation schedule. Such

services promote reducing the number of disputes and conflicts between WUAs and water users and between WUAs and WMOs, and hence WUA personnel also needed to be encouraged.

4. Personnel of WUAs and WMOs should be encouraged both in the case of implementation of planned scopes of repairing works in full and in the case of reducing operational costs.
5. Incentives are also necessary under implementing other measures: i) saving water due to improving organizational and technical efficiency of irrigation canals serviced by WUAs and WMOs; ii) introduction of efficient technologies of water distribution between WUAs and water users; iii) improving of water availability of the irrigation schemes at the expense of use internal water resources, etc.

## Economic incentives for water saving in Central Asia

**(N. Mirzaev.)**

It is clear that one of causes of water deficit in Central Asia is the growth of water demand; and naturally reducing water demand facilitates water problems resolution. *Institutional measures,* including specially developed systems of regulations and incentives are used in the frame of demand management. The systems of regulations and incentives affect individual behavior of people forcing them to do those things which otherwise they would never do. These systems have different forms. One of them is a financial influence that envisages *"compulsion"* by means of payment for water services and penalties for water use in excess of the established limits and *"incentive"* through the right to sell saved irrigation water at market prices to other water users etc.

Only *penalties,* although with low effect, are active under the centralized water governance. Numerous unsuccessful efforts to introduce the *water charge principles* in the Soviet period have shown that it is difficult to provide successful reforms in the water sector without reforming the agricultural sector as a whole by means of transition towards market relations in rural areas.

After independence, Central Asian countries try to reform their economy, including water and agricultural sectors. Matters of saving water become more and more *economically important matters* in the course of reforming water and agricultural sectors. Since, under transition towards market relations, a major target of water users is a maximum income rather than a maximum possible crop yield at any cost (as in the Soviet time), water users are interested in water-saving methods in that extent in which they are profitable for water users under existing natural and economic conditions. Therefore, transition towards the decentralized methods of management, in particular in the water sector, as a rule, is accompanied by the introduction of water charges and granting the right to sell saved irrigation water that are the most important instruments for improving management of water use and water conservation.

At present, all Central Asian countries consider it necessary to introduce water charging, however, since the strategies of market reforms are different, the water charging system is operative only in three of five Central Asian countries.

Water use based on water services for a fee is not practiced in the agricultural sector in Uzbekistan and Turkmenistan. At present, the cost of water services is taken into account in the form of the water tax that is included in the land tax in Uzbekistan. In Kyrgyzstan and Kazakhstan, reforms were initiated during the period of 1992 to 1994 by introducing water charging.

Further, in 1995 to 1996, after issuing the appropriate decrees by Presidents, the mass privatization of land through its free of charge distribution was started. In Tajikistan, water charging was introduced later than in neighboring countries in 1996. In Tajikistan, liberalization of prices on agricultural output took place also later than in Kyrgyzstan and Kazakhstan after issuing the Decree of the President of the Republic of Tajikistan "On the Provision of Rights for Land Use" in 1998.

It is impossible to say definitely that the introduction of water charging has substantially increased the efficiency of water use in Central Asian countries but certain positive results and trends are already observed.

Effects of the introduction of water charging in Kyrgyzstan are the following (according to expert appraisal):

- Reducing water consumption;
- Reducing areas with pumped irrigation;
- Changes in the crop pattern (a share of crops that need less water has increased – cereal crops, tobacco, sunflower);
- Soil and hydrological conditions have become worse over the whole area insignificantly, but in some places they were even improved due to reducing water supply.

The above said about the introduction of water charging in Kyrgyzstan, although in the lesser extent, is true also for Tajikistan. With respect to Kazakhstan, it is still early to speak about positive affects of the introduction of water charging, but its necessity is beyond doubts.

The experience of economic stimulating of the rational water use in Central Asian countries shows that the introduction of water charging is the condition *necessary* but *insufficient* for improving the efficiency of water use. Additional conditions for improving the efficiency of water use are the following:

- Adequate water measurement and accounting, especially at the “bottom” level of water distribution. However, the all-out privatization of land in Kyrgyzstan and Kazakhstan has resulted in abrupt rise of the number of private and dekhkan farms (PFs and DFs), caused problems in establishing the adequate water measurement and accounting systems at the on-farm level and reduced the effect of introducing water charging.
- The financial sustainability of PFs that pay for water services of WUAs and WMOs (Canal Administration and District Water Authorities). Liberalization of the agricultural sector and strengthening the financial status of water users should precede the introduction of charging for water services. In practice, as shown above, the reverse sequence of reforms in Central Asian countries has led to incapacity of numerous water users to pay for water services of WUAs and WMOs. The financial inability of water users has resulted from the inability of authorities not only to support them but also to protect them from resellers under selling agricultural output.
- A proportionality of water tariffs and penalties to operational costs and damages due to infringement of the water discipline[40]. A tariff policy should promote water saving and improve collecting fees for water services both at the level of main canals and at the level of WUAs.

This publication deals with problems of improving the tariff policy and was prepared on the basis of analyzing data collected under implementing the IWRM-Fergana Project. The project covers the pilot main irrigation canals in the Fergana Valley: the SFC (Uzbekistan), AAC (Kyrgyzstan), and KBC (Tajikistan), as well as WUAs in the command areas of these pilot canals.

## The fee collection rates for water services

***Two kinds of water services are considered in this publication:***

- services related to water delivery by the Canal Administration to WUAs; and
- services related to water delivery by WUAs to farmers.

[40] The fact is that too low or high tariffs for water services and penalties cannot act as factors facilitating water saving

In the first case, a water supplier (WS) is the Canal Administration (CA), and in the second case –WUAs. At the same time, in the first case a WUA is a water user (WU), and in the second case – a private farm. However, it is necessary to keep in mind that the end water user that pays for services of the CA and a WUA is a private farm; and a WS's future depends on its financial status.

Diagrams that are presented in Figures 5.39 to 5.42 show that although the fee collection rate for water services is increasing from year to year in the command areas of the KBC and AAC where water charging was put in practice, however, the growth rates of fee collection are quite low due to the difficult financial situation in WUAs and adversely affect the financial status of the CA and correspondingly the quality of O&M.

One of the reasons of low growth rates of fee collection for water services (if to set aside the reasons related to the policy of transition towards the market relations in the water sector and the procedure for writing off WUAs' debts) is the fact that the computing method of tariffs for water delivery need to be improved.

Water users served by the KBC Administration (WUAs) don't hurry to pay as well because from time to time rumors about writing off of their debts that were "fastened" under restructuring the collective farms (on their territory WUAs were established) are being widespread among water users. In 2004, for example, all debts as of January 1, 2003 were written off. Writing off is a positive process, but the adverse fact is that, as a rule, among "winners" those who never paid. The collective farm that had only a 10% debt has lost. It comes to ridiculous things, after writing off of water users' debts the District Water Authorities became the debtor of non-payers.

Payment for services should be made on the monthly basis. The agreement envisages a penalty at the rate of one percent per each overdue day, but no more than 100%. This provision, as a rule, fails. A prepayment should amount to 40% but this provision, with the rare exceptions, are not also implemented[41]. Water users, first of all, pay to the District Water Authorities that provide pumped water supply and according to the leftover principle to the KBC Administration. There is the following explaining of this fact: water users understand that without timely payments the District Water Authorities will not be able to repair pump units, affecting water supply immediately and adversely.

The agreement on irrigation water supply at the rate of 90% from the planned irrigation water supply is signed by the KBC Administration and water users (WUAs). There are two types of agreements that are signed depending on whether water users have investors (mediators) or not (most of water users have investors signing the futures agreements with them). Since 2007, if water users have the investor, the trilateral agreement (the KBC Administration - a water user - an investor) is signed. The agreement with an investor is concluded on water supply only for irrigation of cotton, at the same time, water users pay for water supply for irrigation of other crops. Specialists consider that there is some effect due to the trilateral agreement but insignificant.

The fact is the financial status of water users having investors is worsening from year to year, because these investors (mediators) mainly use the barter payment system (supplying fuel, fertilizers, etc., at that, at high prices) instead of the mutual settlement in cash. Therefore, in Tajikistan, the decision was made (Resolution No 10/13-3 issued by the Government) to finance farmers through the banks (preferential micro-credits). At present, transition towards the new system of financing is in progress.

*(Sources: the minutes of KBC WC's meeting of 23.04.2008)*

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[41] Penalty per each overdue day is provided for but there are not incentives for prepayment.

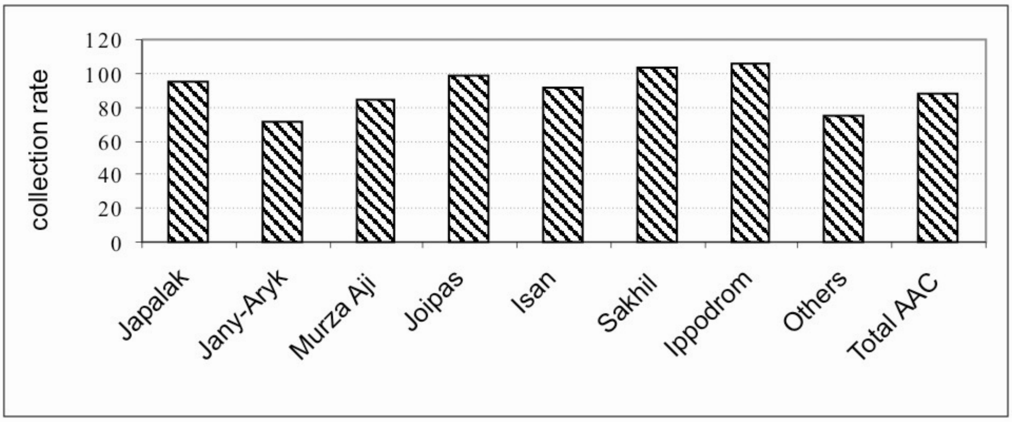


**Figure 5.39 A Fee Collection Rate in the AAC Administration and WUAs (the progressive total over the period of 2003 to 2007)**

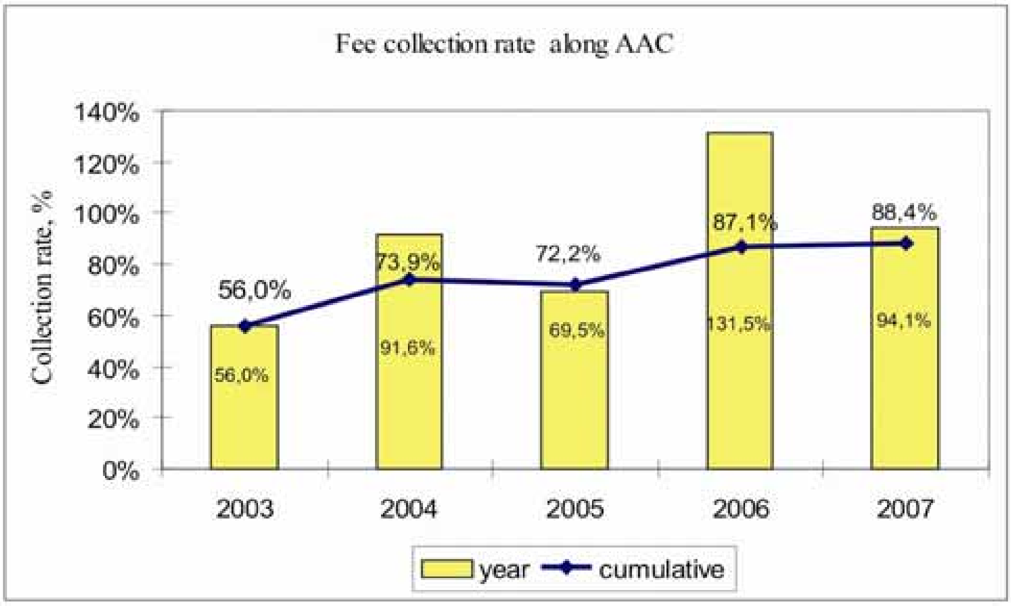


**Figure 5.40 A fee collection rate in the AAC Administration over years**

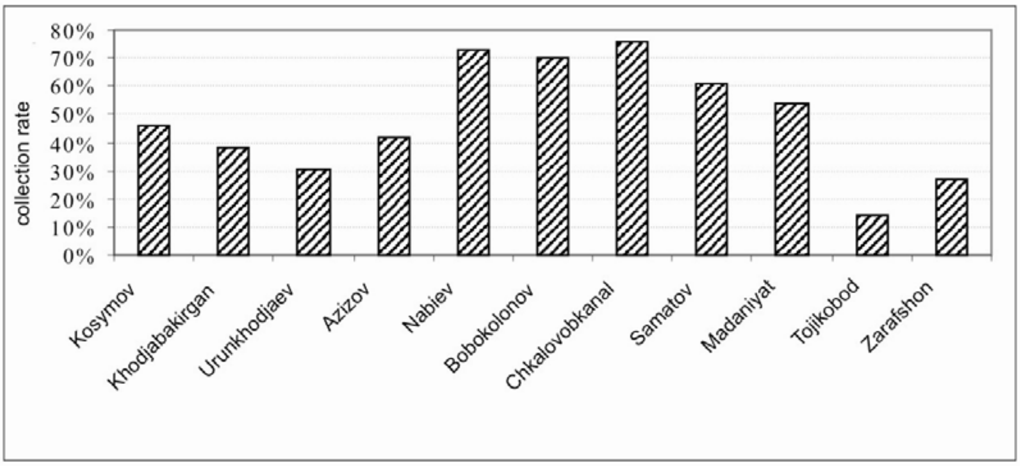


**Figure 5.41 A Fee Collection Rate in the KBC Administration and Water Users (the progressive total over the period of 2004 to 2007)**

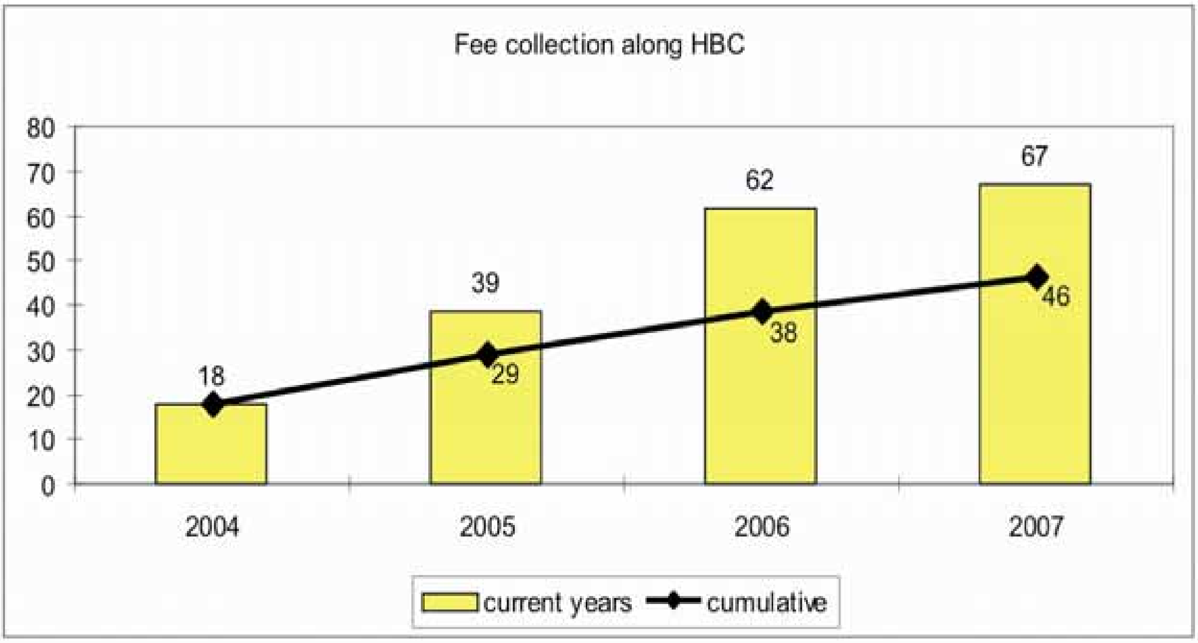


**Figure 5.42 A Fee Collection Rate in the KBC Administration over Years**

## The methodology of adjusting water tariffs

**Table 5.42 Tariffs for water services (per 1000 $m^3$ )[42]**

| Country | Tariff | | Exchange rate |
|---|---|---|---|
| | National currency | US$ | |
| Kyrgyzstan, Som | | | |
| Growing season | 30[43] | 0.82 | 36.4 |
| Off-vegetation period | 10 | 0.27 | 36.4 |
| Tajikistan, Somoni[44] | | | |
| Water supply by gravity | 7.8 | 2.27 | 3.43 |
| Pumped water supply[45] | 12.5 | 3.64 | |

[42] As of April 2008
[43] Tariff - 3 tiyin per 1m3 (plus 1 tiyin as the VAT) does not cover operational costs of the AAC Administration. In specialists' opinion, a tariff should be increased twice
[44] Tariffs as of 10.06.2007 without VAT at the rate of 20%. Water management organizations were not included into the list of organizations that were exempted from VAT. In principle, the matter of the VAT correctness regarding water services should be discussed.
[45] In Israel, tariffs were also differentiated depending on types of water supply (by gravity or pumped). However, that what is acceptable for the country with developed market economy may be unacceptable for Central Asian countries

**Analysis shows that tariffs in Central Asian countries differ by:**

1. a rate (the highest tariffs in Tajikistan)[46];
2. seasons (a growing season and off-vegetation period):
   - i. The differentiated approach under which tariffs in the off-vegetation period three times lower than during the growing season was employed in Kyrgyzstan;
   - ii. The single tariff that does not depend on seasons was established in Tajikistan (local specialists consider that the differentiated approach is more rational since it encourages water users to conduct water applications for land preparation during the off-vegetation period);
3. type of water supply:
   - i.by gravity;
   - ii.pumped;
4. procedures for developing and approval of tariffs. Tariffs are approved by:
   - i.the Parliament (the Jogorku Kenesh) in Kyrgyzstan;
   - ii.the Government (the Ministry of Economy) in Tajikistan.

The existing normative tariffs, as shown above, do not take into account the market principles and, as a rule, do not stimulate the growth rates of fee collection for water services. Hence, the water suppliers, for example, the Canal Administration suffer from shortage of water and water saving; and, at the same time, it is not advantageous for water users to pay for water services in timely manner and, all the more, to make prepayment.

Therefore, the following approach of adjusting tariffs for water services was proposed.[47]

**In general, the formula for computing a tariff can be presented as follows:**

$$T_r = T_p * K \,. \qquad (5.5)$$

*where*

$T_r$ = the calculated tariff for water services (hereinafter referred to as "tariff")

$T_p$ = normative (base) tariff

$K$ = overall adjustment factor

$$K = \frac{K_f}{K_l * K_s * K_t} \,. \qquad (5.6)$$

*where*

$K_f$ = factor of water users' water availability relative to limited water supply (hereinafter referred to as "limit")

$K_l$ = limit factor

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[46] According to the world practice, the realistic level of water charges is about US$ 30 to 60/ha.

[47] It is necessary to stress that the rates of normative tariffs for water services under computing of which the profitability of water users and their readiness to pay should be considered are not discussed in this publication.

$K_s$ = factor of collecting fees for water services (hereinafter referred to as “fee collection rate factor)

$K_t$ = factor of timely charges for water services (hereinafter referred to as “a timeliness factor”)

***1. Computing the limit factor (to take into account water availability of current year)***

$$K_l = \frac{W_l}{W_p}. \tag{5.7}$$

*where*

$W_l$ = limit of water use[48] for the current season

$W_p$ = planned water supply to water users for the current season

***2. Computing the factor of water availability (to take into account actual water supply)[49]***

If to follow the proportionality principle (actual water supplies during ten-day periods are proportional to the limit water supplies):

$$K_f = \frac{W_f}{W_l}. \tag{5.8}$$

If the proportionality principle was not observed (understated or overstated water use relative to limits take place):

$$K_f = \frac{\sum_{d=1}^{m}\left(K_d^f * W_{fd}\right)}{W_f}. \tag{5.9}$$

*where*

$K_d^f =$ actual water availability relative to the limit in d-ten-day period

$$K_d^f = \frac{W_{fd}}{W_{ld}}. \tag{5.10}$$

*where*

**d** = index of a ten-day period

[48] Limits of water supply for the growing season for irrigation systems, provinces etc. are formally established only in Uzbekistan since limited water use are employed here. In dry years, limits are also established in other countries. The term “limit” is traditionally used, although it is more correct to use the term “quota” that means the right for water.

[49] Actual water supply should be taken into account under establishing tariffs for water services, for example in Israel where the cost of 1 m3 equals to $0.60 if actual water supply is less than planned volumes by 50% then tariff equals $0.14 (less by 77%) and if actual water supply is higher by 50% then tariff equals $0.30 (i.e. less by 50%).

m = number of ten-day periods over the period under consideration (in the case of the growing season **m** = 18)

$W_{fd}$ = actual water supplies during a ten-day period

$W_{ld}$ = limited ten-day period water supplies

### *3. Computing the fee collection rate factor*

$$K_s = \frac{P_f}{P_p}. \quad (5.11)$$

*where*

$K_s$ = the fee collection rate factor

$P_p$, $P_f$, = planned and actual amounts of collected fees for water services over the design period

$$P_p = T_p * W_f \quad (5.12)$$

### *4. Computing the timeliness factor*

$$K_t = \frac{100 + F * R}{100}. \quad (5.13)$$

*where*

*F* = a difference between the established and actual date of the payment for water services. For example, a date within the first ten-day period after ending the settlement month, i.e. from 1st to 10th day of each month can be considered as an established date.

**For example:**

- If a payment was made within established terms then *F*=0; and the tariff for the period under consideration (month) is not adjusted and equals to the normative tariff. If a payment for services granted in May was done before the established term, for example, on 25 May (prepayment) then *F*=+5 days (with the sign "+")
- If a payment for services granted in May was done after the established term, for example, on 15 June then *F* =-5 days (with the sign "-")

*R* = coefficient of adjusting daily tariff (in %) that depends on an actual date of payment (prepayment or delayed payment). Its value can be reasonably established taking into account the real situation, for example, from 0.5% to 1.5%.

## Examples of computations

***Example 1***

***Let us assume the following:***

- $K_s$=$K_t$=1, i.e. water users pay for water services in full and timely;
- planned water supply ($W_p$) by a supplier to water users during the growing season amounts to 20 mln. m$^3$;
- different options of limited water supply (even such unlikely but possible option in principle when the limited water supplies are greater than the planned ones) are simulated;
- the principle of proportional readjustment of actual water supply over a ten-day period against limited water supply is observed.

Computing of tariffs is given in Figure 5.43 and Table 5.42. It is obvious that:

a) if $W_f = W_l = W_p$ then the calculated tariff equals to the normative one.

b) if $W_f = W_p$ and variable $W_l$ :

- with decreasing $W_l$ against $W_p$, the calculated tariff increases against the normative one, and vice versa when $W_l$ exceeds $W_p$, the calculated tariff becomes lower than the normative one. Thus:
- The less amount of water resources (dry year) the higher tariffs; this approach corresponds to the market principles, and at that water suppliers do not suffer from water resources deficit, but water users need to employ water-saving measures: reducing the cropped areas; decreasing the land use intensity, exclusion of water-loving crops from the crop pattern (rice, onion etc.), use of shorter furrows, increase in the number of irrigators, introduction of new technologies etc.
- The greater amount of water resources, the lower tariffs; at that water suppliers do not have unearned profit due to the abundance of water, and water users have the opportunity to apply additional kinds of irrigation (water applications for soil leaching, water application for land preparation, irrigations to trigger germination), to increase a share of water-loving crops and the land use intensity etc.

c) If $W_l = W_p$ and variable $W_f$:

- With decreasing $W_f$ against $W_p$, the calculated tariff decreases against the normative one, and vice versa when $W_f$ exceeds $W_p$, the calculated tariff becomes higher than the normative one. Thus, it becomes more profitable for water users to save water[50].

***Example 2***

**Figure 5.43 and Table 5.42 present two options of actual intra-seasonal water distribution (by ten-day periods) relative to the limited water supply:**

- proportional water supply;
- disproportionate water supply.

[50] Of course, the participants of the process of water distribution and other stakeholders can accept some reasonable and mutually acceptable limitations after their discussion

The table shows that in the case of the same value of seasonal water supply (16,000.000 m3) under the first (proportional) option of actual water supply during the growing season $K_{f1}$=0.9 and under the second option, when water abstraction less or greater the limited volumes of water supply, $K_{f2}$=1.24 i.e. under other things being equal, the tariff has increased by 34% due to the nonuniformity of water distribution per ten-day periods (due to water abstraction in the excess of limits).[51] At that, lesser water abstractions result in lowering the factor's value[52], and water abstraction in the excess of limits in rising of the factor's value. Since a share of water abstraction in the excess of limits (relative and absolute values) was higher, rising of the factor's value leading to the growth of tariff rate takes place.

As a whole, after taking into account both coefficients the adjustment factors make up 1.0 и 1.38 respectively.

**Table. 5. 42**
**Computing the Tariff Adjustment Factors for Water Services Taking into Consideration Limited and Actual Water Supplies**

| $W_f$, mln. $m^3$ | $W_l$, mln. $m^3$ | | | | | |
|---|---|---|---|---|---|---|
| | **14** | **16** | **18** | **20** | **22** | **24** |
| 14 | 1.43 | 1.10 | 0.87 | 0.70 | 0.57 | 0.50 |
| 16 | 1.63 | 1.27 | 1.00 | 0.80 | 0.67 | 0.57 |
| 18 | 1.83 | 1.40 | 1.10 | 0.90 | 0.73 | 0.63 |
| 20 | 2.03 | 1.57 | 1.23 | 1.00 | 0.83 | 0.70 |
| 22 | 2.23 | 1.73 | 1.37 | 1.10 | 0.90 | 0.77 |
| 24 | 2.43 | 1.87 | 1.47 | 1.20 | 1.00 | 0.83 |

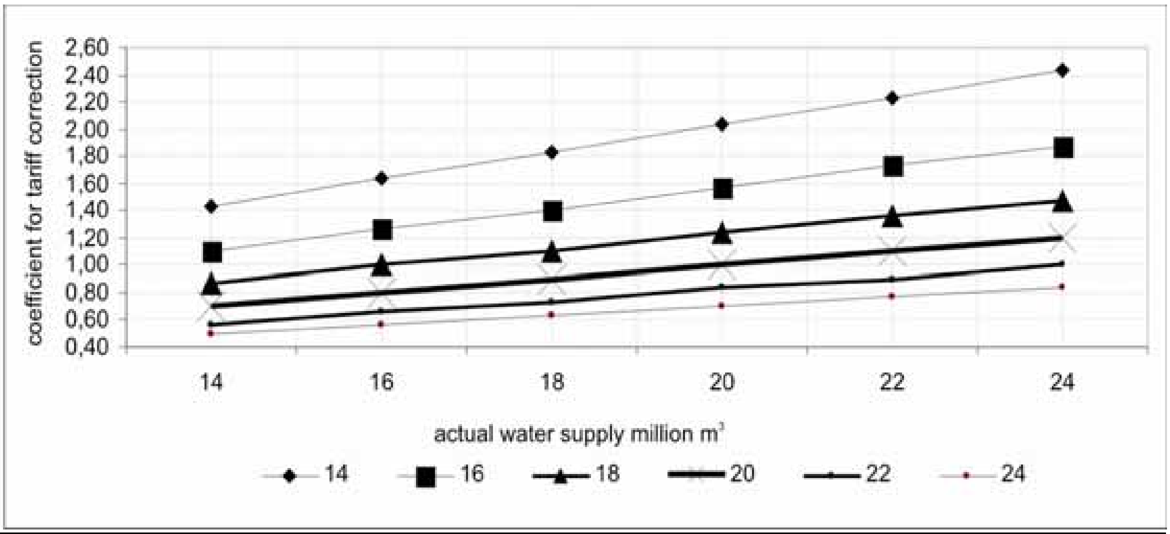


**Figure 5.43 Chart for Computing the Adjustment Factors Taking into Account Limited and Actual Water Supplies**

[51] Penalties for water abstractions in the excess of limited water supply (stoppage of water deliver or penalties) are envisaged, but these measures, as a rule, are not effective.

[52] Lesser water abstractions can be caused: i) at will of water users (in our example just this case is considered); ii) due to force majeure circumstances; and iii) through a water supplier's fault. The agreement between water suppliers and water users foresee such circumstances, but it is difficult to recall the case when water supplier was punished because water supplier always can allege force majeure circumstances. In addition, it is possible that under using our method, lowering the tariff due to lesser water abstractions through a water supplier's fault can be insufficient to cover damage.

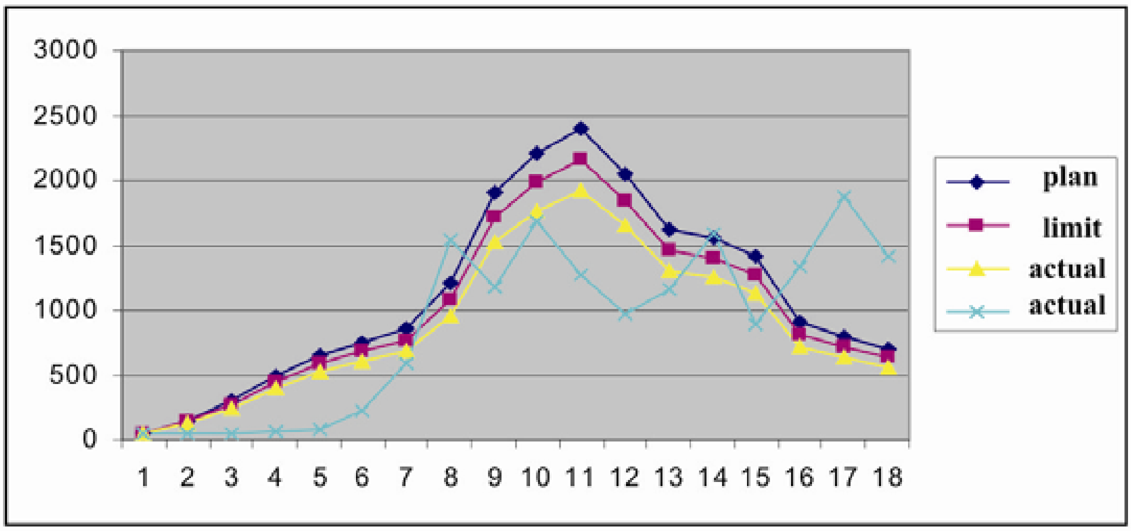


**Figure 5.44 Water Supplies per Ten-Day Periods**

**Table 5.43.**

**Computing the Water Tariff Adjustment Factors under Nonuniformity of Water Distribution per Ten-Day Periods**

| Indicator | Unit | Growing season |
|---|---|---|
| $W_p$ | 000' $m^3$ | 20,000 |
| $W_l$ | 000' $m^3$ | 18,000 |
| $K_l$ | | 0.90 |
| $W_{f1}$ | 000' $m^3$ | 16,000 |
| $K_{f1}$ | | 0.90 |
| $K_1$ | | 1.00 |
| $W_{f2}$ | 000' $m^3$ | 16,000 |
| $K_{f2}$ | | 1.24 |
| $K_2$ | | 1.38 |

***Example 3***

**Let us assume that:**

1. $W_f = W_l = W_p$ , i.e. $K_f = K_l = 1$ and there are not any problems related to water distribution.
2. $R = 1\%$.

Computing of adjustment factors, taking into account a fee collection rate and its timeliness, is given in Table 5.44.

The method of adjusting tariffs can be applied on the monthly or seasonal basis. It is obvious that the seasonal approach, under which mutual settlements with water users taking into account above factors are made in the end of the growing season, is more acceptable during the initial period. Under these circumstances, if a water provider is found as a debtor then a water provider's debt is considered as the prepayment of a water user for the next growing season.

**This approach can be employed at different levels of water sharing:**

- at the main canal's level: relations of the Canal Administration and WUAs;
- at the WUA's level: relations of a WUA and farmers.

In principle, other economic incentives for rising of the level of fee collection rate and water savings are also possible. Only some of them were suggested for their discussion. It is talked of wide discussing not only among scientists but also among water professionals and water users. In the case of positive perception of this approach and after its improvement according to comments, its introduction at the WUA's level can be faster than at the main canal level since, in principle, a WUA can settle this matter at the general meeting of water users. At the main canal's level, it is necessary to arrange the discussion firstly at the CWUC's sessions and then at the enlarged sessions of the CWC with participating of all stakeholders and decision makers.

**Table 5. 44**

**Computing the Adjustment Factors Taking into Account the Fee Collection Rate and Its Timeliness**

| **Indicators** | **Unit** | **Design month** | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|
| | | April | May | June | July | August | September | |
| Initial information | | | | | | | | |
| $W_p$ | 000 $m^3$ | 1,750 | 2,750 | 3,950 | 5,000 | 4,250 | 2,300 | 20,000 |
| $W_f$ | 000 $m^3$ | 1,750 | 2,750 | 3,950 | 5,000 | 4,250 | 2,300 | 20,000 |
| $R$ | % | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Design information | | | | | | | | |
| $P_p$ | US$ | 3,973 | 6,243 | 8,967 | 11,350 | 9,648 | 5,221 | 45,400 |
| $P_{f1}$ | US$ | 3,973 | 6,243 | 8,967 | 11,350 | 9,648 | 5,221 | 45,400 |
| $P_{f2}$ | US$ | 1,230 | 5,000 | 5,750 | 8,700 | 7,700 | 3,400 | 31,780 |
| $P_{f3}$ | US$ | 1,230 | 5,000 | 5,750 | 8,700 | 7,700 | 3,400 | 31,780 |
| $P_{f4}$ | US$ | 5,164 | 8,115 | 11,656 | 14,755 | 12,542 | 6,787 | 59,020 |
| $K_{s1}$ | | | | | | | | 1.00 |

| Indicators | Unit | Design month | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | April | May | June | July | August | September | |
| $K_{s2}$ | | | | | | | | 0.70 |
| $K_{s3}$ | | | | | | | | 0.70 |
| $K_{s4}$ | | | | | | | | 1.30 |
| $D_1$ | | 25 May | 25 June | 25 July | 25 August | 25 September | 25 October | |
| $D_2$ | | 01 May | 01 June | 01 July | 01 August | 01 September | 01 October | |
| $D_3$ | | 25 May | 25 June | 25 July | 25 August | 25 September | 25 October | |
| $D_4$ | | 15April | 15 May | 15 June | 15 July | 15 August | 15 September | |
| $F_1$ | day | -15 | -15 | -15 | -15 | -15 | -15 | |
| $F_2$ | | 0 | 0 | 0 | 0 | 0 | 0 | |
| $F_3$ | | -15 | -15 | -15 | -15 | -15 | -15 | |
| $F_4$ | | 15 | 15 | 15 | 15 | 15 | 15 | |
| $K_{t1}$ | | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| $K_{t2}$ | | 1 | 1 | 1 | 1 | 1 | 1 | 1.00 |
| $K_{t3}$ | | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| $K_{t4}$ | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| $K_1$ | | | | | | | | 0.85 |
| $K_2$ | | | | | | | | 1.43 |
| $K_3$ | | | | | | | | 1.21 |
| $K_4$ | | | | | | | | 0.88 |

*Note*: D – a date of payment for water services in the calculated period – a month

### Proposals for putting into practice

1. For mitigating the water crisis in Central Asia it is necessary to learn to manage water demand in the efficient manner;
2. According to the world practice, the most effective way to manage water demand is the method of economic incentives for water saving;
3. Economic incentives for water saving can be provided through transition towards water charging and improving the tariff policy;

4. Approaches to the adjustment of normative (basic) tariffs that are established by the government (at the main canal's level) or by the WUA general meeting are described in this publication with the purpose of initiating their discussion;
5. Under applying this approach, water suppliers and water users would have the economic incentives for water conservation and efficient use of water resources;
6. Water suppliers and water users should select the mutually acceptable approach and assume some rational and mutually acceptable limitations;
7. This approach to settling financial relations between water suppliers and water users can be used both at the main canal's level and the WUA's level;
8. The consensus is quite possible since the approach has attractive incentives both for water suppliers and water users;
9. This approach should derive encouragement from decision makers since it is directed at water conservation; and
10. This approach shouldn't be foisted on participants of the process of water allocation; on the contrary, it is very important to organize its discussion and improvement, taking into consideration their comments and wishes.

## 5.9. Capacity Building and Training are Key Tools for Implementing IWRM

**(P.D. Umarov)**

The capacity-building program complies with the fundamental provisions of the Regional Water Resources Management Strategy in the Aral Sea Basin [9] and IWRM. It encompasses the ICWC training system, along with strengthening the network of regional organizations and their subdivisions, establishment of regional and national information systems and communication facilities, SCADA, and developing the legal base for joint management of transboundary water resources.

Collection of information on modern world trends on development and improvement of the water sector practices and dissemination of this knowledge by conducting 'get-to-know' seminars, where the IWRM experience gained in countries such as Canada, France and Israel have preceded the popularization of IWRM in the region. The SANIIRI[53] experience, gained in the 1970s and 1980s by conducting regular scientific, practical and advanced training for water professionals from developing countries and providing technical assistance, within the framework program developed by the UN Economic Commissions for Africa, Asia and the Pacific, Latin America and Caribbean Basin etc., was very useful for this activities. At that time, the Regional Branch of All-Union Institute for Advanced Training of Water Professionals (for specialists from Central Asian countries, Kazakhstan and the Caucasus) was also established under the umbrella of the SANIIRI.

Reviewing the experience accumulated in our national water sector and comparing it with modern achievements of our foreign colleagues, one can state the fact that our science and practice undoubtedly were at sufficiently high level, although there were some shortcomings, for example, insufficient consideration of nature needs and the potentials of participatory approach in water resources management. Still, after the disintegration of the USSR and rupture of former links, with economic hardships faced in the course of transition towards the market economy, and lowered scientific and technical potential in the water sector in all Central Asian countries, the SANIIRI (already in the status of the SIC ICWC) continues the development of human resources. The young specialists familiar with modern methods of informatics, management, economy and legislation are being trained. At the same time, maintaining and developing relations with the International Commission on Irrigation and Drainage (ICID), UN Economic Commissions, UNESCO, FAO, CIDA, USAID, Mashav, NATO and other international agencies, the SIC ICWC has initiated the exchange of information and knowledge, including the organization of regional seminars in Tashkent and abroad.

[53] SANIIRI is the research institute under the Ministry of Water Resources of the USSR that serviced the irrigation and drainage subsectors.

This combination of the regional experience with international scientific and technical co-operation has promoted, to a considerable degree, the formation of the ICWC and development of the Aral Sea Basin Programs, GEF and Tasic projects. The Terms of References for these projects included the component of training and study tours for sectoral leaders to develop their own understanding of the needs of reforming the water resources management system along with the IWRM approach. Through these activities, public awareness on forthcoming water crisis, the necessary political support for the urgent necessity of introducing IWRM and transforming it into the state policy are being achieved.

The ICWC with its executive bodies (SIC ICWC, BWOs "Amu Darya" and "Syr Darya," and the Secretariat) has developed relations with international water communities. As a result, in 1996, the World Bank supported development of "*The Basic Provisions for the Development of the Regional Water Management Strategy in the Aral Sea Basin". In this document,* and for the first time, the need of implementing IWRM and as one of the key components of it, the 'program of capacity building for joint transboundary water resources management and development', has been developed and then approved at the governmental level.

In parallel with above, due to realization of the needs in regular advanced training courses for water professionals, a decision was made at the 21st ICWC Session (24.10.1998) to establish Training Center with the financial support from the Canadian International Development Agency (CIDA). Thus, since 2000 the five-year project: "The Water Resources Management Training Project in the Aral Sea Basin" was launched in the partnership with the McGill University and Mount Royal College (Canada). The ICWC Training Center has started its activities by the kick-off seminar with the participation of senior officers of the ICWC and its executive bodies in compliance with the approved plan of advanced training courses for senior water professionals. The training policy aimed at achieving the awareness of IWRM backgrounds by the senior policy makers, leaders of governmental and non-governmental organizations and other stakeholders involved in implementing the pilot projects at each level of the water management hierarchy was specified in the course of this seminar. During the initial stage, senior officers of appropriate ministries and departments, then managers of regional and basin water management bodies, and finally specialists of water agencies were step-by-step involved into the training process.


**Photo: Management of the SIC ICWC and ICWC Training Center together with the GWP Chair Mrs. Margaret Catley-Carlson**

The basic training strategy is the popularization of IWRM concepts and embedding them in the national action plans of reforming the national water sectors. Active participation of the leaders of national water sectors - ICWC members in the training courses has provided all-round support to social mobilization of water users and all stakeholders and the preparation of national IWRM action plans with the their follow-up approval by national governments. Such a training strategy was also aimed at raising the public awareness of the need in seeking inexpensive solutions and non-governmental funds for improving the water sector through developing new forms of institutions and public participation. All these actions have facilitated the advancement of IWRM and its recognition in national legal and normative documents.

A principle feature of these training activities were to ground the research findings of joint inter-state programs and various regional projects such as “IWRM-Fergana”, “IWRM Strategic Planning”, “Transition to IWRM in Lower Reaches of the Amu Darya and Syr Darya Rivers”, “Drainage Problems in Central Asia”, “Water & Education” “TWINBASIN”, “Central Asia Regional Water Information Base (CAREWIB)” etc. These research findings were used as case studies in lectures and presentations in the training courses. Regular upgrading the presentations, diversifying the seminars’ topics and improving training methods including the elements of situation modeling was also facilitated the co-operation with colleagues from the leading international universities and institutions, including the McGill University and Mount Royal College (Canada), IHE-UNESCO and ILRI (The Netherlands), Bonn University and Stuttgart University (Germany) etc. With the appointment of its Director, the regular information exchange between the membership of SIC ICWC and such international organizations as the ICID, WWC, INBO, IWRA, and GWP was established thanks to the support of such donor organizations as the CIDA, WB, SDC, ADB, USAID and as well as others who promotes solving these tasks. Mentioning the fact that establishment of the Regional Technical Advisory Committee of the GWP CACENA was also initiated by the director of the SIC ICWC and the kick-off seminar with participation of representatives of the GWP Secretariat was also held in the ICWC Training Center, is quite appropriate here.

Another feature of our training is the improvement of its efficiency due to decentralization through establishing the branches of the ICWC Training Center and covering greater number of water professionals. In Osh, for training specialists from the Fergana Valley’s provinces within boundaries of Kyrgyzstan, Tajikistan and Uzbekistan (with the support from SDC); in Urgench for training specialists representing provinces in the Amu Darya Lower Reach within boundaries of Turkmenistan, Uzbekistan and Karakalpakstan (with the support from CIDA); in Alma-Ata (with USAID support ) and in Bishkek (with ADB support). It is also planned to establish the similar branches in Dushanbe (for training specialists representing South Tajikistan and Syrkhandarya and Kashkadarya provinces of Uzbekistan) and in Kyzyl-Orda (for training specialists representing South Kazakhstan and North Uzbekistan).

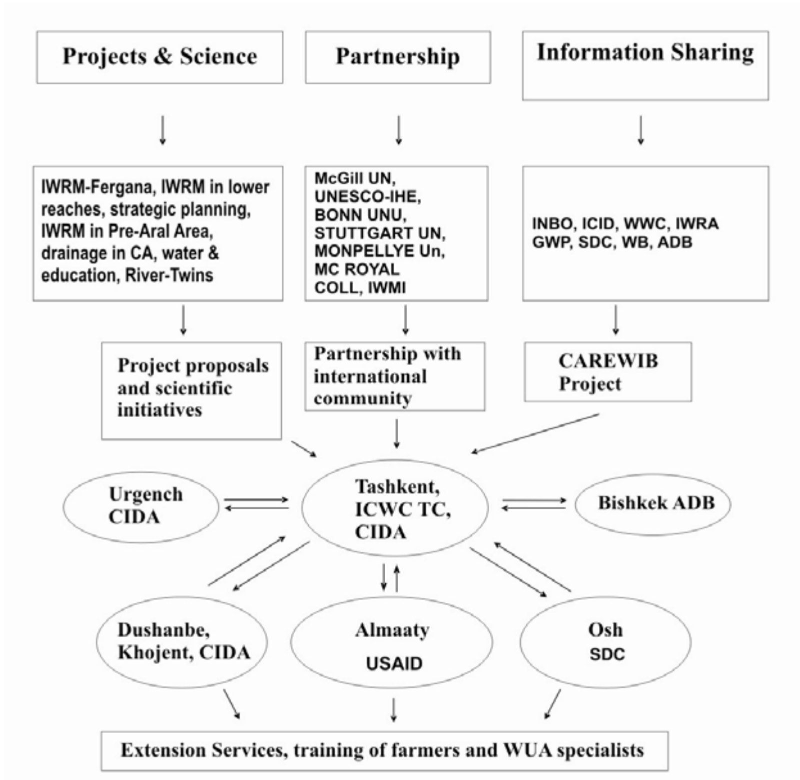


**Figure 5. 45 Dissemination of Water-Related Knowledge and Information**

Apart from the Osh Branch of ICWC Training Center, where seminars for training the specialists from Canal Administrations, provincial and district water management organizations and WUAs are held, the local training centers in Fergana, Andijan, and Khodjent were established in the frame of the IWRM-Fergana Project. In addition, the pilot training center on the basis of the pilot WUA "Akbarabad" was established in Kuva District of Fergana Province for training farmers and representatives of WUAs, community-based governments and village committees. Results of local training activities show that in order to improve the water use practice and water productivity the dissemination of positive experiences should be organized through the extension services. Therefore, further development of training activities requires the establishment of the special training points located directly on demonstration fields. In the framework of consultancy assistance, the trainers trained at higher levels of the training pyramid will be able to use these demo fields to train farmers to use up-to-date methods of water measurement and accounting, water applications and other technologies related to raising of water and land productivity.

***Interaction of the ICWC Training Center and its branches is organized in the following way:***

- Workshops for specialists of higher and middle levels and preparation of programs, workbooks and learning aids for the branches are conducted in the ICWC Training Center in Tashkent;
- Training of lower level's personnel of water management organizations is conducted in ICWC Training Center's branches by trainers who participated in preparation of programs of training courses and learning aids, using the network of project demonstration sites, database and the integrated information system of the ICWC Training Center.

Another important feature of activities of the Training Centre is the thematic seminars, involving representatives of related sectors. Topics of the training seminars are the followings:

**Photo: Professor Ch. Madromoto (McGill University) Opens the Regular Seminar Session at the ICWC Training Center**

- integrated water resources management;
- co-operation in transboundary river basins;

- water legislation and policy; and
- improving irrigated farming.

The specialists from ministries and departments of nature protection, energy and representatives of NGOs along with the water professionals from Central Asian countries attended the first two seminars. The representatives of Ministries of Foreign Affairs and Ministries of Justice from each country, who are engaged in the preparation of inter-state agreements and national legislation in the field of water economy and nature protection were invited to attend at the seminars on water legislation and policy that were held with participation of experts from the Great Britain (the Dundee University) and Israel (the Israel Center of Negotiations and Arbitration).

The training system in the ICWC Training Center, envisages the organization of monthly 7-day seminars for training 20 to 30 persons, in the equal proportion representing five countries. , And in between these seminars, additional trainings are conducted in the branches. Those are held by lectures (specialists from local water management organizations who were specially trained by the lead trainers from the ICWC Main Training Center) for similar numbers of participants.

The accepted interactive form of training based on up front dissemination of the tutorials and additional training documents, and organizing dialogues and discussions on current problems and tasks faced by the water sector under the leadership of experienced moderators (often the ICWC members), facilitates fellow feeling, openness and trust. Essentially, each regional training seminar turns into a “round table” for representatives of different countries and economic sectors where the “brainstorming[54]” encouraged by moderators and an appropriate topic of lecture promotes reaching the consensus in the region at the cross-sectoral and inter-state level. At the same time, the minutes with collective recommendations are drawn up at the end of each seminar is sent to all ICWC members for further dissemination and taking the measures for upgrading and improving the existing systems.


**Photo: Participants of the Seminar Held at the ICWC Training Center**

Establishment of an enabling environment for friendly contacts between specialists from different countries and economic sectors engaged in solving water problems during joint exercises and leisure-time is an additional achievement of such regional trainings. This is especially important because today’s participants

[54] intensive discussion to solve problems or generate ideas

of training courses are young people who in the nearest future can be leaders of local or republican authorities, large production associations and even economic sectors i.e. the policy makers.

Up to now, more than 2690 specialists have learnt such topics as IWRM principles and experience, water legislation, best irrigated farming practice, participatory approach, gender aspects of IWRM and others in the ICWC Training Center.

**Table 5.45 Training of Water Professionals: Number and Distribution over Countries**

| Country / Year | Kazakhstan | Kyrgyzstan | Tajikistan | Turkmenistan | Uzbekistan | Other countries | Total |
|---|---|---|---|---|---|---|---|
| 2000 | 9 | 11 | 11 | 6 | 12 | - | 49 |
| 2001 | 63 | 45 | 55 | 27 | 99 | 7 | 296 |
| 2002 | 76 | 71 | 60 | 28 | 104 | 5 | 344 |
| 2003 | 41 | 89 | 64 | 30 | 159 | 1 | 384 |
| 2004 | 73 | 85 | 74 | 38 | 227 | 1 | 498 |
| 2005 | 49 | 90 | 76 | 39 | 192 | 9 | 455 |
| 2006 | 70 | 85 | 84 | 28 | 386 | 15 | 668 |
| **Total** | **381** | **476** | **424** | **196** | **1179** | **38** | **2694** |

The ICWC training Center has established the special database with current information on each former participant of training courses to support feedback with them. This database is annually updated, taking into account all changes in their professional status and some of them are invited for jobs in our branches. Thus, specialists who were trained in the ICWC Training Center in Tashkent can train the lower level personnel of water management organizations, WUA and farmers using the program modules, methodological manuals and visual aids developed in the ICWC Training Center. At that, the efficient multi-step system, under which each trainee hands over his knowledge to his peers and lower levels (the domino principle), is established.

Information on the ICWC Training Center’s activities and also its recent and planned seminars is available on the website. For qualitative evaluating efficiency of these seminars’, let us review, for example, the advanced course on integrated water resources management attended by the overwhelming majority of trainees representing water professionals of top and middle levels of the water management hierarchy as well as water users and their associations. Raising their awareness on the significance and necessity of the water sector reforms through introduction of advanced principles of water resources management, prepared the enabling environment not only for implementing the IWRM-Fergana Project but also for the project of water resources management in the transboundary Chu-Talas basin, based on the participatory approach taking into account the interests of all stakeholders.

All these activities, in turn, have resulted, on the one hand, in widening the circle of like-minded persons and disseminating IWRM ideas as the single way for our planet to survive in the future and, on the other hand, in strengthening the partnership of water professionals for solving water problems. At present, the opportunities for introducing IWRM in the river lower reaches of the Amu Darya and Syr Darya, as well as in the Zerafshan River Basin are being reviewed according to the same principles.

Raising the awareness level in respect of IWRM and involving water management organizations’ personnel and water users in appropriate pilot projects have been promoted step-by-step. This has resulted in inclusion of these ideas into important legal documents, such as Water Codes of Kazakhstan, Kyrgyzstan and Tajikistan, the Law “On Water Users Associations” (Kazakhstan), the Decree signed by the President of the Republic of Uzbekistan “On Major Directions of Reforming the Agricultural Sector” and the Resolution of the Cabinet of Ministers “On Improving Governance of the Water Sector” (Uzbekistan).

Similar positive results were achieved in the cooperation related to joint management of transboundary water resources and developing water legislation and policy due to the advanced seminars with participation all stakeholders involved in activities of cross-sectoral conciliation commissions engaged in the preparation of inter-state agreements. The experience of seminars and their collective minutes undoubtedly confirm that countries located in the Aral Sea basin can successfully and efficiently solve the problems of water availability for irrigation and hydropower generation only based on effective mutually beneficial collaboration. Such co-operation should base on the principles of hydro-solidarity, mutual respect, consideration of all stakeholders’ interests, minimizing harm for the irrigation practice, hydropower generation, and the environment and using the existing potential under transition towards the market economy.

It is obvious that before, the separatist tendencies that impeded activities related to realization of agreements on information exchange and strengthening the regional executive agencies that were earlier signed by the ICWC members have dominated in inter-state water relations. Now, understanding of the need in consolidation based on the collaboration and readiness to revive activities of conciliation commissions is rising due to widening the circle of like-minded persons in appropriate ministries and institutions in each riparian country.

There are similar positive shifts related to the advanced courses on improving the irrigated farming practices. Those are creating the awareness that under water resources scarcity, the only solution to mitigate contradictions between supply and demand of water is demand management, based on the introduction of water-saving technologies. As a result, the awareness of opportunities for achieving potential water productivity, enable to increase agricultural output twice with reduced water consumption by 10%, is rising. This, in turn, stimulated the governments to allocate investments for establishing the network of demonstration sites that play a role of the extension services for farmers, WUAs and water management organizations and demonstration of latest methods of water conservation. In the course of the advanced training on water-saving technologies and raising water and land productivity, the need of involving women in solving these socially-significant tasks and developing the special program “Water, Gender Aspects and Agriculture Production Improvement” was revealed.

Series of seminars, with invited representatives of NGOs and mass media, was conducted to raise the public awareness. Trainees of these advanced courses, studied the current problems of the water sector and nature protection, including the peculiarities of reforming and democratization of the governance of water sector. Popularization of the importance of participatory approaches under the introduction of IWRM and water conservation practices is the only way of survival under the growing water resources scarcity is the important message conveyed through these training activities.

A series of seminars under the framework of ‘Water & Education Project’ that is supported by the OSCE and the Ministry of Education of the Republic of Uzbekistan was conducted to form the vision of the future generation of water consumers that should be oriented on care of water resources. IWRM basics are explained to school teachers at these seminars, in order to facilitate the integration of IWRM principles into school curricula.

The regularity is a key factor in the establishment of an efficient training system. It is important not only due to permanent personnel turnover at all levels of water management hierarchy but also due to update of knowledge and methods tested at pilot systems that should be disseminated among water users. Advanced courses on IWRM, therefore, for Heads of departments and divisions of the MAWR (committees, departments, central administration) should be held on a regular basis (no less than twice a year: prior to and after the growing season) in Tashkent, Urgench, Alma-Ata and Bishkek. In addition, the similar advanced courses need to be organized for chiefs of provincial water authorities and BISA, their deputies and heads of water use departments, representatives of local governments and WUAs’ specialists no less than twice a year in each province of Central Asian countries. These advanced courses should cover the following topics:

- institutional and legal aspects of improving the system of establishing WUAs, Canal Water Users Unions, and Water Users Groups;
- improvement of the water measurement and accounting systems at the level of WUA, WUG and CWUC; and
- Rehabilitation of irrigation and drainage systems and ameliorative measures on the fields.

Advanced courses for water professionals and capacity-building efforts in the water sector need to be developed along with upgrading the information system, introduction of the SCADA and creating the legal base for joint management of transboundary water resources. This was initiated in 1996, when the regional information system "WARMIS" and the database[55] on land and water resources with GIS component were established in the frame of the WARMAP Project[56] (the EU Tacis Program). This system is regularly updated and improved, with filling information along the following blocks: economy, surface water resources, groundwater, land resources, climatic data, industry, administrative-territorial system, the ecological aspects of the Aral Sea and Pre-Aral area. At present, this activities is in progress with financial support from the SDC in the framework of the project "Central Asian Regional Water & Environment Information Base (CAREWIB)". The project has created a web-portal for water and environmental issues in Central Asia ("CA Water-Info") and the regional information system including the knowledge database. This database with a GIS component, information block of Hydro-Meteorological Services with data on river flow rates, BWO block with data on sharing water resources in river basins, and analytic block with a set of modules and models for assessing current water availability and forecasting annual and mean annual water availability. The project is aimed at capacity building of water management organizations through their involvement in the relevant network operations. They are actively interacting at the regional, basin and national levels through establishment of national information systems linked to regional, basin and national databases. At the same time, in order to maintain the sustainable operation of the CAREWIB, the advanced courses are conducted for the specialists, who services the national information systems. They flow through the introductory course on the unified methodological base of building-up the information system. At the end receive the software and existing data on their countries and provinces, as well as the follow-up transfer of data for the purpose of supporting and developing the national databases. In return, provide regular information exchange and filling the regional database with appropriate data. Coordinated actions of specialists at all levels of the water management hierarchy and free access to information for all stakeholders will undoubtedly facilitate capacity building of the water sector and successful introduction of IWRM in the region.

The establishment of systems of control and data acquisition (SCADA) at water intakes of inter-state importance, was initiated on waterworks serviced by BWO "Syr Darya" with the financial support of the USAID, and now is implemented on pilot main canals of the IWRM-Fergana project and funded by the SDC. This system equipped with electronic means of accessing, storing, and transferring information allows preventing not only uncontrolled water diversions from the river but also raising the accuracy of water supply (up to 2% instead of 10% in the past) and reduces unproductive water losses. In addition, the integrated complex of automated transmition of technological information ensures free access to information by all stakeholders. The daily updated actual data on flow rates and water levels at all waterworks serves as a confidence-building measure in the process of joint water resources management. The special training seminars are held in the ICWC Training Center, its branches and directly at waterworks equipped with the SCADA systems for specialists responsible for operation of these systems to improve their professional skills. The introduction of SCADA system on waterworks serviced by BWO "Amu Darya" is planned in the nearest future with the support of ADB.

Developing the legal base for joint management of transboundary water resources was also initiated under the framework of the WARMAP project that enabled the preparation of drafts of four agreements regulating the institutional set-up, information exchange, water use and nature protection. Authorized national working groups consisting of representatives from different economic sectors were established and they work on continuing basis provids the continuity to this activities of improving legal base of regional cooperation. In parallel, activities on improving the national water legislations, by means of including the

[55] The WARMIS Database is a relational database, consisting of tables with text data. The database contains information on water and land resources and their use, climate, economic indicators, and water quality.
[56] Water Resources Management and Agricultural Production Project

provisions that regulate the introduction of IWRM as a key tool to raise water productivity at all levels of water use was initiated. At present, this activities is supported by the ADB and implemented through the project: «Improvement of Shared Water Resources Management in Central Asia» (ADB RETA 6163) that is aimed at developing the program of legal and institutional measures for capacity building of inter-state water co-operation in the Aral Sea basin. As a result of this activities the drafts of agreements were developed and then discussed at regional workshops, covering the following aspects: i) information exchange; ii) strengthening the ICWC status; iii) joint use of water and hydropower resources of the Syr Darya River; and some separate regulations and rules of river basins management.

Inclusion of the findings of all abovementioned projects into workbooks of the ICWC Training Center creates the closed cycle of continuous self-improving the established training system and the continuity of capacity building process.

In the process of capacity building it is necessary to extend the subject area and to involve specialists from related economic sectors such as hydropower generation, drinking water supply, nature protection, hydro-meteorological services into activities related to improving water governance and ensuring rational use of water resources. At the same time, it is necessary to organize the special seminars aimed at preparing the base for public participation in IWRM and establishment of network of NGOs interacting with the water authorities in each Central Asian countries. There is a need to conduct training courses on management of water and environment projects, including such aspects as preparing for economic reforms, improving agricultural production, developing fishery in irrigation systems. In addition, the scope of activities should be extended to works related to the training programs of international development agencies and financing institutions.

Thus, the established system for capacity building of the water sector assists water professionals to study the world experience, to project the path “from the vision towards the action”, to screen priorities, to reach the new quality levels using the state-of-the-art systems of computerization and informatics, as well as internet resources. Along with raising the level of professional knowledge and acquaintance with state-of-the-art technology in the field of water and land resources management, irrigation and drainage and environmental protection, the established system of training facilitates, the strengthening of cooperation between riparian countries and development of the common approaches at the level of technical experts and policy makers. Hence, the ICWC Training Center, being the champion of state-of-the-art technology in the field of water and land resources management, also becomes the platform for strengthening the regional cooperation in practical implementing IWRM at the level of irrigation systems and river basins in coordination with national priorities, balancing national needs with regional limitations.

## 5.10. Gender Aspects of IWRM

**(G.V. Stulina, D.R. Ziganshina, Sh.Sh. Mukhamedjanov)**

Water is an economic, social and ecological good granted for the welfare of all the people without any exception. Considering the IWRM systems, the UNDP links water with four key areas of activities: i) struggle against poverty; ii) life support; iii) environmental protection; and iv) gender equality. A community consists of individuals and groups with different rights, welfare, power and abilities to express their needs and rights; and this fact should be taken into consideration while managing water resources.

As a rule, the extent of participation, interests, priorities and responsibilities of women and men are different in the governance of water resources. There are also gender differences in access to water resources and in water rights. Gender inequalities of women and men are evident in terms of knowledge and various experiences in such areas as water services, water policy and water availability. Any initiative in the water resources management sphere needs to be assessed concerning its impacts on women and men in order to understand clearly all the effects and to avoid negative consequences. Mainstreaming gender in IWRM strategies and plans has three key entry points [2]:

1. While developing new initiatives and programs, it is necessary to carry out a good gender analysis to specify the differences in their perceptions by women and men. Ideally, both women and men should be involved in carrying out the gender analysis;

2. Based on findings of this analysis, all initiatives have to take into account perspectives, needs, and interests of both men and women; and to promote a more active role of women to reduce the level of gender inequality, if possible;
3. It is necessary to use participatory approaches, facilitating the equal participation of women and men in water resources management, especially at the level of decision-making.

### *Key provisions of the gender theory*

The gender theory has originated from social sciences more than thirty years ago and, by now, spread all over the world. One of its fundamental provisions is differentiation in applying such terms as “sex” and “gender”. In social sciences, the term “sex” refers to the biological -anatomic structure of a human being. At the same time, the term “gender” is used to specify differences between male and female social roles and their emotional characteristics that society prescribes to people according to their sexual distinctions. A hierarchical structure that considers a male as the dominating factor and a female as the subordinated factor underlies gender differentiations. As a result, both men and women are “victims” of the traditional system of social norms and stereotypes. It is necessary to remind that gender relations may be quite different in various cultures; and as our survey has revealed, relations between women and men in countries under consideration are drastically different. It follows from this that gender is the cultural, social, and historical concept, and at the same time, gender relations are inter-changeable in time. This is not a rigid framework into which willy-nilly we have to squeeze ourselves in, obeying its rules; however, this is the system, which needs to be changed, if it has become out-of-date and does not meet demands of the times. The gender theory and methodology provide to scientists new analytical tools for investigating society and enables them to discover social and cultural mechanisms that form gender disparity in traditional society. However, the fundamental values necessary for development of countries and their residents independently of gender differentiation encompass the following concepts:

***Freedom:*** Men and women have equal rights to prosperous life and parenting of children without fearing famine, violence, oppression, and inequity. The democracies, based on people’s will, ensure these rights in the best way.

***Equalit:.*** No human being in the country has to be deprived of the opportunity to use advantages of democratic development. Men and women should be provided with equal rights and opportunities.

***Tolerance:*** Given all, there are many religions, cultures, and languages, which people have to respect by each other. One should not fear or suppress differences between people; vice versa, it is necessary to keep them for future generations.

***Respect to nature***: Prudence should be displayed in all aspects including the attitude towards natural resources (water and land). Only in this manner, we can preserve and hand over immense wealth granted by nature to our descendants. Out-of-date and inefficient production and uses should be eliminated in the interests of our descendants.

***Responsibility:*** Responsibility for managing economic and social development in countries.

### *Gender analysis carried out in the water sector in Central Asia and the Caucasus*

In 2005, with the assistance of GWP CACENA, the researchers from Kazakhstan, Tajikistan, Turkmenistan, Kyrgyzstan, Armenia, Azerbaijan, Georgia, and Uzbekistan took part in a study monitoring gender equality aspects in countries of Central Asia and Caucasus [2]. The researchers were authorised to select specific regions within their countries, which would ensure the representative sample of all types of household management (in private farms, agricultural cooperatives (shirkats), family (dekhkan) farms etc.). The gender survey was conducted in the form of filling the questionnaires by interviewers based on answers of owners and members of rural households.

Data of questionnaires were entered into the database and then analyzed. With results of these analysis, reports that reflected the current situation with respect to gender relations were prepared for each country.

The population in the regions under consideration, to a greater or lesser extent, is aware of real problems faced by women rather than the gender theory. Men's views on these problems differ from those of women. In other words, the question how "an oriental man" treats gender problems and whether he is ready to be at the one social level together with a woman remains traditionally topical. Traditionally, many explain the difference in social status of men and women and disparity in their rights through biological reasons. However, the analysis of historical, ethnographic, and cultural facts reveals that major causes of antithesis of women and men are social ones, i.e. norms of behavior established (designed) by society. Therefore, these social and cultural norms are in the focus of our studies, which were conducted in rural areas, where mentioned traditions are the most conservative. We attempted to review whether society deals with men and women in different ways, and why they have unequal opportunities for self-realization in public and personal spheres despite the fact that the equality is legally recognized in all legal documents adopted by the states. However, religious principles, centuries-old traditions, and way of life in countries under consideration, primarily presume the gender disparity with respect to the female population in these countries. Georgia is the only exclusion to the general rule, where the attitude toward women always differed from generally accepted norms in the oriental countries.

Mentioned problems are aggravated by economic hardships that limit the financial stability of men and women, and, in addition, restricts women's access to control their own livelihoods. However, there is no doubt that poverty affects men and women in different ways. The quality, composition, and quantity of food consumption as well as access to good education and qualitative medical services may be indicators that reflect the poverty rate. People who legally have various rights, do not have any opportunity to use them without economic support. The high unemployment in countries under consideration, including the latent unemployment caused by domestic circumstances, has baneful consequences for women. Women make up about two-thirds of the total number of unemployed and those who are working are basically engaged in unpaid or low-paying occupations. Underemployment remains the critical and real indicator of poverty in the countries. Women are the especially vulnerable group since they are engaged in low-paying and temporary works. Gender challenges in the field of labor and employment also can depend on the current legislation on women's social security, which very often limits entrepreneurs' who wish to hire women. Conditions of employed women are also problematic since they are being engaged in the economic sectors, where traditionally wages are low: public health and education. Even greater problems exist in the agricultural and informal sectors where labor of women is practically not protected by the state in the form of social guarantees, and therefore there is high likelihood for violation of human rights and for wrongful exploitation of women labor.

Gender disparity in the field of employment is observed at all hierarchical levels. Existing gender disparity restricts access of women to specific economic sectors and their professional promotions. The likelihood to find a proper job is very low; usually this is low-paid, low-skill, and seasonal work. Currently, the number of women seeking jobs at informal labor market is considerably increased in the region.

It is necessary to note that women actively participate in agricultural production. Rural women are mainly engaged in producing agricultural outputs for provision of their own families and for sale. Therefore, they are concerned with problems of marketing for their agricultural products, of its hauling, and prices. Banks unwillingly grant credits on the security of property preferring to deal with entrepreneurs that already have profitable farms, and these are usually men.

Rural women have less time for marketing activities, less access to agricultural knowledge, and less professional skills in order to establish their own businesses. Reforms of the rural sector, privatization of agricultural enterprises, and establishing private farms are implemented without due participation of women because of their low representation in local governments and the lack of funds and skills for rural entrepreneurial activities. Taking into account these aspects, we would like to recommend developing programs on financing and training, which are targeted at women-farmers, or women, who wants to become entrepreneurs.

The curriculum on gender issues is valuable for students and teachers at colleges of social sciences and secondary schools, because it covers both discussion and analysis of problems, which affect each of us: a person and his relations with the world, freedom and its limitations, differences between people and the need for observing equal rights (despite differences), marriage, the family, relations between spouses and children, traditional and democratic values, and many other things. In other words, the gender curriculum should be aimed at: (i) development of social responsibility of each person; (ii) forming of the system of humanitarian values and sense of equity; and (iii) protection of human rights. The idea of equal secondary education for girls and boys is supported by less than 40 percent of women; at the same time, 60.7 percent of women speak in support of different curriculums depending on gender. Most male and female respondents consider that such subjects as mathematics, physics, technical and legal knowledge, and sports are more important for boys, at the same time, such subjects as housekeeping, history, literature, ethics, psychology of the family life, and sexual education are more important for girls. Based on traditional stereotypes with respect to roles of women and men, the adults themselves who suffer from gender disparity unknowingly bring up their children in the same spirit. Schools often follows this path. It is necessary to stop this process and to propose people a new democratic outlook.

Therefore, the need in changing consciousness of men and women is extremely topical today. None of the respondents pointed gender equity as a social value. However, any social changes are starting with shift in consciousness.

The analysis [2] has shown that certain discrimination of rural women that becomes apparent, in principal economic dependence from their husbands and other members of the family, takes place practically in all Central Asian countries. As was mentioned, only 7.6 percent of women in countries of Transcaucasia and 3.2 percent of women in Central Asian countries possess the right to manage the family budget independently. And, most women cannot spend money earned by themselves at their own discretion. A negligible amount of women has received access to land resources for establishing a farm as a proprietress. Discrimination of women is observed in the increase of unrequited labor on garden plots; in addition, the low level of utility services negatively affects women negatively by increasing their physical inputs. Mass involvement of women in agricultural works in farms of Tajikistan, Uzbekistan, and Turkmenistan is seasonal, and at the same time they carry out the most labor-intensive and low-paid works.

The survey revealed that a share of women having higher and special secondary education amounts to 14.8 percent of all women in Central Asian countries. However, most women are engaged in low-paid budget sectors, and therefore, according to data of the survey, the gender gap in input to the family budget makes up 55 percent in the CAR. Neglecting personal interests owing to fear of loosing the opportunity to work and earn money, women agree to be engaged in low-status and low-skill occupations without opportunities to upgrade their professional skills.

There are certain obstacles for developing business undertakings among women. An overwhelming number of women-entrepreneurs operate in the field of small retail trade without access to infrastructure, systems of credit and transport services. Therefore, they have to sell small lots (of goods), in general, (this is quite a labor-intensive occupation taking into account remoteness of markets) only to satisfy the momentary needs of their families. Both men and women treat positively to the development of female business, although men are more cautious in their assessments. Respondents mentioned the following causes that impede active involvement of women to private business (in descending order):

- lack of money to start-up businesses;
- bureaucratic barriers;
- lack of specialized knowledge and education;
- lack of professional skill for business management; and
- restricted access to education.

Dynamic revival of such traditions as early marriages and isolated life, and declined prestige of education has resulted in decreasing a share of female students in higher education institutions and colleges. In turn, this has resulted in low representation of rural women at the high-skill labor markets in the regions. It is necessary to note that basic concerns for children and aged people lie on "women's shoulders", and, in turn, increase workload on women and do not enable them to use existing opportunities for self-realization and self-perfection. This analysis has sufficiently supplemented the earlier studies related to evaluating the gender situation.

On the initiative of the project “Adaptation to Climatic Changes” that is jointly implemented by the SIC ICWC and McGill University (Canada), the study “Gender Aspects of Water Resources Management” was undertaken in pilot districts in Uzbekistan, Kyrgyzstan and Tajikistan to specify the vital problems in private farms in various areas including public health, education, culture, access to resources, employment, income-generating activities etc. Gender problems related to access to and management of water resources were analyzed. Gender inequalityin such areas as the rights on land use, access to water, control over resources, participation in governance of water resources in the agricultural sector, access to markets and commercial services is obviously observed in the water and agricultural sector. A substantial target of this study is also the collection of reliable information on basic issues of gender disparity.

On the initiative of the GWP CACENA and ICWC, in 2004, with the Business Women Association (the Kokand Branch, Uzbekistan) using PRA methods conducted a field survey and analyzed gender problems in the water and agricultural sector in the region (in Kuva District of Fergana Province). The general conclusion from this study is that problems of rural women, such as access to water, land, financial, and material resources and to education and culture, are topical and it may be considered that most of rural women are restricted in realizing their opportunities. Findings of our gender survey testify that revision to the social policy, in respect to rural women should be done. It is necessary to initiate a transition towards practical implementation of tasks aimed at decreasing the level of gender discrepancy.

This gender survey has shown that redistribution of gender roles in the family take place in the rural areas. Men are losing the status of “bread-winners”; at the same time, search for job forces many rural inhabitants to leave their households for other regions. All these factors considerably affect the social stability and result in imbalance within households and families. The status of rural women is aggravated by greater workload resulted from non-paid housekeeping labor and traditional possession of many children. A few major factors that strengthen the rural women’s vulnerability were specified, and among them the following:

- “the time deficit” due to intensive and non-payable housekeeping labor that restricts considerably the women opportunities;
- the lack of proper conditions of life (running water, power cut, and irregular gas supply) that aggravates the problem of housekeeping;
- as long as women, in considerable less extent, occupy leading management positions in the agricultural sector, they have less organizational skill. At the same time, the gender survey has shown that women are more active in comparing with men in matters of introducing a new agricultural practice and principles of self-organization;
- the low level of representation of women in local governments predetermined the fact that rural women did not practically participate in privatization of enterprises;
- agricultural activities presumes the greater participation of women. At the same time, women are engaged in low-paying and low-skill works with the low level of labor efficiency;
- women have to spend more time on their garden plots to supply foodstuff to their families. Output produced in households due to the lack of machinery, insufficient funds, undeveloped market and sale system does not generate any income. It means that women are mostly busy in producing non-marketable agricultural products;
- traditional views on gender-based social roles negatively affect social and income-generation activities of women in the rural regions. Incidents of family violence with respect to women take place.
- increase in the workload on women that is related to up-bringing of their children due to decline in the social security and the number of nursary schools; along with children, disabled workers, war veterans and pensioners are major consumers of social services.
- the low level of access to education and in this connection the lack of professional skill do not promote women to be more active at the labor market; and

- limited opportunities for proper leisure and entertainment due to the lack or non-functioning rural cultural centers.

## Gender Aspects of the IWRM-Fergana Project

One of the IWRM tools is social mechanisms. This includes i) training of younger generation; ii) involving water users and other stakeholders in water resources management; iii) training water users and other stakeholders; iv) public participation; v) partnership of governmental and community-based organizations; vi) establishing good relations between stakeholders and WMOs; vii) use of traditions and public experience; viii) water ethics; ix) social mobilization; x) guarantees of water supply to the poor; and xi) public awareness. Each of above mentioned mechanisms should be reviewed from the gender aspects.

Gender analysis implemented under the IWRM-Fergana Project has shown that yet there is gender imbalances in water resources management (Table 5.45).

There were 2157 people participated in the trainings and seminars, out of which only 166 were women. Following was the gender distribution over the training components: i) water distribution on pilot canals – 520 men and 52 women; ii) WUAs' activities – 373 men and 17 women; iii) farm practice – 1047 men and 91 women. A percentage of women, who have attended the training seminars amounts to 7% on average. This percentage is ranging from 3% to 12% over the countries (Figure 5.46).

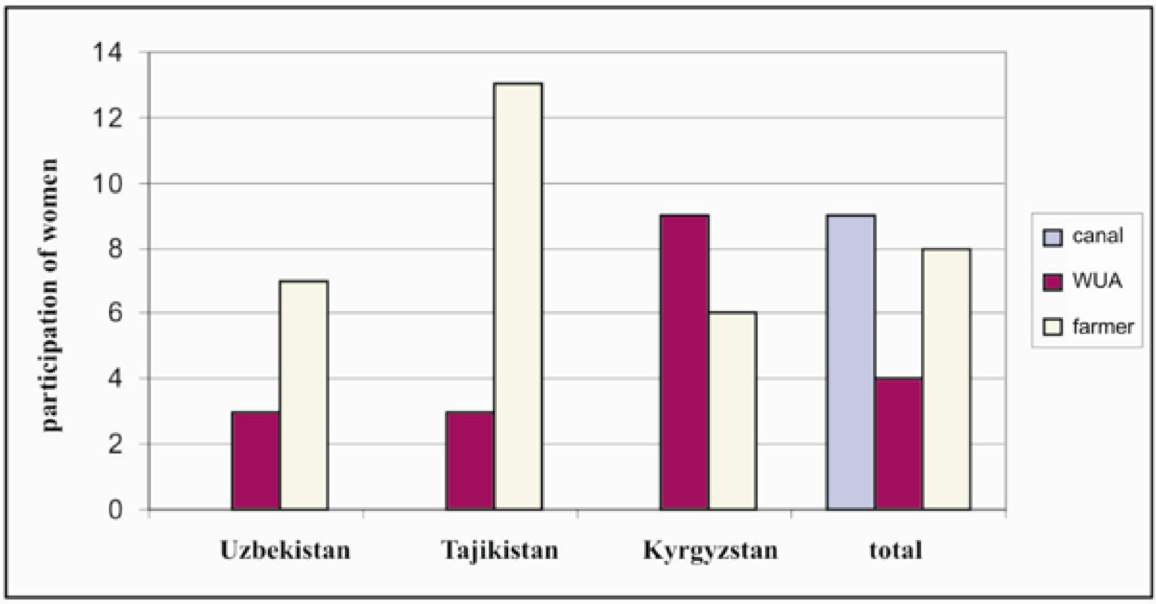


**Figure 5.46 Participation of Women in Training Activities of the IWRM-Fergana Project**

However, it is necessary to note that the level of women's business activities is rising in rural areas; and women-leaders are appearing. For example, Mrs. Masturkhon Sayfutdinova is the chair of the Canal Water Users Council that was established for the first time in Central Asia. Such leaders, having the considerable experiences in agriculture and governance, crush the social stereotypes of perception of women as housewives who do unskilled works in a field. Changing social conditions force many women to manage their farms without any assistance. In Uzbekistan, for instance, women head 17,000 out of 212,000 private farms. Their social activeness should be supported by raising their gender awareness and professional development.

In the Akhunbabaev District of Fergana Province in Uzbekistan, about 10% of the executive positions, such as Deputy Khakim of the District, chief editor of the daily newspaper, municipal chief engineers, chief bookkeepers, are women. Women make a considerable contribution into the family budget. Taking into account that income from smallholdings amounts to 19% of the total, this share of incomes can mainly be referred to as result of female labor.

In Jabbar-Rasulov District in Soghd Province, women are mainly responsible for the potable water supply since only 14% of households have running water in their courtyards. Other 86% of residents carry water using bicycles and handcarts or buckets. Out of these women provide 95%. It would be interesting to know what the right to distribute water in households belong to women (82.9%), at the same time, in private farms – only 9.7%! However, at present, due to considerable migration of men for labor (migrant workers), the number of women playing the role of irrigators and water managers has drastically increased.

### *Measures recommended providing gender equality in Center Asia*

The gender survey enabled us to make a conclusion that discrimination of rural women in access to water resources and water management negatively affect the general social status of women. To improve this situation it is necessary to implement a complex of measures, including the following actions:

1. Conduct training courses covering matters of water use and management for the groups consisting mainly of women. The curricula for these courses should include learning water-saving technique and methods of water management;
2. promoting establishment of water users' groups, at the same time, women who participated in the training courses should be initiators of establishing water users' groups (WUGs), and their major actors;
3. conducting the campaigns that popularize the ideas of establishing rural WUGs, practical application of water-saving technologies, installation of water-metering devices etc.;
4. supporting initiatives, which facilitate protection of water sources from pollution, their development and improving their sanitary conditions; and
5. Organizing workshops for exchanging experiences in the field of water use with invited water professionals and representatives of the regions where WUGs were already established and successfully operate.

It is necessary to promote formation of budgets seeking additional financial resources for social aid to rural residents. Rural women should be considered as a specific target group. At the same time, it is necessary to take into account diversity of social groups living in specific regions and conditions of their life, and closely cooperate with activists of non-governmental organizations created in the regions, whose activities address gender issues.

There is a need for Gender Study Centers, the purpose of which will be promotion of public awareness with respect to gender issues, dissemination of knowledge produced by social and humanitarian sciences regarding gender aspects, developing the gender curriculum for educational institutions, as well as implementing the gender educational programs and pilot projects.

At present, the website "Gender and Water" on the Internet portal "CAWATER" and the project "GWANET" (the Central Asian Gender and Water Network) that was initiated by the SIC ICWC and financed by the ADB, with the purpose of establishing informal network for disseminating knowledge, analyzing gender situation in the water sector and to forward problems and proposals to decision-makers can be considered as a substantial progress in raising awareness on this topic in Central Asia.

## Gender Balance

| Indicator | Country | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Uzbekistan | | | Tajikistan | | | Kyrgyzstan | | | | | |
| | **male** | **female** | **total** | **male** | **female** | **total** | **male** | **female** | **total** | **male** | **female** | **total** |
| Project personnel | 104 | 11 | 115 | 24 | 1 | 25 | 23 | 2 | 25 | 151 | 14 | 165 |
| Training participants: | | | | | | | | | | | | |
| Topic: CC activities | | | | | | | | | | 520 | 52 | 572 |
| Topic: WUA's activities | 231 | 8 | 239 | 69 | 2 | 71 | 73 | 7 | 80 | 373 | 17 | 390 |
| including: | 8 | - | 8 | 2 | - | 2 | 1 | - | 1 | 11 | - | 11 |
| *Council Chairman* | 54 | 1 | 55 | 3 | - | 3 | 7 | - | 7 | 64 | 1 | 65 |
| | - | 1 | 1 | - | - | - | 5 | - | 5 | 5 | 1 | 6 |
| *WUA director* | 106 | 1 | 107 | 32 | - | 32 | 29 | 1 | 30 | 167 | 2 | 169 |
| *WAG leader* | | | | | | | | | | | | |
| *WUA members* | 40 | 3 | 43 | 16 | 2 | 18 | 15 | 6 | 21 | 71 | 11 | 82 |
| | 586 | 40 | 626 | 235 | 37 | 272 | 226 | 14 | 240 | 1047 | 91 | 1138 |
| *WMO* | 30 | 4 | 34 | 10 | 1 | 11 | 11 | 1 | 12 | 51 | 6 | 57 |
| Topic: Activities at the farmers' level | | | | | | | | | | | | |
| TC of the SIC | | | | | | | | | | | | |
| Board composition of the CWUC | 6 | 1 | 7 | 5 | 0 | 5 | 7 | 0 | 7 | 18 | 1 | 19 |
| Composition of branches' boards | 62 | 2 | 64 | | | | | | | | | |

## The IWRM-Fergana Phase-III Project: Component «Pilot Canals»

*I. Composition of Project Team*

| No | Specialists | Number of members | Incl.: women |
|---|---|---|---|
| 1 | Regional group | **13** | **2** |
| 2 | Local groups (total):<br>including:<br>- in SFC command area<br>- in AAC command area<br>- in KBC command area | **34**<br><br>19<br>8<br>7 | **4**<br><br>2<br>1<br>1 |
| | **Total:** | **47** | **6** |

*II. Composition of Training Seminars' participants*[57]

| No | Year | Number of participants | Incl.: women |
|---|---|---|---|
| 1 | 2005 | 53 | 4 |
| 2 | 2006 | 264 | 31 |
| 3 | 2007 | 255 | 17 |
| | **Total:** | **572** | **52** |

*III. Composition of Boards of the Canal Water Users Unions*

| No | Pilot Canal | Number of members | Incl.: women |
|---|---|---|---|
| 1 | SFC | 7 | 1 |
| 2 | AAC | 7 | |
| 3 | KBC | 5 | |
| | **Total:** | **19** | **1** |

[57] Since May 1, 2005 until September 15, 2007

### *IV. Composition of Branches' Boards of the SFC Water Users Union*

| No | Hydro-operational site | Number of members | Including: women |
|---|---|---|---|
| 1 | K-1 | 5 | |
| 2 | Aravan | 7 | |
| 3 | Khamza | 7 | |
| 4 | Besholish | 9 | |
| 5 | Margilan | 5 | |
| 6 | Fayzabad | 7 | 1 |
| 7 | Palvantash | 5 | |
| 8 | KFC | 7 | |
| 9 | Akbarabad | 7 | 1 |
| 10 | Shalhrikansay | 5 | |
| | **Total:** | **64** | **2** |

# CHAPTER VI
# PROSPECTS OF IMPLEMENTING IWRM IN THE REGION

## 6.1. Developing the National Water Policy

**(V.I. Sokolov, V.A. Dukhovny)**

The World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 called upon all countries to adopt integrated water resources management and water efficiency strategies by the end of 2005 particularly, in support of developing countries. Although the concept of integrated water resources management was repeatedly discussed at many international conferences in 1990s and in the beginning of the 2000s, the crucial step towards IWRM was made at the abovementioned World Summit, where the special directive was adopted with the following provisions [31]:

**«Develop IWRM and water efficiency plans by 2005, in support of developing countries, through actions at all levels to:**

a) Develop and implement national/regional strategies, plans and programs with regard to integrated river basin, watershed and groundwater management and introduce measures to improve the efficiency of water infrastructure to reduce losses and increase recycling of water;

b) Employ a full range of policy instruments, including regulation, monitoring, voluntary measures, market and information-based tools, land-use management and cost recovery of water services, without cost recovery objectives becoming a barrier to access to safe water by poor people, and adopt an integrated water basin approach;

c) Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving of ecosystems and their functioning;

d) Develop programs for mitigating the effects of extreme water-related events;

e) Support the diffusion of technology and capacity-building for non-conventional water resources and conservation technologies, to developing countries and regions facing water scarcity conditions or subject to drought and desertification;

f) Support, where appropriate, efforts and programs for energy-efficient, sustainable and cost-effective desalinization of seawater, water recycling and water harvesting from coastal fogs in developing countries through such measures as technological, technical and financial assistance and other modalities;

g) Facilitate the establishment of public-private partnerships and other forms of partnership that give priority to the needs of the poor, within stable and transparent national regulatory frameworks provided by Governments, while respecting local conditions, involving all concerned stakeholders, and monitoring the performance and improving accountability of public institutions and private companies.

**The WSSD Directive gives five clear indications [31]:**

1. Countries have to transform IWRM principles into the action plan;
2. Countries have to complete the IWRM action plans by the end of 2005;
3. All countries should prepare the action plans; whether they are rich or poor, and whether they have excessive available water resources or water deficit;
4. Support to developing countries in preparing the action plans should be provided;
5. A content of these plans should be comprehensive, covering institutional, financial and technological aspects.

What the WSSD Directive actually means? This is only the preparation of the national action plan or the first step on the long way of institutional reforms, or everything taken together? What is a practical value of preparing the IWRM plan? How this plan will correlate with everyday activities aimed at promotion of national economic and social development?

In order to answer all these questions, each country in our region has to develop its own concept of preparing the national IWRM plan, as a minimum.

## Organizing the process of national IWRM planning

***The national plan of implementing IWRM should include, as minimum, the following key components:***

a) analysis of the destabilizing factors and their influence on social and economic situation;
b) general status of IWRM within the country and its specific aspects in some areas;
c) IWRM action plans both at the national and basin level; and
d) mechanisms of introducing IWRM

A diagram of IWRM planning process for the river basin is given in Figure 6.1 below, representing the logical sequence of necessary phases and measures, as well as public participation stages. In addition, the sequence of implementing the key IWRM principles is demonstrated in the right part of this diagram. IWRM introduction plans have to be aimed at the followings:

- establishing the certain institutional framework at the national and basin level, and co-ordination of all water resources management organizations over horizontal cross-sectoral links and over vertical links between hierarchical levels of water resources management;
- joint management of all available water resources (surface, ground and return water);
- integrating water and land resources, irrigation and drainage systems and correspondingly water and drainage management organizations, and the latter with water users and land owners;
- accounting and satisfying the water demand in social and economic spheres;
- specifying ecologically permissible water diversion from rivers;
- measures for water conservation;

- establishing databases and the information network in the basin organizations, covering not only information on water resources but also on all factors affecting water resources management and use, as well as economic, social, and environmental impacts on water users and nature; and
- prioritizing the social mobilization of water users and water management organizations and involving them in IWRM activities as driving force of IWRM introduction

***In addition, the base of national IWRM plan should consists of three components:***

- plan of technical improvements in water use and water demand management;
- plan and the institutional framework for training all water stakeholders; and
- plan of establishing pilot projects in all specific areas

## 6.2. The IWRM Introduction Process and a Role of Strategic Planning

Putting IWRM into practice is the quite complicated process, which, first, should involve scientists, water practitioners, policy-makers and their planning agencies that are preparing the important decisions, and water users, taking into consideration the complicated system of their relations and links. When and how to start the IWRM planning depends on the following key prerequisites:

- the appropriate level of public awareness concerning the need of radical changes to the existing approaches of water supply to the population and nature;
- specialists of water management organizations and conservancies, as well as scientists working in such areas as economy, ecology and social development should be familiar with the IWRM experiences all around the world particularly, in countries with similar conditions and recognize the need of introducing IWRM in their own country as the path of solving painful problems. They have got the opportunity to disseminate this experience in their own country and to raise the public awareness concerning the advantageous effects of the IWRM introduction; and
- government agencies and policy-makers in various public authorities (parliaments, ministries, and provincial administrations) should be ready to establish the “governance” system that was described in Chapter 2, which will be aimed at developing the national IWRM framework

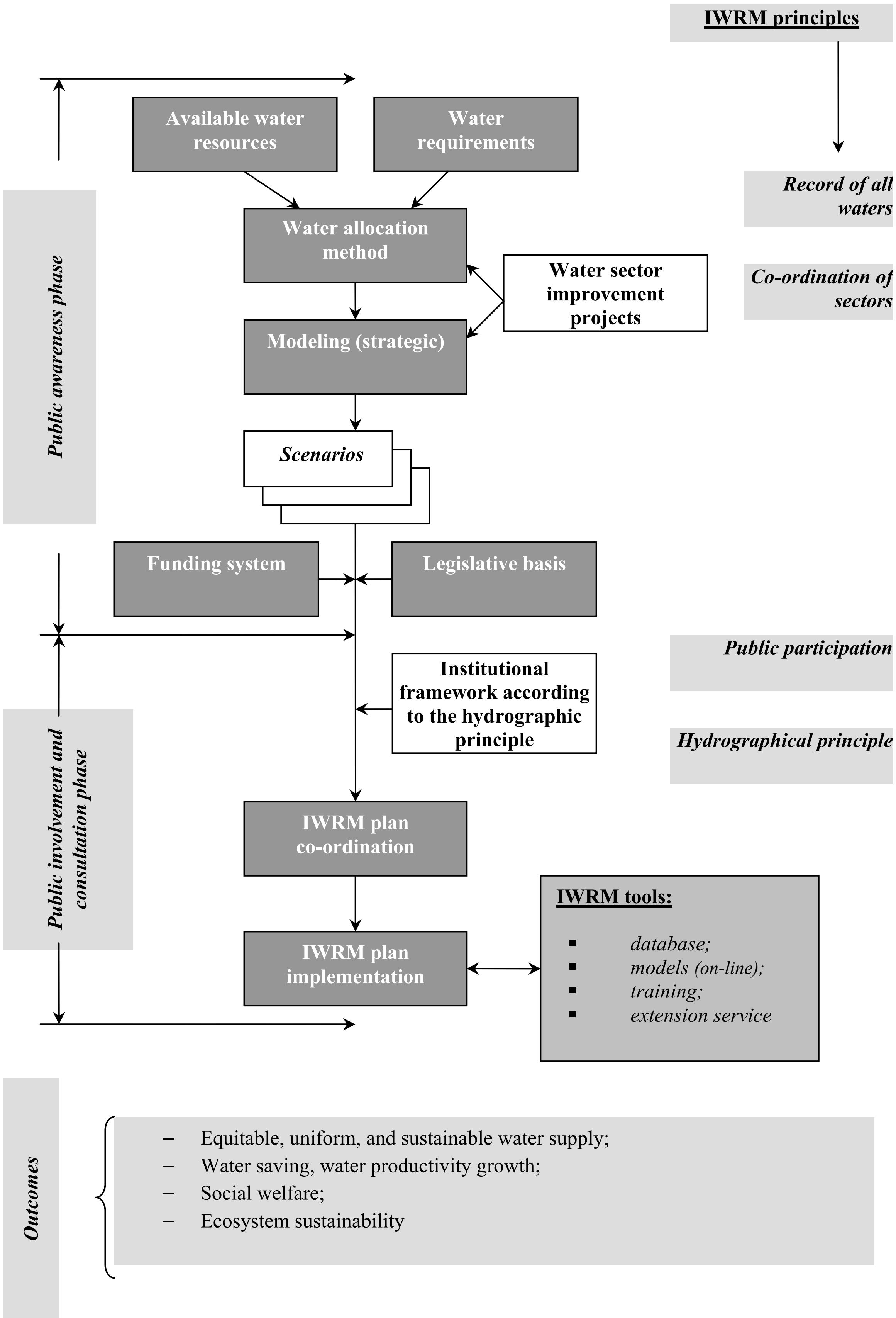


**Figure 6.1 Phases of National Planning and Implementing IWRM**

***The IWRM introduction process goes through the following phases:***

- initiating the process and creating the enabling environment for the introduction of IWRM;
- strategic planning;
- planning the work processes;
- pilot projects; and
- dissemination of the experience gained over river basins and countries in the region.

***At each phase the following activities are implemented:***

- analysis and elaboration of recommendations;
- social mobilization and involvement of appropriate stakeholders and decision-makers for each phase; and
- training of decision-makers, executors and stakeholders that would have a specific role in each phase

These activities are in permanent interaction, supplementing and enriching each other, facilitate a feedback and improvements, and therefore one cannot consider each of them to contribute separately to complete the IWRM introduction process or even to initiate its progress. These activities require driving forces, and, in turn, driving forces can be effective only if there are "brains" and "conductors" of these activities. The process of introducing IWRM can be initiated with establishment of the governance framework and distributing the roles among actors:

- who will play the role of an ideologue, generator of ideas and "leader looking ahead" in this process;
- who is the manager, with required powers and resources;
- who knows how to form public opinion and initiate social mobilization;
- who knows how to finance these interrelated measures;
- who knows how to facilitate the introduction process; and
- who supervises the effectiveness of activities

In its fundamental publications [31, 36, 40, and 56], the Global Water Partnership (GWP), one of major promoter of IWRM introduction, considers that international donors and agencies that act on the basis of WSSD resolutions (2002) or national governments can be "driving forces" of the IWRM planning process. At the same time, the GWP suggests a clear-cut distribution of roles and responsibilities (Table 6.1). When the role of "owner of the process" belongs to the national government that can, *sui juris*, establish the special Steering Committee or working group for governing this process. The GWP network assigns a leading role in this process to its partners and regional coordinators, who should provide the public platform for dialogue and information exchange, and support the processes of developing IWRM plans and strategies based on consultation processes, capacity building, knowledge dissemination and training.

Another an absolutely different approach was recommended in some EU projects. According to them the concept of multi-stakeholders dialogue, which for example, is developed within the frame of EMPOWERS Partnership [56]. Although their approach, so-called SDCA, contains many correct and useful provisions, the key idea (the primary nature of the dialogue, prior to target actions) is wrong in essence. "Innovation can be seen as the outcome of a mutual learning and social change process taking place among a large number of autonomies, actors of mutual interdependence, challenging them to create conditions through, which innovation can take place." Further, the process boils down to formation of spontaneous understanding among all stakeholders concerning the need of autonomic selection and establishment of common platforms for transition towards IWRM. Although, authors understand very well the complexity of establishing such a platforms in the water sector, they hope that differences and representation of different interests and actual situations can provide the constructive base for innovations and introduction of IWRM. One can agree with some provisions of this concept such as establishment of "horizontal" cross-sectoral coordination and "vertical" coordination of all hierarchical levels, and organizing dialogues between them, employing such instrument of analysis as the Rapid Appraisal of Agricultural Knowledge Systems (RAAKS) developed in the Wageningen University (The Netherlands). However, as a whole, spontaneous mechanisms for IWRM introduction based only on induced awareness, may be a possibility only in well developed countries.

**Table 6.1 Breakdown of Roles and Responsibilities for Introducing IWRM [57]**

| | |
|---|---|
| *National government* | • **Lead role, "owner" of the process**<br>• **Mobilize funding**<br>• **Sets macro-economic policy environment** |
| Steering committee (group with wide representation) | • **Guide the process**<br>• **Mobilize support across sectors and interest groups**<br>• **Guarantee quality output**<br>• **monitor implementation progress** |
| Management team (group of qualified professionals) | • **Manage day-to-day processes for strategy development, implementation and capacity building** |
| Facilitating institutions, where appropriate (for example, national NGOs, GWP Country or Regional Partnerships or local UN country teams) | • **Provide neutral platform for dialogue**<br>• **Support strategy development process by providing advice and sharing knowledge**<br>• **Foster capacity building and training** |

The GWP approach is closer to the ground realities in our countries than the EU approach. However, the assigning of a role of "leading owner of the process" to the national government is sooner a particular case than general, because national government agencies are too busy in their day-to-day business and they are unable to execute this leading role, unless a special unit responsible for the IWRM introduction process will be established within their frameworks.

The leading positions in initiating and developing IWRM should belong to ideologues and mediators of this ideology, who can use all necessary tools: analysis, social mobilization, information exchange and training that are combined with the multilateral dialogues. IWRM itself predetermines the need in establishing conceptual, coordination and executive center. The "introduction" is the process of overcoming certain tendencies and inertia of existing status-quo, which as "*swamp*" resists and hampers current reforms and will impede further innovations.

*Governing the introduction process* is one of preconditions for achieving the success; and it is very important to select a right leader who can combine functions of an ideologue and initiator of this process. A candidate for this role should meet the following requirements:

- excellent knowledge of the IWRM principles, mechanisms and areas of activities;
- possess information on the situation in target areas;
- possess creative and scientific abilities in order to formulate ideas and to plan the ways for their realization;
- possess the practical skills of planning and distribution of assignments per components among executors, who can combined them to a single team; and
- sufficiently sociable and democratic in order to consolidate the team; and, at the same time, be able to create the enabling environment for implementing each of planned tasks

In short, this person should possess combined abilities of a scientist who can suggest ideas, analyze and generalize information and a good manager who can define the goals beneficial for society and put them in practice. Such a principle was practically applied many times, for example, while implementing the very complicated and multidisciplinary programs such as 'space program' (S.P. Korolev) or establishing and developing the Microsoft Corporation (Bill Gates & Paul Allen). A triumvirate consisting of three like-minded persons: an ideologue-scientist, a decision-maker, having powers and governmental support and a manager, directly responsible for governing the introduction process is another option that should be grounded on the scientific idea and its development. In both cases, based on the suggested idea, the process must be implemented according to a plan that has to include four types of support: a political support through a decision-maker, who represents the authorities; information support through a specially established group or NGO; social support through the mobilization and involvement of stakeholders; and finally financial support that is very important for funding the introduction process (Figure 6.2: a and b).

It is very important to organize result-oriented research and pilot projects for improving and adapting IWRM principles to specific conditions with follow-up, and putting them into practice according to the following sequence: "research project – planning of introduction – pilot projects – final large-scale introduction." Implementing this process in the frame of an exclusively scientific program, initially means the orientation on its low efficiency. The content and formulations of the scientific concept is often built according to laws that are incomprehensible for a practitioner, because any novelty, like an end in itself, captivates a researcher, like a treasure hunter or a gold prospector, by the process of searching in itself. An opportunity to receive results, which nobody reached before and the process of gaining new knowledge allure a scientist, forcing him to forget how and where his discovery can be practically used. Such scientific passion is good for academic investigations, but it is absolutely unacceptable for studies aimed at wide introduction and practical use of their results.

The IWRM introduction process requires strict and purpose-oriented planning and its implementation taking into consideration the national and regional priorities, current trends and legislation, and provides for the phased progress and appropriate measures to cover gaps between phases.

How the projects that listed in "the EU Water Initiative" look in this respect? [46]. How do they reflect this complicated process (if to judge from their abstracts)? We made attempt to systematize their outcomes. Out of 87 projects listed and having abstracts: i) manuals, policy briefs, legal recommendations are envisaged in 12 projects; ii) policy guidelines in 44 projects; iii) information websites in 35 projects; iv) seminars and disseminating recommendations in 18 projects; v) stakeholders involvement in 18 projects; vi) pilot activities in 28 projects; and vii) practical recommendations and putting them into practice only in 19 projects.

In most cases, projects' outcomes are not aimed at real practical use, but only at preparing manuals, websites, policy briefs, information networks, databases, conducting seminars and rarely at implementing pilot projects for testing recommended technologies and approaches, and transferring them for follow-up introduction (less than 30%). This means that primarily the projects under the umbrella of the EU Water Initiative didn't envisage the introduction of their outcomes.

The introduction processes in any area of activities provides a set of new ideas, technologies and tools. After testing and adaptation of them before transfering these ideas into a critical mass of rational reforms, they should replace the routine technologies. Therefore, *putting scientific ideas into practice requires an* *integrated approach and introducing IWRM to a wider audience too, because it encompasses social, economic, and environmental reforms based on technical and technological innovations.*

For this purpose, it is necessary to provide an *integrated planning of innovations, as well as* it's integrated implementation through pre-envisaged transfer from one target-oriented project to another with continued financial support.

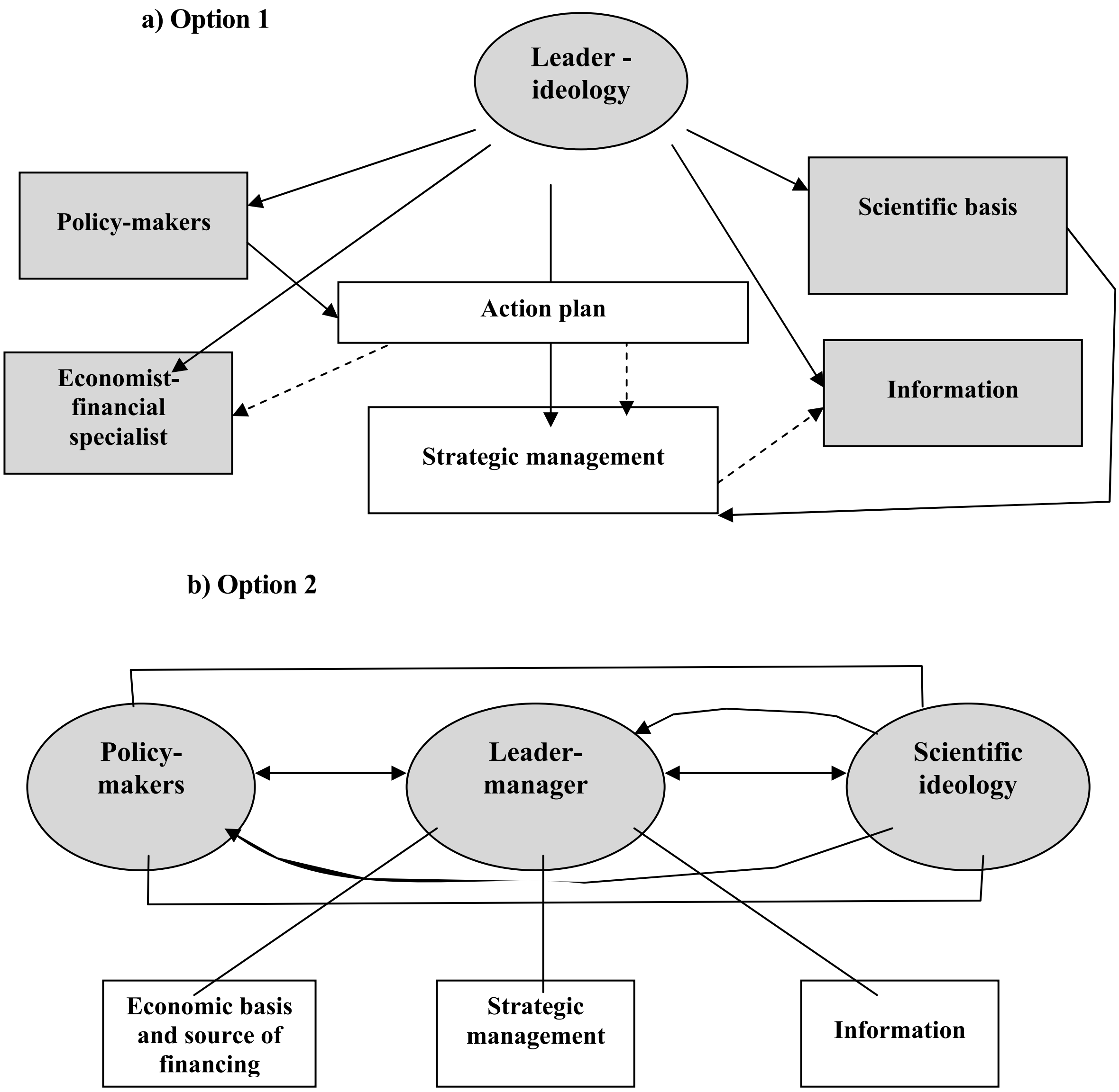


**Figure 6.2 Options for Governing IWRM Introduction Process**

*Focus on target, efficient and practical use of scientific results is the first precondition* for successful implementation of follow-up activities, related to introduction and disseminating the results achieved and gained experiences. A "generator" of scientific ideas, who formulates the program and plans the expected output, should clearly envisage what he would like to obtain already at this phase. He should clearly present what obstacles should be overcome in the process of research and follow-up pilot operation cycles (this should be substantiated by the executors), and he has to focus on the scientists and/or their partners, on their outputs that they need to produce.

To reach the final purpose, it is important to specify the phases of introduction process and necessary instruments. The following five phases are proposed as constituents of the process:

- start-up stage for the initiation of the process;
- strategic planning;
- development of work plans;
- pilot projects; and
- experience dissemination and extension of IWRM coverage

***The following set of instruments will be used for activities at the last four phases:***

- analysis and development of key approaches;
- social mobilization;
- mechanisms and practical tools; and
- training.

Taking into consideration that each country coordinates its water management tasks and requirements with political targets and plans of social and economic development, it is important to specify necessary set of instruments for each phase, the sequence of their application and their links as shown in Figure 6.3. Continued inflow of new analytical and practical solutions and information and interchange of them between instruments (mechanisms) of the introduction process takes place. At the same time, all fundamental approaches and mechanisms, over both vertical and horizontal links, must be clearly specified at the beginning of initiation of any IWRM introduction process, in order to establish the specific systems of activities, links and public participation, which shall be approved by the government with resolutions at the beginning and at follow-up phases.

At the same time, all approaches and mechanisms should pass through "the filter of public opinion" involving policy-makers and other stakeholders. The awareness of these approaches and mutual understanding of various stakeholders' groups have to be reached through the process of training and dialogue.

the composition of stakeholders (SH) needs to be differentiated, according to the specific phase. At the "*initiation*" phase, according to Figure 6.2 "a" and "b", the framework of governance and main leaders, needs to be specified forming the "core" who holds the same views and partners-promoters. At the "*strategic planning*" phase, it is important to have the personal interest and support of decision-makers in the government and provincial (or basin) organizations, on which supposedly initiation of this process depends. At the same time, the most advanced and active representatives of stakeholders from the grassroots organizations, who can be a mouthpiece of water users and water consumers, as well as representatives from other target groups and the appropriate water authorities, should be involved.

At the "work plans development" phase, when the plans of IWRM introduction process is being drawn up, it is necessary to involve specialists and water users who stand close to practical tasks and their implementation and to turn them into owners and enthusiasts of this process rather than executors of somebody else's ideas (in the follow-up activities they should act in the same manner regarding the participants of pilot projects and further IWRM introduction).

**Let us review separately the each phase shown in Figure 6.3.**

*Initiation of the process* is the most important phase, where the foundation is established for all successes in the future. Based on scientific analysis, it is necessary to raise the awareness of "pregnancy" (preparedness) of the water sector and all other water users for the transition towards IWRM. This analysis has to be based on evidences of the "revolutionary" situation when, -rephrasing Karl Marx, water users "do not want to live as before" and top water managers "cannot govern in a new way." For our region, occurrence of this situation was revealed from a number of studies: the WARMAP-TACIS (1997 to 2000) [13]; INCO-Copernicus (2000) [4]; etc. These projects have shown that with reforms or restructuring of the agricultural and other economic sectors, the large state water users and water sector as a whole cannot meet the needs of private and cooperative water users. There exist a huge potential for improving water resources management.

Through other projects ("Principal Provisions of the Water Management Strategy in the Aral Sea Basin" GEF, 1997 [9]; "Strategic Planning and Sustainable Water Resources Management in Central Asia", UNESCAP, 1999 to 2000, [8]) and during study tours abroad, the Ministers of water resources from Central Asian countries, firsthand acquainted with the world experience of putting IWRM into practice. This activities allowed a deeper understanding of the need for transition towards IWRM in the region. Collaboration with the Swiss Agency for Development and Cooperation (SDC) and International Water Management Institute (IWMI) allowed finding the financial resources for the development of the first solutions and implementing pilot projects in three countries. This has resulted in the selection of "key executors", and the coordination of these solutions with three Ministries of Water Resources and was crowned with the decision of the ICWC to establish a regional working group and the Steering Committee. Deputy Ministers of national ministries of water resources were assigned as key executors. The group of initiators has developed the road map and, together with Canadian and Israeli specialists, organized the training seminar for key executors to raise their awareness on IWRM based on the international experience.

Using the international experience and own analysis of pilot projects are important for raising awareness concerning the need, appropriateness, and profitability of putting IWRM into practice. Bombarding with information, it is necessary to convince the higher echelons of stakeholders on the appropriateness to refuse former practices, since, otherwise it can be dangerous not only for the society, but also for the subjects under "pressure for innovation." One of the ministers said: "A government official can refuse from the routine style of management and attempt to convince the government to start reforms only if, he understands, of course through the pressure of information, that unless he does make it happen, he might lose his position and all perspectives."

National IWRM plans for Kyrgyzstan, Tajikistan, and Uzbekistan were developed through the project initiated by the GWP CACENA and UCC-Water (2005 and 2006) and was conducted according to well-tested steps of the "road map" [15]:

- preparing the fundamental ideas based on findings of earlier developed projects (EU INCO-COPERNICUS Program project, Grant INCO-ICA-2-2000-1039 [4], the ICWC and ESCAP: Strategic Planning and Sustainable Water Resources Management in Central Asia [8]) and generalization of the world experience;
- presenting basic IWRM indicators to decision-makers at the governmental level and to leaders of stakeholders to raise their awareness of IWRM through the training seminars and round tables;
- discussion of the future projects with end users and decision-makers and incorporating their inputs into the project activities in the form of conceptual, technical, and financial assistance; discussion of expected results and project resources;
- selection and appointment of project executors and members of the Steering Committee; and agreement on communication and feedback with them;
- selection of pilot projects;

***Strategic planning*** **should include the following key activities:**

- analysis of the current situation and destabilizing factors;
- assessment of the preparedness to introduce IWRM in the planned zone, basin or region based on the following indicators:

  - social need for introducing IWRM;
  - awareness of these needs among decision-makers and advanced part of the society;
  - scientists and practitioners can suggest solutions relevant to these needs; scientific criteria meet with public interests;
  - suggested solutions will be feasible for the government and society;
  - "decision-makers" are ready to listen to scientists and practitioners and to cooperate with them;
- phases of IWRM introduction, scope of works and appropriate instruments: the information system, training, social mobilization, developing the "road map" in detail;
- specifying the target groups and the level of stakeholders' knowledge, their interests and abilities; and
- definition of IWRM strategic objectives for achieving the MDGs.

The strategic planning, as the first phase of IWRM introduction, creates the basis for involving all stakeholders; but they don't have to participate absolutely and simultaneously at all stages.

*Development of Work plans* is started with selecting pilot projects and definition of their objectives. Only irrigation systems where the maximum potential of IWRM may be shown, both in enhancing the efficiency of water resources use and its socio-economic and environmental effects should be selected for the pilot projects. The selected systems should be coordinated with local authorities, stakeholders and, more important, with decision-makers and the fact that their consent has to be reflected in relevant documents. At the same time, specific considerations should be given to key aspects, socio-economic and water management situation, and especially selecting the local partners that has to be organized on the competitive basis.

In the framework of the IWRM-Fergana Project [3, 41], the work plans were prepared jointly with SIC ICWC, IWMI, SDC, three Ministries of Water Resources (Kyrgyzstan, Tajikistan and Uzbekistan), water authorities of seven provinces in the Fergana Valley and were completed within six months. The information on this activities and further practical implementation of the IWRM approaches are described in other chapters of this book.

**Figure 6.3 Coordination of Works under Introducing IWRM Tools at Different Stages**

| Phases | Analysis and approaches | Social mobilization | Mechanisms and tools | Training |
|---|---|---|---|---|
| **Initiating the process** | • analyzing the preparedness to IWRM;<br>• analyzing the IWRM experience and its adaptation;<br>• specifying "driving forces";<br>• specifying funding sources;<br>• drafting "the road map"; | • awareness building of "PM" and their readiness to initiate the process;<br>• searching the key future partners among stakeholders (SH);<br>• public awareness | • governmental decision on initiating the process;<br>• establishing the Coordinating Committee;<br>• establishing the Steering Committee; | • training future leaders of the process;<br>• dialogue with PM and SH |
| **Strategic planning** | • objectives;<br>• water situation;<br>• evaluating interests and powers;<br>• IWRM scenarios;<br>• target groups;<br>• assessment of priorities; | • specifying the stakeholders;<br>• leading policy-makers (PM);<br>• interests of target groups and their potential;<br>• discussing the analytical reports;<br>• co-ordination of the strategy and approaches | • knowledge base;<br>• water resources;<br>• indicators of water availability and water productivity;<br>• innovations | • policy-makers (PM);<br>• stakeholders;<br>• water managers;<br>• dialogue and round table |
| **Working planning** | • specifying the pilot projects;<br>• target groups of pilot projects<br>• scope of work and scheduling;<br>• expected results;<br>• fund sources;<br>• improving the legal base | • co-ordination with PM and SH;<br>• mobilizing the target groups of pilot projects;<br>• gender aspects;<br>• co-ordination and approval;<br>• seeking financial resources;<br>• selecting the execution agencies | • specification of the DB for pilot projects;<br>• specification of approaches<br>• establishing the IMS;<br>• rational of information | • training target groups;<br>• training the executors ;<br>• training the members of future public bodies |
| **Pilot projects** | • works cross-linking;<br>• cost estimates and budget;<br>• pilot projects management;<br>• current and future analysis | • mobilizing per pilot projects, water users groups, and water management organization;<br>• establishing public governance bodies;<br>• legal approaches and solutions | • adjustment of the DB;<br>• monitoring the progress;<br>• monitoring the compliance with the plans;<br>• information service | • training on specific subjects;<br>• training of pilot project personnel;<br>• training-dialogue with SH;<br>• seminar for discussing the results |
| **Dissemination of IWRM experience** | • analyzing the results of pilot projects;<br>• recommendations for their dissemination;<br>• dissemination areas;<br>• selecting introduction tools and mechanisms;<br>• analyzing the progress;<br>• the final report;<br>• the necessary legislation. | • specifying new categories PM and SH;<br>• their social and target mobilization;<br>• the introduction coordinating process;<br>• approval of public governance and management bodies; projects; | • new BD and IMS;<br>• the monitoring system;<br>• public participation forums;<br>• public opinion polls;<br>• mechanisms of conflict resolution;<br>• co-ordination of the development projects with donors | • training new PM and SH;<br>• training on IMS use;<br>• training on IWRM;<br>• dialogue with agencies' staff;<br>• general dialogue |

A specific feature related to introduction IWRM consists of continuous adjustment and development of the “road map” to achieve the planned objectives:

- evaluation of achieved results together with the end users and decision-makers;
- recommendations to “governance” regarding further improvements of the legal, financial, institutional and other kinds of activities;
- feasible scope of works and projects for further development;
- action plan with the cost-benefit analysis;
- definition of the target groups of stakeholders and approaches for involving them in the introduction process; a plan of social mobilization of stakeholders, taking into consideration their specific character and organizing them into appropriate groups;
- training plan for the target groups of stakeholders and dissemination of gained experience;
- capacity building of the information system; and
- assessment of the progress and feedback.

It is important to ensure the sources of financing for this process, active role of its participants and involvement of stakeholders, as well as mobilization of donors’ investments of associated sectors; the last task is the most difficult.

**Let us consider a role of various instruments at different phases of IWRM introduction.**

***Analysis and key approaches***

Considering the multiplicity of aspects of IWRM, the analytical part of initiation phase should cover, first of all, the baseline situation (prior to the IWRM introduction) in water use, management and protection, and the management and use of other natural resources (land, energy potential, flora and fauna), as well as social and economic factors. Then plan the targets and levels for each of these factors. Further, under strategic planning, it is necessary to select feasible scenarios and define phases of their implementation. Those should be developed in detail for each stage at the phase of work plans development. At the phase of pilot project implementation, the analysis has to show, to what extent those targets, which were planned at previous phases are feasible; and taking into account the outcomes of pilot projects, adjustments of the plans has to be made. From the very beginning, the analysis must cover not only water management aspects but also the set of key results of introducing IWRM, especially those that are aimed at achieving the MDGs, keeping in mind, first, efficient use in all economic sectors of allocated water from the sources and satisfaction of the water needs of the society and nature.

*Social mobilization* shouldn’t be considered as the campaign of involving stakeholders for one occasion. At “*initiation*” and “*strategic planning*” phases, the social mobilization campaign is aimed at “looking-ahead” representatives of society and future leaders of the IWRM introduction process. With transition towards the phase of developing work plans and then pilot projects, this activities should be step-by-step extended to increase the number of target groups and directions of their activities and for further deepening and developing their links both over “vertical” and “horizontal.” At that, key tasks of social mobilization also change from such activities as familiarization of stakeholders with IWRM principles to their involving into strategic planning activities and step-by-step transferring to them a role of “owner’ of this process. Thus, they should become not only bearers of ideas but also creative participants of IWRM who, has an excellent knowledge of water use and distribution problems, breathe new life into the IWRM introduction process. Social mobilization gradually changes its direction towards involving of stakeholders into governance, elaboration of new forms of management and, finally, development of management directives (a business plan, schedule of water use) and follow-up monitoring of their implementation and achieving planned indicators, etc.

Stakeholders are a source of feedback during the IWRM introduction process that is used for its in-process adjustments, and is the basis for systematic transferring the process into hands of those who are most interested in introducing IWRM.

*Instruments and mechanisms* of introducing IWRM are not confined only to institutional instruments. Here, it is necessary to focus on the communication systems and equipping the same; databases that gradually accumulate information with development of the process and covering more and more areas of activities; the system of monitoring water use and adjustment plans of water use, according to real demands of water users; models for operational management and planning; conflict resolution system, etc.

In parallel to these instruments and social mobilization, the training system should be active with changing thematic coverage and trainees from decision-makers and leaders of stakeholders towards executors at grassroots level. For follow-up, enhance the training courses arranged according to the “top-down” principle by practical “bottom-up” results. Lectures should be accompanied with “dialogues” and “round tables” with following on-the-job training for personnel of the Canal Administrations and Canal Water Users Councils, WUAs’ members and staff, as well as for farmers in the frame of consulting activities. The more experience learnt from the process of IWRM introduction the wider and more diverse coverage of training activities; however, just such an approach guarantees the progress, since the training is not only dissemination of existing knowledge but also gathering and accumulation of new collective knowledge about the IWRM introduction process.

There is one very important conclusion we would make based on the foreign and our own experience. Introducing IWRM presents a long-term and phased process that step-by-step, involving more and more intellectual potential, participants, and objects. In Chile, for example, “community pregnancy” related to the need in reforming the water sector arose in the 1980s, but the IWRM system was finally established in the national scale only in 2005 [7]. We have initiated the process of introducing IWRM in Central Asia almost ten years ago, but managed to cover only small part of the region.

IWRM has to be broadened and deepen, because, with time, the potential of technical progress, on the one hand, and social and economic conditions on the other hand, are changing. These changes and new opportunities dictate the need in new adjustments to the strategy and instruments, to raise the IWRM efficiency and to win more and more supporters “top-down” and “bottom-up.”

## 6.3 The Public Awareness Campaign

**(V.I. Sokolov )**

The understanding on the importance of developing an appropriate social norm and attitude to water resources management is rising. A personal attitude to this problem should be interlinked with social norms. Decisions on water resources management must be based on the social values of water resources. It is necessary to establish a balance between commercial activities, emotions and social values.

There are a few reasons why the public awareness needs to be raised, and community representatives should be involved in water resources management:

- urgent need in water conservation;
- rising of sanitary requirements;
- protection of ecosystems;
- incentives for the public participation in governance;
- developing the self-regulating organizations;
- reforming the water policy; and
- heightened awareness of the new generation on water problems

The strategy of awareness creation should be grounded on the fact that water governance becomes a part of political instruments. Raised awareness is the direct response medium where all stakeholders specify their roles, responsibilities and ways of meeting their interests. At the same time, an awareness creation facilitates the formation of social norms and behavior concerning all members of the society, aimed at efficient, environmentally sound and cautious use of water, i.e. social encouragement of the principles of sustainable development.

***While Initiating public participation campaigns, it is necessary to keep in mind the following:***

- how many people need to be covered by this campaign;
- target groups;
- agenda of the campaign, its all-inclusiveness and detailed elaboration; and
- extent of public involvement

***Key components of the campaign:***

- market aspects;
- educational aspects;
- social / local aspects

***Phases of the campaign:***

- assessment of the current practice and search for possible improvements (motives);
- elaboration of the ideology;
- defining methods of public relations and involvement; and
- indicators for evaluation

***Assessment of the current practice and search for possible improvements:***

- analysis of the current practices of water use;
- assessment of current “good practices”;
- coordinating the water-saving activities;
- defining the objectives and indicators of public participation (taking into account all interests, but involving only those who can really change something or influence on something);
- seeking acceptable solutions; and
- testing on the pilot objects – demonstration of advanced methods.

***Elaborating the ideology:***

- search for valid arguments;
- taking into account religious postulates;
- taking into account cultural values and traditions; and
- seeking the simple methods for describing any problem (the clarity – «fool-proofness»).

***Definition of methods of public relations and involvement:***

- personal presentations of professionals and involving mass media;
- intensifying the campaign in a short periods of time;
- brochures and booklets;
- traditional events (festivals, festive occasions, fairs, etc.);
- water fee charges; and
- involvement of advertising agencies

***Indicators for evaluation:***

- quantitative assessments (amount of people, women, target groups, etc.);
- evaluating the extent of participation;
- discussing the concepts in focus-groups; and
- Sociological surveys and interviews (questionnaire).

***Training of trainers for the mobilization campaign:***

- training teachers;
- training trainers; and
- a package of manuals and learning aids for trainers.

***Other instruments:***

- the water measuring and accounting system (at water sources and on the field);
- water pricing;
- water conservation;
- financial incentives; and
- access to water-related information (periodical publication of data: who, how much and for which purpose consumes water).

***Supporting public participation:***

- political support (lobbying through politicians);
- governmental support, interviews of professionals;
- support of scientists; and
- support of religious leaders.

***Support by cooperative and non-commercial sectors:***

- water users associations;
- “round tables”;
- large water consumers;

- municipal authorities;
- public events organized by sponsors;
- water-saving contests (bonus funds); and
- trade unions.

***Education:***

- activities in schools;
- seminars for teachers;
- target children's creativity (target exhibitions);
- summer camps;
- study tours to water infrastructure;
- posters (instructional wall sheet); and
- inclusion of specialized topics in the curricula ("Water and History", "Water and Legislation", "Water Resources –Geography", "Water and Chemistry", "Water and Mathematics", etc.).

***Involving mass media:***

- newspapers, magazines, radio, TV;
- posters, booklets (educational to support initiatives);
- institutional aspects of involving mass media;
- Internet (websites, virtual conferences, nets);
- press-conferences; and
- exhibitions and concerts.

The key motto for the public awareness campaign is: "from awareness to practical actions!" Some details of practical implementation of the public awareness campaigns in the form of social mobilization in the Fergana Valley were described in Chapter 4 above.

## 6.4. Water and Education

**(V.V. Khegay, A.A, Kadirov)**

There is one important factor that affects the current or recommended for the future measures, for the implementation of IWRM principles – the human factor. Water may be and should be saved not only by the introduction of water saving methods of management and economic incentives for water users, and selecting the correct and rational ways for solving problems, but also by an intensification of the human factor. Reorganizing public consciousness and attitude to water, through liquidation of gaps between the notions: "my" and "our" or "public", is needed. It can be achieved through adopting, especially among younger generation, the concepts such as «water is the greatest good and therefore the greatest value granted to us»; « like water, human beings are a part of nature, therefore he cannot be the master of neither nature, nor water». Also through the revival of solicitous attitude of our ancestors to water, expressed by statements such as "Water contamination is the greatest sin" and "Water is life!". However, a few things can be achieved by slogans and appeals. Public consciousness can be shifted in the necessary direction only on the basis of purposeful, integrated and persevering training of people, employing stored knowledge, experience of water use gathered by our ancestors and contemporaries, not forgetting of mistakes made by the last generations in water management and nature management, as a whole. On a question «who is to be a trainee? » there is a natural answer - no doubt, the schoolchildren. In a few years, they will become adults and active part of the population. Generations, competent in water issues should come to take our place.

Now, strong dependence on the educational programs that were developed and applied still in the Soviet period is being traced in educational systems of most of Central Asian countries. However, specific improvements of the general educational programs in some states are, by this time, in progress. For example, the School Textbooks Publication System Improvement Plan was prepared in Uzbekistan. In accordance with this plan, textbooks and manuals with the general name: «People and Environment» have been prepared. Four textbooks "A Human Being and Water", "A Human Being and Air", "A Human Being and Land", and "A Human Being and Biodiversity" will be published as well as the manual for teachers generalizing all four above-named themes. At present, the Environment Education Training and Research Laboratory of the Training and Methodical Center "Bioecosan" under the Ministry of Education of the Republic of Uzbekistan has prepared 19 scientific and methodical recommendations for secondary schools to promote the ecological education.

In support of the mentioned efforts in reforming general educational programs, the Global Water Partnership for Countries of Central Asia and Caucasus together with the SIC ICWC and Regional Ecological Center (CAREC) has proposed to include the water and ecological topics into the educational programs.

**The goal of this initiative** is to provide scientific and methodical assistance to experts of national education, to the training and methodical institutions to improve the general educational programs for a number of school subjects (history, geography, chemistry, economic and legal knowledge). This is in tune with the purpose of equipping pupils with good knowledge of the water problems, at the time of graduation, providing their conscious and solicitous attitude to water.

For the realization of this initiative in the Republic of Uzbekistan, it is necessary to keep in mind that the proposed measures and recommendations should not contradict with the laws adopted by the republic (Law on Education and Law on the National Professional Training Program) and the governmental decrees in the field of school education. It means that all amendments and modifications to the general educational programs should be in the context of the public education standard, and meet the principles incorporated in it.

One of principles of the state education standard says that education should meet requirements of the nation and society, and needs of personality. Today, the water matters are a subject of special attention of the State and affect more and more the interests of the society and personalities. Though curriculums of the listed school subjects contain elements covering those or other issues related to water resources management, water properties and data on water formation sources, etc., but all these actions under present conditions are absolutely not enough and do not meet requirements of the State, society and ordinary people.

Creation of a separate school subject: "Water Resources" or "Water Problems" now seems to be impossible, though it would enable to unify knowledge on water and its resources and to focus attention of schoolchildren to concrete practical questions. It is necessary to find ways of integrating the topic "Water resources" into curriculums of school subjects. Implementing this task by including these topics into different subjects seems to be acceptable to the most, but it is too difficult and uncertain. The following sequence seems to be logical: identification of what knowledge pupils have to learn in the complete set from 5 to 11 grade (as though there is a separate topic "Water Resources"), then to formulate what pupils should know in the final, and further. To define what they should be able to do. Such an order should be uniform under formation of topics of curriculums for all school subjects. It enables to find out what questions of the proposed list already are available in existing curriculums, what questions can be easily entered in them, what questions can be included by replacement of those or other parts in curriculums, and what questions remains excluded, and their inclusion or exclusion is to be decided by the relevant approving departments.

***Pupils (5 to 11 grades) should get knowledge on the following matters under the topic "Water Resources":***

- What is water? Physical states of water and its chemical composition; Water in living matter;
- Natural water and its origin; Water in the atmosphere, on the Earth surface, and in the interior of the Earth; The natural water cycle;
- Total waters reserves (oceans, seas, rivers, lakes, glaciers, icebergs, underground water, soil water);
- Water resources of Central Asia, the Aral Sea Basin and some rivers in the region;
- Fresh water deficiency; the causes of fresh water deficiency;
- Ecosystems in river basins and reasons for their destruction;
- Hydrology of the rivers in Central Asia; Hydrological regimes of rivers and their transformation under anthropogenic impacts;
- River water quality; Transformation of river water quality on the way from river head towards its mouth and in time; the causes of river pollution;
- Drinking water, drinking water requirements, information on the drinking water standard;
- Water reservoirs in river basins, their influence on hydrology and other characteristics of rivers;
- Internal and interstate (transboundary) rivers; Examples of difference in flow management of such rivers;
- Canals, waterworks (intakes, control structures, and off-takes); water measurements at canals; canal efficiency;
- Water infrastructure and dam safety; Examples of dam destructions and their consequences;
- Development of river basins with a view of irrigated agriculture;
- Some information on the irrigation development history in the region stage by stage: before colonization of Turkestan by Russia, during the colonial period, and under the Soviet Power;
- Irrigation and water allocation; development of institutional and physical water infrastructure in the country
- The careful and solicitous attitude of our ancestors to water and its use; conceptions reflected in proverbs and sayings;
- Features of irrigation development during the Soviet period; Achievements, shortcomings, and mistakes resulted in drying up of the Aral Sea;
- Information on water resources management methods; the concept of integrated water resources management (IWRM);
- Water User Associations (WUAs) is a link between the public water suppliers and water users (dekhkan and private farms);
- Water is not only the most valuable and necessary natural resource, but also under the certain conditions - the good having a price;
- Economic mechanisms in the water sector;
- Interrelation between a national economy and its water safety, as well as water resources conservation;
- Legal issues related to water resources, their use and protection;

- Islamic statutes concerning water relations and water use;
- The national law on water and water use; the governmental resolutions in the field of water resources and their use

***By the moment of graduation from school, pupils should know that:***

- Natural waters of all kinds and physical states are, somehow or other, interrelated and are in permanent cycles - big and small cycles;
- Mankind, for its purposes, uses waters first of all the rivers (big and small rivers), freshwater lakes, dynamic underground water reserves;
- Fresh water to be used by people in the various purposes (drinking and domestic water supply, irrigation, many other needs for which fresh water is necessary) is quantitatively limited, is deteriorated owing to anthropogenic activities, disposal of waste water without treatment to water sources;
- Sustainable economic development of any country, hence, well-being of each of its citizen, directly depends on adequate provision of the country with fresh water resources. Therefore, water conservation and its rational use attract the public attention more and more and gain in the practical importance for society and people;
- Water is valuable natural gift, an irreplaceable resource, and under specific conditions, a good with a price tag. For this reason, use of economic mechanisms (purchase and sale) in water relations is quite naturally and promotes seeking solutions on water conservation and protection;
- Water conservation is a duty of each person here, there and everywhere, where qualitative fresh water is used. To save water means to preserve personal and public savings;
- Deficiency of fresh water (under its quantitative consistancy) is irreversible process due to the population growth and development of water-consuming branches of the economy in the country.
- The duty of everyone is an understanding of decisions and measures of the government directed to mitigation of tension consequences related to water, and strict fulfillment of own duties regarding their implementation in practice.

***What a graduate of the secondary school should be able to do?***

- To eliminate or promote elimination of fresh water losses (leakage from taps and other plumbing fixture in apartments, basements of apartment houses, and other places), or its use not for direct purpose;
- To explain to relatives and close people the necessity of solicitous attitude to water and its economical use; to be able to measure volume of leaks in apartments with the help of improvised means (a bottle or a glass, and watch) and to express this loss in money;
- To explain people those around him main regulations and meaning of national laws concerning water and water use, last resolutions of the government on water resources and their use.

Quantitative indicators of the national education system specify a scope of necessary works for introducing water themes in the school curricula. For example, in the Republic of Uzbekistan there are 160 administrative districts in 12 provinces and the Autonomous Republic of Karakalpakstan; and the departments of education are active in each district. Taking into account large cities and their subdivision into districts (Tashkent, Samarqand, etc.), as well as towns in provinces (without subdivision into districts) with their city departments of education, the number of district departments of education amounts to 200. In 2005, about 9,737 schools including primary, secondary and special schools, lyceums and gymnasiums were functioning in Uzbekistan. Since our initiative does not cover the primary schools and from 1st to 4th-class pupils of secondary schools, hence 9,555 schools with 3,752,980 pupils (from 5th to 11th-class pupils) will be covered by this initiative. The total number of teachers amounts to 461,797 persons including 60,000 teachers who give lessons covering subjects (geography, chemistry, history, legal basics, economic basics, etc.), into which the water themes should be integrated (about 300 teachers per each district, on average).

***This activities includes the following key directions:***

- Preparatory works for establishing the system of centralized courses for training trainers with the follow-up daylong seminars under their leadership in all districts of the republic;
- Supporting activities of these centralized courses and the training necessary number of trainers;
- Organizing the one-day seminars (per each school subject specified for integration of water themes) in all districts of the republic with a coverage of all teachers who give lessons in subjects, which will be integrated with the water themes; and
- Preparation of various tutorials and learning aids to be used during training at centralized courses and one-day seminars, as well as in the future in the secondary schools.

## 6.5. Climate changes - is good or evil for the water sector?

**(G.V. Stulina)**

Since the origin of life, different climatic changes took place on the planet Earth, with considerable fluctuations from global warming towards cold spells and vice versa. Ice Ages, in certain periods of Earth's history, sea ice or glaciers have covered a significant portion of the planet's surface, were changing into the periods of global warming that were lasting millions of years. Because of climate changes, flora and fauna were subjected to considerable transformations. Some species of animals and plants disappeared and others have appeared; some civilizations vanished completely.

Mankind, living on Earth for many thousands of years has never was able to influence on weather events. While these events exert considerable impacts on the human beings and communities as far as, first of all, they affect food supply, living conditions in cities and rural areas and access to safe water and energy.

More than 400 million people living in arid, semi-arid and subtropical regions, often overpopulated and economically underdeveloped, are subjected to a serious risk of climatic changes and follow-up effects of political, economic and social instability. Climate changes can become the trials and tribulations for some countries. The whole regions where there is resource deficits and capacities necessary for rapid adaptation to more severe conditions, will be subject to grave consequences of climate changes: hurricanes, floods, and droughts.

It is necessary to note that the future weather conditions or specific elements of sudden climate changes cannot be predicted with a high accuracy. However, studying the retrospective of climate changes provides some useful guidelines. At present, the task of limiting dangerous anthropogenic interference with the climate system is quite topical for policy-makers.

Scientists from all over the world recognize that global warming is already a reality. The UN Intergovernmental Panel on Climate Change (IPCC) concluded that human economic activities (an anthropogenic factor) changes our climate system and will continue to impact on it in the future.

The Earth's surface temperature has risen over the past millennium and it would naturally affect physical and biological systems. Scientists from all over the world recognize that global warming causes gradual changes such as raising global mean sea level, shift in the climatic zones due to rising temperature, and the precipitation patterns. The climate change can also result in increasing the frequency and scale of extreme weather events such as hurricanes, floods, and droughts.

Tracking the history of century-long climatic conditions allows to note that the periods of global warming changes into the periods of global cooling. Since 14th century, the North-Atlantic region had gone through a cold spell that lasted until the mid of 19th century. This cold spell could be caused by a substantial slowdown of the ocean conveyance system, although the opinion that reduced amount of solar radiation reached the earth's surface and/or global tectonic events could cause changes in the ocean system is more widespread. This period that is often called as the Little Ice Age, lasted since 1300 until 1850, resulting in severe winters and sudden climatic shifts and strongly affected the agricultural, economic and political situations in Europe. After that, the global warming has started, which has lasted over 20th century and continues at the beginning of 21st century. As a result, strong positive climate feedback[58] (Figure 6.4) speeds up the rates of annual warming from 0.2 Fahrenheit degree (0.11 $^oC$) up to 0.4 Fahrenheit degree (0.22 $^o$ C), and finally up to 0.5 Fahrenheit degree (0.28 $^oC$) in some areas.

With heating up the earth's surface, the hydrological cycle (evaporation, precipitation, and surface runoff) speeds up the rise of temperature. By far the most abundant greenhouse gas is water vapor, which reaches the atmosphere through evaporation from oceans, lakes, and rivers, and intercepts additional heat flows and increases the mean temperature near the Earth's surface. With increasing evaporation, a rise of the Earth's near surface temperature also takes place resulting in drying up of forests and grasslands. Due to perishing and cutting trees, forests absorb carbon dioxide to lesser extent leading to higher rates of rise surface temperature as well as due to strong and uncontrollable forest fires. Furthermore, higher temperatures cause melting of snow cover in mountains, on open fields, high-latitude tundra areas and permafrost soils in north zones. When soil adsorbs solar radiation and its reflection power is decreasing the surface temperatures are rising much faster.

Since the processes of climate change is going on all over, one can say with certainty that these changes are of the global scale and according to the forecasts of scientists will last up to 2010.

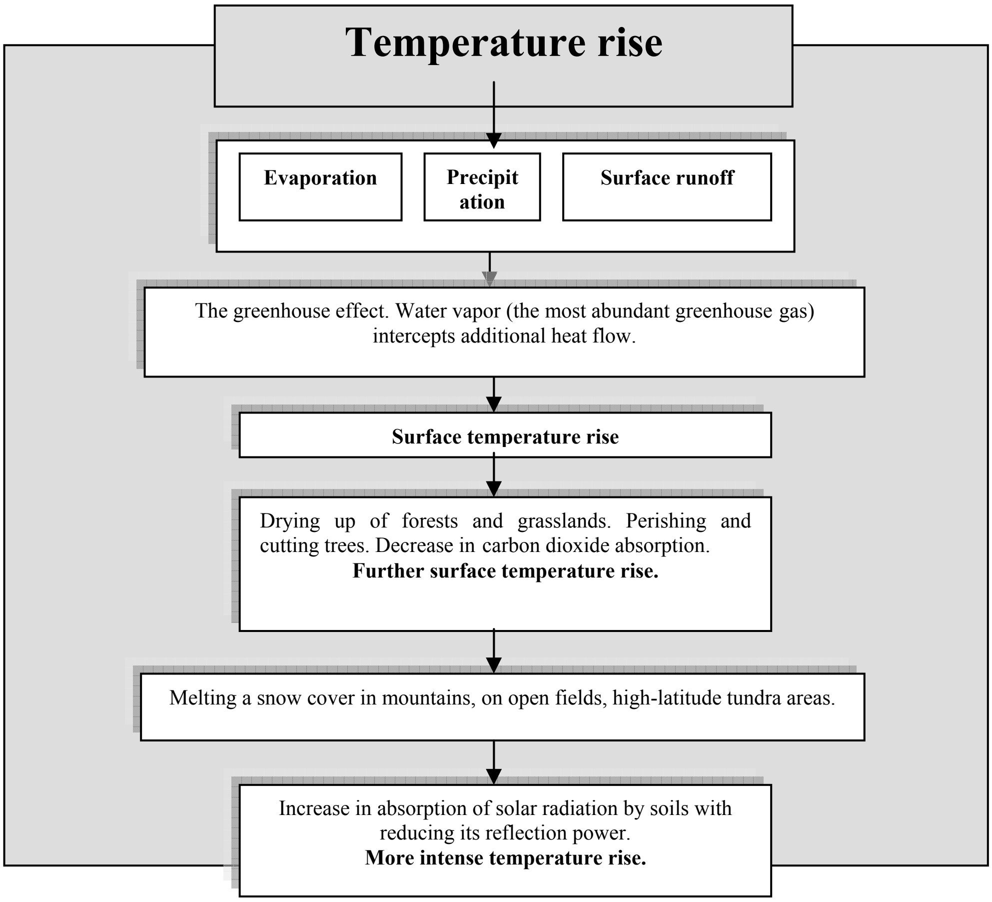


**Figure 6.4 A Framework of Climatic Feedback: UN Intergovernmental Expert Panel on Climate Changes**

The rates and duration of global warming that are observed during the 20th century are unprecedented over the last millennium. An increase in maximum temperatures, number of hot days and heat indicators is observed almost over

[58] An interaction mechanism between processes in the *climate system* is called a climate feedback, when the result of an initial process triggers changes in a second process that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it

all continents in second half of the 20th century. It is expected that trends of mean surface temperature rise will be kept, and the forecasted rise will vary from 1.4 to 5.8 °C.

More and more evidences that regional climate changes resulted in various transformations of physical and biological systems in most of regions in the world. They include reducing of glacial areas, thawing of permafrost soils, changes in frequency and intensity of precipitation, shifts in the dates of the beginning and end of the growing season, earlier plant flowering and emergence of insects, as well as shifts in plant and animals ranges in response to climate changes.

Central Asian countries, as members of the world community, have also experienced difficulties caused by climate changes [57]. Effects of joint influence of anthropogenic factor and climate changes that resulted in the Aral Sea disaster are especially visible in the Central Asian region.

The first meteorological observations over the territory of Uzbekistan were started more than 100 years ago. At present, there are 87 meteorological stations, 94 gauging posts, and 120 river flow measurement stations. 18 of them were included into the Global Hydrological Observation System, and 3 into the Global Climate Observation System. Purposeful research on climate changes in Central Asia were initiated in the 1980s.

Studying of climate trends using the series of instrumental measurements has shown that, at present, changes of different components of the climate system are being observed. Positive trends prevail in the temperature series, and the tendency of warming is found both during the cold six-month period and the warm six-month period.

For obtaining an objective assessment of climate changes over the territory, the SANIGMI specialists have selected 50 weather stations having series of observations since 1931 that are located in various conditions from the point of view of anthropogenic impacts on the climate and in different physical and geographical conditions. Thus, there was the opportunity to analyze variability of the mean values that were computed for two basic 30-year series of observations (1931 to 1960 and 1961 to 1990).

***Air temperature.*** Analysis of mean values denotes a significant changes in the directions of warming up. The most significant warming over the territory was observed in April, June, November, and December. In these months, a significant rise of mean monthly air temperature was observed at most weather stations (from 50.2% to 92.3%). At the same time, a significant decrease in mean values was observed less frequently (from 7.7% to 19.8%), mainly in autumn months. Thus, even based on the analysis of the historical series of mean monthly temperatures, it is possible to conclude that statistically significant warming is being observed over the considered territory. The standard deviations of mean monthly temperatures vary to a little degree due to a high natural variability of air temperatures.

Assessment of changes in maximum air temperatures has revealed tendencies of their increase over most of months. It is of interest to note that in summer and autumn, the tendency of minimum air temperatures rise is more visible than maximum ones; at the same time, lowering of maximum air temperatures was observed at rather considerable number of weather stations in summer. Influence of the Aral Sea on the pattern of changes in minimum air temperatures (in November) is observed. This becomes apparent in lower rates of minimum air temperature rise over the area in the vicinity of the Aral Sea due to the effect of aridization (reducing of humidity in the zone of exposed sea bed) that causes widening the range of daily air temperature fluctuations. This case shows that impacts of lowering the sea level and drying up of an exposed seabed on the microclimate of this region during certain months are already visible through changes of the climatic norms.

The areas with decreasing maximum air temperatures that are localized by the irrigation districts (Golodnaya Steppe, Karshi Steppe, Fergana Valley, Surkhandarya Valley). The maximum air temperature in these areas has decreased by more than 1°C compared to the natural variability of maximum air temperatures and these regions distinctly stand out. Observed data over the period of 1991 to 2000 shows that the annual air temperature over this region continues to rise. During the last decade, already winter months have contributed, to a greater extent, to the general picture of warming. For example, the mean 10-year air temperature over the winter period was higher than the base value over the whole area, and in some districts, excess amounted to 1.2-1.5 °C. Observations in the mountain river basins confirms the sustained trends of decreasing transient snow reserves. Degrading glaciers and reduction of their area also takes place; and rise of air temperature by 1-2 °C will intensify this degradation process. Over the period of 1957 to 1980, glaciers in the Aral Sea basin have lost about 115.5 km3 of ice (about 104 km3 of water) or almost

20% of ice reserves as of 1957 (a base level). By the beginning of 2000, the ice losses made up additional 14% of ice reserves as of 1957. According to forecasts, by 2020-2025, the glaciers will lose additionally not less than 10% of the initial volume (of the year 1957) [58].

None of climatic scenarios developed according to the methodology suggested by the UN Intergovernmental Panel Climate Change show an increase in water reserves in the region in the future. In contrast, the decrease in water reserves by 3% to 40% was predicted based on simulations using different models. Water deficit continues to grow while reducing available water resources, and increasing water consumption for crops cultivation. Table 6.2 shows the water resources changes found in Chirchik-Akhangaran basin using assessments (two climatic models **"ECHAM4" and "HadCM2"** were used).

**Table 6. 2 Comparison of Two Scenarios for Developing Water Resources in the Chirchik-Akhangaran Basin**

| Year | Total available resources | | Water demand | |
|---|---|---|---|---|
| | BAU/ECHAM4 | OPT/ HadCM2 | BAU/ECHAM | OPT/ HadCM2 |
| 2006 | 7,908 | 8,019 | 4,778 | 4,968 |
| 2011 | 8,841 | 9,404 | 4,714 | 5,404 |
| 2016 | 7,263 | 7,540 | 4,714 | 5,188 |
| 2021 | 6,662 | 6,944 | 5,299 | 5,958 |
| 2024 | 5,154 | 5,871 | 5,362 | 6,270 |

Total available water resources in the basin will decrease during next 10 years by 8% and 6% respectively according to the two scenarios of economic development ("BAU – business as usual" and "OPT – optimistic"). By 2024, the decrease in available water resources will reach 35% and 28% respectively according to "BAU" and "OPT", at the same time, water demands will increase by 12% and 26%. Different approaches and scenarios can be used to assess impacts of expected global warming on water resources.

The mountainous river flow model developed by the SANIGMI allows take into account the basic natural laws of runoff formation and evaluating impacts of climate changes on river flows, snow cover, and glaciers in the scale of separate river basins. In the region, rivers react to the warming process in different ways, due to different drainage patterns of their watersheds. Discharge of rivers fed by snowmelt is faster decreasing with a temperature rise. Rivers fed mainly by glaciers are more "inertial" relative to a temperature rise, since the increase in air temperature that intensifies melting of high-altitude snow covers and glaciers is partly compensated at the expense of specific characteristics of watersheds. Nevertheless, due to glaciers' degradation, which is in progress and will be enhanced owing to an air temperature rise, in the second case, decrease in river flows will intensify. This is likely to happen even more actively in the future.

### Adaptation of the water sector to climate change

The modern civilization may either adapt to current and future weather conditions and climate changes or mitigate their negative impacts in any feasible way. At present, the task of limiting dangerous anthropogenic interference with the climate system is quite topical for policy-makers.

Studies of climate trends in the Aral Sea basin testifies the changes in different components of the climate system, positive trends in the temperature series over the cold and the warm six-month periods, increase in the atmospheric concentration of $CO_2$ and the greenhouse effect. All these factors affect the sustainable development of the region, and, first of all, the agricultural sector where, at present, 70 to 90% of population are engaged. Impacts of above factors on crop productivity are given in Table 6.3.

Studies of the present situation, correct assessment of "bottlenecks" in social and economic development and inter-state policy in the region, as well as developing appropriate measures for desertification control and mitigating of consequences of drought events, allows to withstand adverse effects of the climate change.

**Table 6. 3. Impacts of Climate Factors on Agricultural Production in Central Asia**

| Indicator | Affects | |
|---|---|---|
| Air temperature | Increased duration of the growing season; | + |
| | Earlier date of sowing | + |
| | Conditions suitable for germination, advancing phenological phases and growth | ± |
| | Extremely high temperatures impede physiological processes in plants | - |
| Air humidity | Evaporation intensity | - |
| | Creating conditions for moisture and heat exchange necessary for each specific crop | + |
| Precipitation | Soil moisture and air humidity create natural wet conditions necessary for crop germination | + |
| | Storms can be a hinder for germination and agricultural works | - |
| Temperature, humidity and precipitation | Forming crop evapotranspiration as a whole | + |
| | Affect salinization | - |
| Atmospheric concentration of $CO_2$ | Affecting the photosynthesis intensity and gas exchange | - |
| | Forming biomass and crop productivity | + |

Most of irrigated lands in the Aral Sea basin belong to subtropical, semi-desert, desert and piedmont zones. The agro-climatic potential allows cultivating many subtropical plants including cotton and plants belonging to the temperate zone. However, the Aral Sea basin being the most northern zone where cotton is cultivated, it does not have sufficiently sustainable conditions for harvesting guaranteed cotton yields everywhere within the basin. Deteriorating soil conditions and socio-economic factors are a key cause of the loss of land productivity, especially over the recent

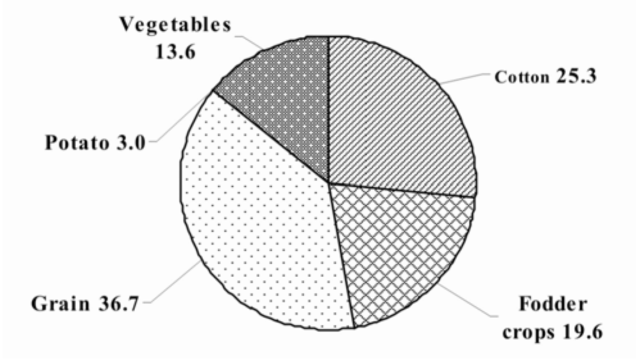


**Figure 6. 5 The Sown Area Pattern in the Aral Sea 2005)**

period of time. Only 52% of irrigated lands can be referred to lands with satisfactory soil and hydro-geological conditions. Irrigated areas with medium and heavy saline soils are increasing. In the region, agricultural land consists of irrigated land, rain-fed land and natural grazing areas. A total area under irrigation amounts to 7.95 million ha. The crop pattern is given in Figure 6.5.

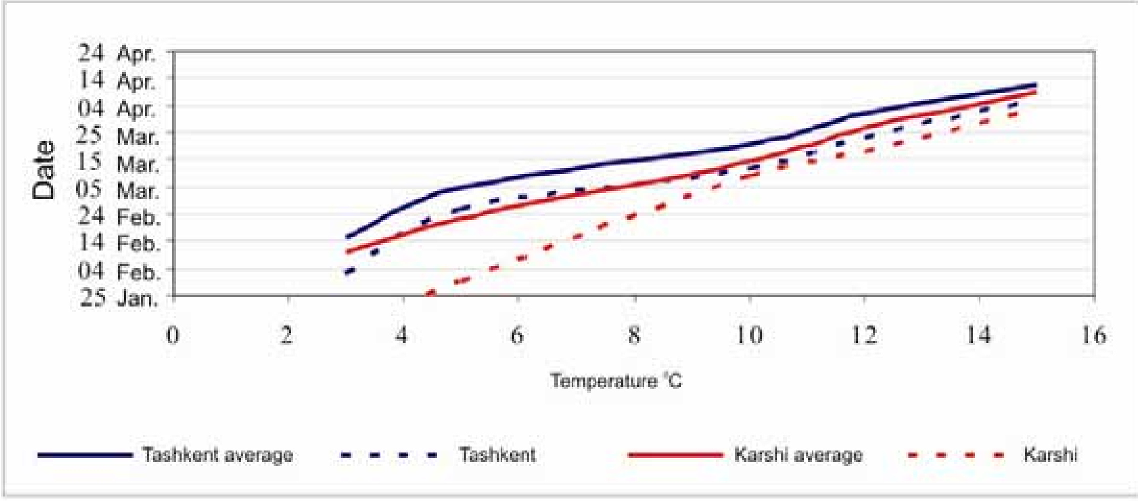


**Figure 6. 6 Crossing over the Limits Established for Air Temperatures**

**(Cp – present conditions, 1 – under climate changes: using data of weather stations in Tashkent and Kashkadarya provinces)**

Because of warming and increase in an amount of precipitation, a shift is observed in the altitudinal and latitudinal climatic zones. A border between subtropical and temperate climatic zones has shifted by 150 to 200 km northward and by 50 to 100 km between the actual rain-fed zone and the quasi-rain-fed zone. This means that the northern areas are being transformed into the territories with climatic characteristics more typical for southern areas. Figure 6.6 shows that with air temperature rise due to global warming, the limits established for air temperatures (3, 5, 10, 12, and 15 $^{o}$C) in Tashkent Province are lowering up to the mean annual values in Kashkadarya Province. It means that dates of sowing various crops become earlier and, in turn, the growing season starts earlier. Thus, one can say with certainty that under changing climatic conditions, the more northern Tashkent Province gains the climatic characteristics of more southern Kashkadarya Province.

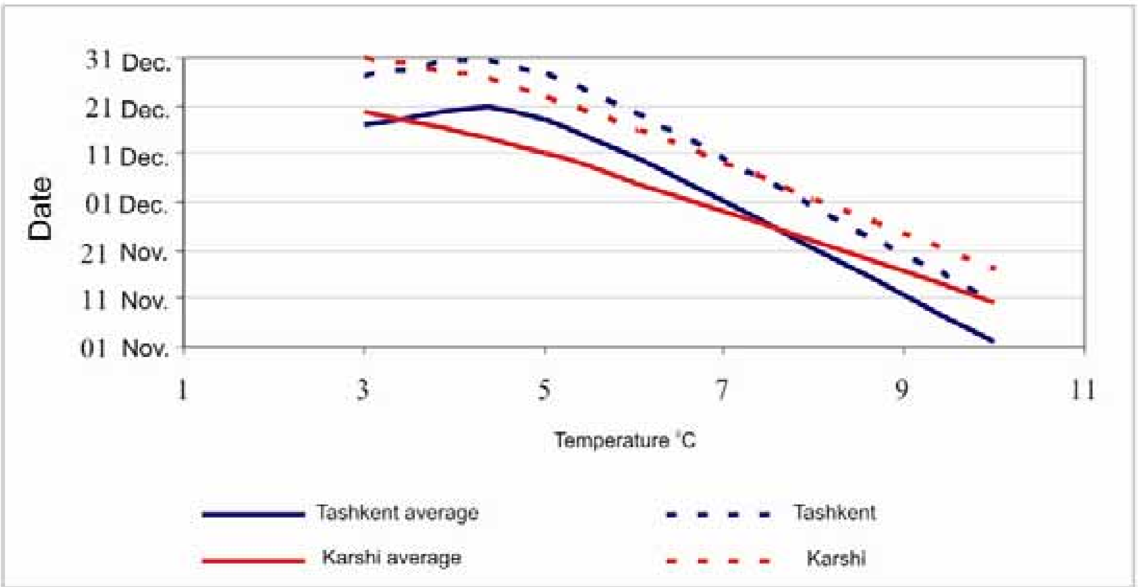


**Figure 6. 7 Crossing over the Limits Established for Air Temperatures**

**(Cp – present conditions, 1 – under climate changes: using data of weather stations in Tashkent and Kashkadarya provinces)**

Figure 6.7 shows that the autumn temperatures under crossing over the limits established for Tashkent Province due to the climate change are higher than mean annual temperatures in Kashkadarya Province. They are shifted on 7 to 17 days. This means that the growing season comes to an end later on. A difference in the dates of crossing over the temperature points of 10, 15, and 20 $^{o}$C in spring and autumn amounts to 15-30 days, on average, over the whole irrigated area.

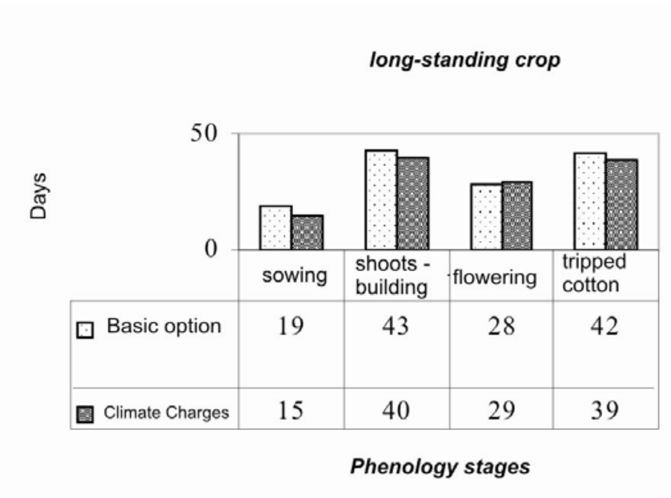


**Figure 6. 8 Changes in the Growing Season**

Changes in climate forced agricultural managers to revise the principles of crop cultivation practice. All the sequence of farming operations should be modified under these conditions of rising temperature, changes in air humidity and river flow pattern.

Key factor that affects the crop development rates is the thermal conditions over the growing season, which can be characterized by an average daily air temperature. Shift in the phenological phases occurs when a necessary sum of effective temperatures is provided.

As was mentioned above, a temperature rise provides more prolonged growing season, and at the same time, shifts in dates of phenological phases take place due to changed weather conditions (a duration of specific phenological phases). The length of phenological phases under usual and changed climate conditions is given in Figures 6.8 and 6.9.

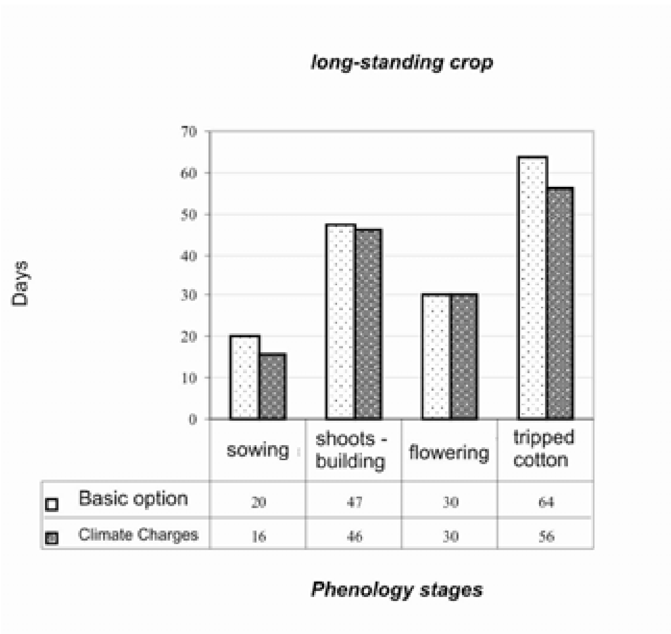


**Figure 6. 9 Changes in the Growing Season**

Dates of sowing are also shifted. Due to air temperature rise in spring and the increase in soil moisture, sowing operations are started earlier. Therefore, the dates of sowing that were established based on mean annual data are not acceptable under new conditions of climate change. Ignoring the current changes results in reducing of crop yields by 10 to 20% on average, since the most important period for forming yields will be affected by increased temperatures in comparison to optimal mean annual ones.

An extension of the potential growing season will allow growing 2 to 3 yields a year, with the assumption that irrigation water will be available. The rise in air temperature will cause a rise in crop water consumption by 5 to 8% according to our estimate. However, water consumption per unit agricultural output can be reduced at the expense of crop yield growth; at the same time, the effect of higher water productivity can be enhanced in the case of planting secondary crops.

Temperature rise and heightened atmospheric concentration of $CO_2$ can advantageously affect plant growth [13]. Under climate change conditions, the potential productivity of most crops shall increase, if *due supply* *of key inputs such as fertilizers, irrigation water, pesticides, etc* are done. Only rice that is especially susceptible to temperature rise is an exception to this rule. Under air temperatures higher than 32 $^{o}$ C and heightened atmospheric concentration of $CO_2$, productivity of rice is decreasing (Table 6.4).

The adverse affect of climate change is the increase in the number of days with high temperatures that can cause the water stress of plants, especially under low water availability for irrigation. The experience of food crops cultivation (water melons, maize) in the Fergana Valley and Syrdarya Province with application a polyethylene film as a mulch allowed simulating temperature rise expected, in line with some scenarios of climate change (Figure 6.10). A few variants of mulching were used (a transparent film laid over the soil surface; gallery-type film cover, and black polyethylene film cover); and their results were compared with food crop cultivations on open ground.

**Table 6. 4 Trends of Crop Yields, centner/ha**

| Province | Cotton | | Rice | | Maize | |
|---|---|---|---|---|---|---|
| | Average over the 5-year period | Climate change | Average over the 5-year period | Climate change | Average over the 5-year period | Climate change |
| Karakalpakstan | 14.1 | 15.5 | 19.9 | 17.9 | 10.7 | 12.0 |
| Andijan | 30.0 | 33.0 | 37.1 | 33.4 | 54.4 | 60.9 |
| Bukhara | 28.4 | 31.2 | 27.1 | 24.4 | 35.2 | 39.4 |
| Kashkadarya | 21.5 | 23.7 | | | 17.6 | 19.7 |
| Namangan | 25.0 | 27.5 | 20.9 | 18.8 | 41.2 | 46.1 |
| Samarkand | 22.7 | 24.9 | 21.6 | 19.5 | 29.1 | 32.6 |
| Surkhandarya | 27.0 | 29.7 | 25.3 | 22.8 | 36.9 | 41.3 |
| Khorezm | 26.5 | 29.1 | 40.5 | 36.4 | 37.6 | 42.1 |
| Fergana | 26.3 | 28.9 | 31.4 | 28.2 | 35.6 | 39.8 |
| Tashkent | 23.7 | 26.0 | 33.4 | 30.1 | 29.9 | 33.4 |
| Syrdarya | 14.4 | 15.9 | 22.9 | 20.6 | 30.8 | 34.4 |
| Jizakh | 15.7 | 17.3 | 15.1 | 13.6 | 19.9 | 22.3 |
| Navoi | 25.6 | 28.1 | 15.4 | 13.8 | 19.3 | 21.6 |

Soil temperature values at sowing and during the germination period are the most critical. Sowing of water melon was conducted at the minimum permissible temperature of 13 $^{o}$C at a depth of seed lying that should be uniform over a whole field. Three days after sowing, a temperature of soil underneath a gallery-type film cover and a transparent film laid over the soil surface was 15 $^{o}$ C or sufficient for seed germination. A temperature of soil underneath a black polyethylene film cover was ranged from 12 $^{o}$ C to 10.5 $^{o}$ C. In the variant of using a transparent film laid over the soil surface, temperature rise resulted in earlier ripening (by 20 days) and the increased productivity (by 30%) in comparing with the “business as usual” variant.

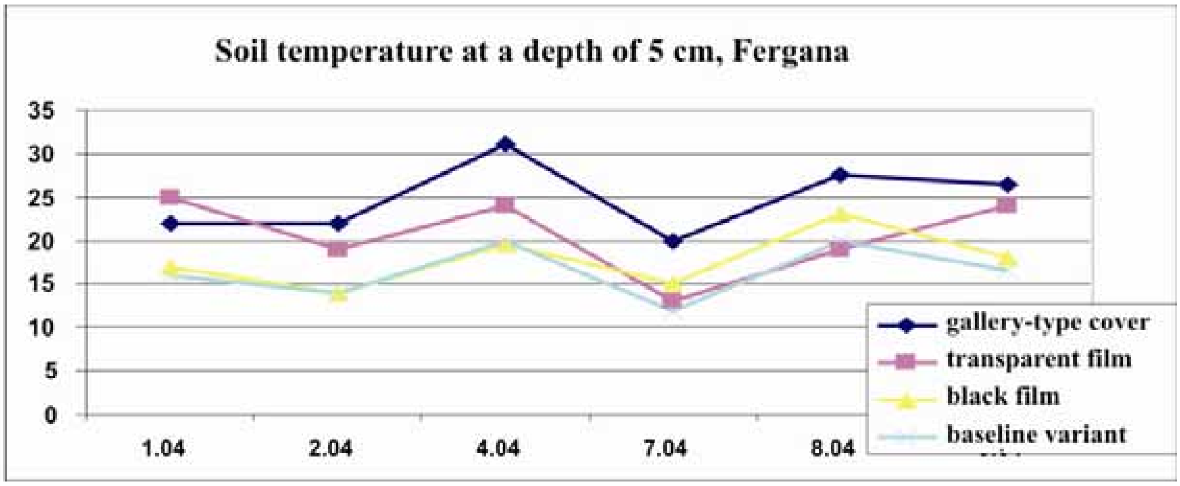


**Figure 6. 10 Soil Temperature Pattern on Demonstration Fields**

Adverse affects of temperature rise and extreme weather events were simulated using a gallery-type film cover when in daytime, the temperature raised up to 40 $^{o}$ C, causing considerable slowdown of plant development and, finally, decreasing the productivity (by 8% with compared to "business as usual" variant). It can be noted that mulching and alternate furrow irrigation allows improving the irrigation water productivity almost by 70% (Table 6.5).

**Table 6.5 Increase in Irrigation Water Productivity under Maize Cultivation with Mulching by a Film**

| Field Irrigation system | Water supply in the growing season | % of average value | Crop yield | % of average value | Water productivity | % of average value |
|---|---|---|---|---|---|---|
| | $m^3$/ha | % | kg/ha | % | kg/$m^3$ | % |
| Alternate furrow irrigation, mulching with a transparent film | 725 | -20 | 5400 | 35 | 7.4 | 69 |
| Traditional furrow irrigation, mulching with a transparent film | 915 | 1 | 5520 | 38 | 6.0 | 37 |
| Alternate furrow irrigation, "business as usual" variant | 730 | -20 | 3400 | -15 | 4.7 | 6 |
| Traditional furrow irrigation, "business as usual" variant | 907 | 0 | 4000 | 0 | 4.4 | 0 |

**What conclusions can be made based on the analysis of climate change effects?**

1. Climate change is an indisputable fact and it is a factor that considerably affects natural resources in the region;
2. It must be kept in mind that climate change has both advantageous and adverse affects, therefore the adaptation measures need to be developed for mitigating possible adverse affects;
3. Shifting the climatic zones southward is being observed;
4. According to all scenarios of climate changes the increase in crop water consumption in the future is predicted; and
5. Conditions for crop development and growth are changing resulting in the potentially possible extension of growing season and creating an opportunity for harvesting a few yields.

## 6.6. Water and Globalization: Impacts on Central Asia

**(V.A. Dukhovny)**

The modern world is entangled in global networks more than ever in the world history. Information space has been formed according to rules of Internet and electronic messaging and ensures instantaneous communication and momentary dissemination of any news, thus bringing about apparent unity of the world. At the same time, many other networks (financial, trade, economic, legal, and institutional) with their own rules of existence and play, while being in continuous development and interacting among themselves, are nothing more than the phenomenon of globalization. This phenomenon, if does not rule the world, at least, is representing one of the fundamentals of its present status, past transformations, and future prospects.

It is quite natural that the water sector, as one of the economic branches and simultaneously a chief actor of environmental management, couldn't avoid being involved into the globalization process that affected this sector since the 1950s. Globalization analysts, both supporters and opponents, single out its several aspects.

- political, economic, technological and environmental; and
- cultural, ideological, and even religious aspects that are not particularly highlighted but both earlier and especially now, in the age of information and communication revolution, have gained specifically powerful influence

Each globalization aspect had a profound influence on the water sector in some countries, regions and all over the world. Undoubtedly, these aspects play different roles at each development stage, and the influence of globalization at the regional and national level are also different depending on the extent of adverse affects of "governance" or its withstanding such phenomena. The water sector was involved in various spheres of globalization even in those periods when the water sector was developing independently within national boundaries. Trends of these processes are quite well observed in Central Asian countries that could not withstand the world tendencies despite being behind the Curtain for a long time. Globalization effects have many-sides and multifactor. Therefore, a clear-cut distinguish between positive and negative aspects of these processes is needed. An attempt to analyze the influence of "globalism" on the water sector in Central Asia is presented below.

### *Globalization has initially demonstrated advantages*

Globalization, as a process of spreading certain influence all over the world, became apparent in the water sector in the 1950s, when global water organizations were established and activities of UN agencies' in the area of water problems were initiated. Later, the International Commission on Irrigation and Drainage (ICID) and the International Association of Hydraulic Engineering and Research (IAHR) were established. They were the pioneers as early as in the 1950s, applied great efforts to establish national committees of these organizations in many developed and developing countries and creating a common platforms for experience sharing, knowledge and information exchange. These organisations have significantly promoted the cross-fertilization of water management approaches practiced by developed countries into developing countries, as well as experience of former 'socialist states' into 'capitalist states' and vice versa. Exactly these activities have promoted not only scientific and professional capacity building and 'know-how' exchange, but also formation of professional relations. This has subsequently facilitated considerably in the establishment of the global community of water professionals at the end of the $20^{th}$ century. In the past decades, we have been witnessing a rapid upsurge in diverse activities launched by the international water community. Activities of the interstate organizations under the UN umbrella has played an important role in disseminating 'know-how' and water knowledge. First of all, this can be referred to the UNESCO with its water assessment program that involved a great number of participants from various countries on both sides of the Curtain, as well as from developing countries. The same can be referred to the UN regional commissions such as the UN Economic and Social Commission for Asia and the Pacific (ESCAP), the UN Economic Commission for Latin America and the Caribbean (ECCLAC) and the UN Economic Commission for Africa (ECA), and associated international research centres involved in solving water-related problems such as the International Institute of Applied Science and System Analyses (JASSA) in Vienna and the Consultative Group on International Agricultural Research (CGIAR).

At that time, representatives of water science and practice of the former Soviet Union actively participated at the world water forums, for example, the Minister of Water Resources of the USSR, E.E. Alekseevsky, was the President of the ICID and the outstanding soviet scientists such as A.N. Askochensky, V.V. Poslavsky, K.K. Shhubladze and B.G. Shtepa were vice-presidents of this organization. The Ninth World Congress of the ICID was successfully held in Moscow in 1975; and the First Afro-Asian Regional Conference of the ICID was held in Tashkent in 1976. These events attracted attention to significant advantages in the field of land reclamation and water management in the USSR, raising the world-wide prestige of soviet water professionals and concurrently involving them into the process of improving the principles and approaches to water management on an international scale. This was two-way knowledge exchange. The USSR has gained experiences of advanced irrigation methods (drip irrigation, some types of sprinkler irrigation, automation of waterworks), while the soviet scientists made a great contribution to the world development through their achievements in hydrological school, in such areas as assessing water resources, plotting hydrographs of river flows with statistical uncertainty, drainage theory and practice, construction of large dams (Nurek, Toktogul, Bratsk and other dams) where the country played the leading roles in the world.

Great efforts were made to elaborate the so-called "integrated methods" of development and irrigation of virgin lands in the course of implementing the large-scale development projects in desert areas of Central Asia and Kazakhstan and reclamation of formerly abandoned lands in Azerbaijan, the Volga Region, and Kalmykia. All these activities promoted good foreign relations including signing the contracts for implementing works in various countries as well as procurement of equipment and technologies from abroad. Commercial activities in the field of water management has widely spread not only over countries of the so-called 'socialist block' (Vietnam, North Korea, etc.), but also over countries such as Egypt, Syria, Yemen, Mozambique, Iraq, etc. Constructing the Aswan Dam on the Nile River was undoubtedly a great success of soviet hydro-engineering theory and practice. This project had the great technical and political significance, demonstrating the world over the technological and organizational potential of the Soviet hydropower engineering. In the 1960s and 1980s, the irrigation and drainage activities boomed all over the world resulted in elaboration of a new water management and land reclamation concept, which had transformed irrigation, drainage and water management into recognized tools for reducing and even eradication poverty and famine, as well as solving many other social problems of the modern world. In this connection, the comment in the book for visitors made by the prime-minister of Turkey, Mr. Suleiman

Demirel, during his visit to a site of newly reclaimed lands in the Hunger Steppe in 1967, is quite noteworthy. He wrote, “Rulers, who are willing to provide their people with bread, jobs and opportunities of happy development, should come here and make use of this wonderful experience of social reconstruction through applying it in their own countries.”

The 1970s and 1980s are marked with the new heights of global influence on water development processes. During those years, humanity began to see clearly that continuation of unrestrained use of natural resources by mankind, without care for their renewal capacity and considering ecological requirements may lead not only to regional disasters but even to a global crisis. However, this movement has initially failed to gain a worldwide support, but has initiated the development of two important principles of the global water policy. The first principle went back to Brutland’s slogan: ‘*Man! You have not inherited nature from your ancestors, but borrowed it from your descendants*’. This slogan has gained worldwide recognition and promoted the prestige of those countries, which follow the principle of nature conservation for future generations. While *the prestige effect* that was of the great significance for political leaders and public movements, especially in developed countries was not a key factor, which could restrain the world from destructive over-consumption of natural resources, it had the immense moral and ever-growing political influence in any case.

Under the influence of activities of the Rome Club [46] in the 1970s and of the JASSA, an opinion regarding the need for environmental dimensions in all large-scale public action plans and programs was being formed in the Soviet Union. The State Committee for Nature Conservation and some government panels were established. For example, to solve problems of the Aral Sea and Caspian Sea. The “green movement” was supported by the Government, which resulted in a number of governmental resolutions and decrees. In particular, the Resolution on Socio-Economic and Environmental Improvement in the Aral Sea Basin that laid the foundation for future joint water resources management in the river basins of the Amu Darya and Syr Darya by establishing the Basin Water Organizations (BWO “Amu Darya” and BWO “Syr Darya”). The Water Code of the USSR has largely reflected new ideas and corresponded, in many respects, to new world tendencies. However, the Soviet management methods, being only formally democratic, did not provide real involvment of stakeholders and the general public in developing the mechanisms of public participation and control over the implementation of these quite correct decisions that remained mainly on paper.

The second aspect of this process was the emergence of documents that formed the legal basis for use of water and other natural resources at both the international and national levels, like the Helsinki Rules and later, after a long-lasting campaign, the Ramsar Convention; the Convention on Combating Desertification (1992); the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992) and, finally, the UN Convention on the Law of the Non-Navigational Uses of International Watercourses (1997). It is not surprising that the Central-Asian countries, just after gaining their independence, were forced to set up their national legislation and relations with neighbors on the basis of old traditions but keeping in mind the UN conventions. Though issues of legal force and jurisdiction are quite vague in these documents, they nevertheless afford an opportunity for conceiving the purposive political movement of the international community towards equitable and reasonable use of water resources, as well as adherence to the “polluter pays” principle.

Summarizing results of the first phase of globalization in the water sector in Central Asia, as well as all over the post-Soviet area, one can note its positive impacts on legal, scientific, and technological progress, on establishing cultural exchange between the countries that previously were isolated from each other, and on forming additional values based on joint actions. In addition, the foundation was laid for water technologies exchange on the commercial basis.

### *The Period after Independence: a New Impulse for Globalization*

The declaration of independence by the Central Asian countries in September-October 1991 posed a problem to the new Governments - where to go and which way to choose for economic and political development? Naturally, the water sector had found itself at the crossroads due to its close relation with the public priorities and directions, particularly in the light of agricultural reforms. Taking into account that the world practice did not know the examples of transition from under-developed socialism towards capitalism and the free market, the governments of the five republics tried to find a acceptable model among the modern capitalistic economies.

The world became opened for Central Asia, and Central Asia has opened up for the world. This openness was dualistic: non-politicized groups that encompass most of water professionals and, in general, of highly-qualified unbiased western professionals were surprised by the existing scientific and technological potential and, at the same time, they have critically analyzed the shortcomings and mistakes of current water management practice.

The understanding of the similarity and differences in the technical approaches, drawbacks and ways of overcoming them was reached just due to such a co-operation. The co-operation with leading specialists was gradually established facilitating the joint elaboration of programs and action plans such as: the Aral Sea Basin Phase-1 Program (1994), the Principal Provisions of the Water Management Strategy in the Aral Sea Basin (1997) [9], the Water Resources Management and Agricultural Production Program" (EU TACIS WARMAP-1, 1995-1997) and others. One cannot but admit a great contribution to this co-operation of such outstanding specialists as Guy le Moigne, Janusz Kindler, Bob Rangeley, Arrigo di Carlo, Michael Armitage, Jutzchak Alster, Joop de Schutter and many others.

Activities of these specialists together with the regional water institutions contributed to the development of new approaches based on up-to-date technologies, information techniques, computerization, etc. In addition, the western work style based on participatory approach has become quite widespread. Both factors promoted the public awareness regarding the need to meet environmental demands with respect to preserving nature. As a result, in 1993, in parallel to the ICWC, the International Fund for Saving the Aral Sea (IFAS) has established the Commission for Sustainable Development; however, it was only a flash in the pan. Nevertheless, according to the saying: "nature abhors a vacuum", and thanks to the initiative of Kazakh specialists, the Regional Environmental Centre was established and managed to stir up relevant activities on the regional level. A cohort of environmental partners has joined the water institutions. Finally, these activities have resulted in implementing the pioneer environmental projects (the Aral Sea Wetland Restoration Project, the Amu Darya and Syr Darya Deltas Biodiversity Rehabilitation Project, etc.).

Another side of the openness is the transformation of the region into a scene for political games. A situation was curious enough, since the international financial institutions skilfully combined the granting of their financial resources with specific political requirements, became the key actors rather than the newly established embassies and missions with their diplomatic activities. The political approach of "the Greeks bearing gifts" had several targets: to prove the disastrous nature and incapacity of the socialistic system and once and for all, to undermine the confidence to its potential, and under the guise of democracy and progress to impose their own vision on the future regional development. However, one aspect was hidden here: transforming the region from the source of raw materials of the Soviet monopoly into the market for western competing economies and, first of all, into the source of fuel and energy resources. Central Asia has possessed rather powerful industrial, agricultural, and human potential. For achieving abovementioned targets this potential need to be destroyed. For realization of such targets quite favourable local conditions have arisen - break-off of economic relations with Russia, loss of federal subsidies, and, at the start, inability of the Central Asian national governments to employ their potential for generating own financial resources for governmental regulation and support of national economies. These factors have caused certain economic recession, setback in agricultural production, disruption of the scientific potential, huge brain drain, and lowering the educational level.

What direction could be selected by national governments in the region? A key demand of all international financial institutions is denationalization and privatisation. A requirement to provide self-sufficiency as the prerequisite of the economic stability and as a new form of the slogan "people in trouble are left to themselves" has resulted in stagnation of the industrial sector at the first stage, and then in liquidation and step-by-step pilfering of the huge assets. For instance, in Uzbekistan, the production potential in the water sector amounted to more than 10 million m3 of reinforced concrete, 12 thousand km of drainage ceramic pipes, 15 thousand tons of polyethylene goods, hundreds of excavators, levellers, drainage machines, pumps and pumping units, water-measuring devices, facilities, etc. Over the period since 1991 until 1996, this huge production potential was destroyed; and the privatised assets made up less than 10% of the former ones. Moreover, many items, such as drainage pipes and machinery were completely liquidated and pilfered. The national governments were not able to assess and prevent this destructive process, which, eventually, led to loss of the economic potential in the water sector as a whole and, as a consequence, in irrigated agriculture. While in the past the scope of preventive flushing the subsurface drains amounted to about 2,000 km annually, at present, it makes up only 200 km. It remains only to be surprised that under such conditions 60 to 70% of subsurface drains remain to be operational, though their service life is more than 30 years, of which the recent 15 years only negligible maintenance works were being implemented (10 times less than required).

Orientation towards complete privatization of irrigated agriculture and denial of forms of cooperation were more fatal. Regional irrigated agriculture adapted to larger mechanized forms of production has practically degraded, being accompanied with considerable decrease in water and land productivity.

It is interesting that while the world suppliers of grain, such as the USA, Canada, and China, as well as of cotton, such as the USA and China focused their attention to large-scale farming and a high level of mechanization, recommendations for our region were aimed at small-scale privatization. As a result, the average plot of an arable land was reduced to 1 ha in Kyrgyzstan, 4 to 6 ha in Kazakhstan and 10 to 15 ha in Uzbekistan. High-efficient production of such crops as cotton, wheat and corn is impossible under given conditions. Therefore, some years later, an opposite phenomenon could be observed: consolidation of plots. For example, by 2005 in South-Kazakhstan Province, an average area of plots has increased up to 18 to 20 ha through sub-tenancy, transfer of title to tenancy, etc.

At the same time, the Japanese approach that is the most appropriate for small-scale farming and is based on combining cooperative and regional forms of ownership and responsibility was disregarded and not disseminated in the region.

Decrease in irrigated agricultural productivity under transition from the customary method of works (collective forms) concurred with the drop in prices for agricultural outputs (Figure 6.11). Figure 6.11 shows that over the recent 15 years, grain prices decreased twice, cotton - 1.5 times and rice more than twice. This has led to an abrupt drop in profitability of irrigated lands in the region. Data given in Table 6.6 taken from the Water Resources Management and Agricultural Production program (EU TACIS Program, 1994-1998) and the GEF Project: "Water Resources and Environmental Management in the Aral Sea Basin", Component A-2 ("Water Conservation", 1998) financed by the World Bank shows that the mean profitability of irrigated land decreased from 300 - 980 US$/ha in 1993 - 1995 to 150 - 580 US$/ha in 2002.

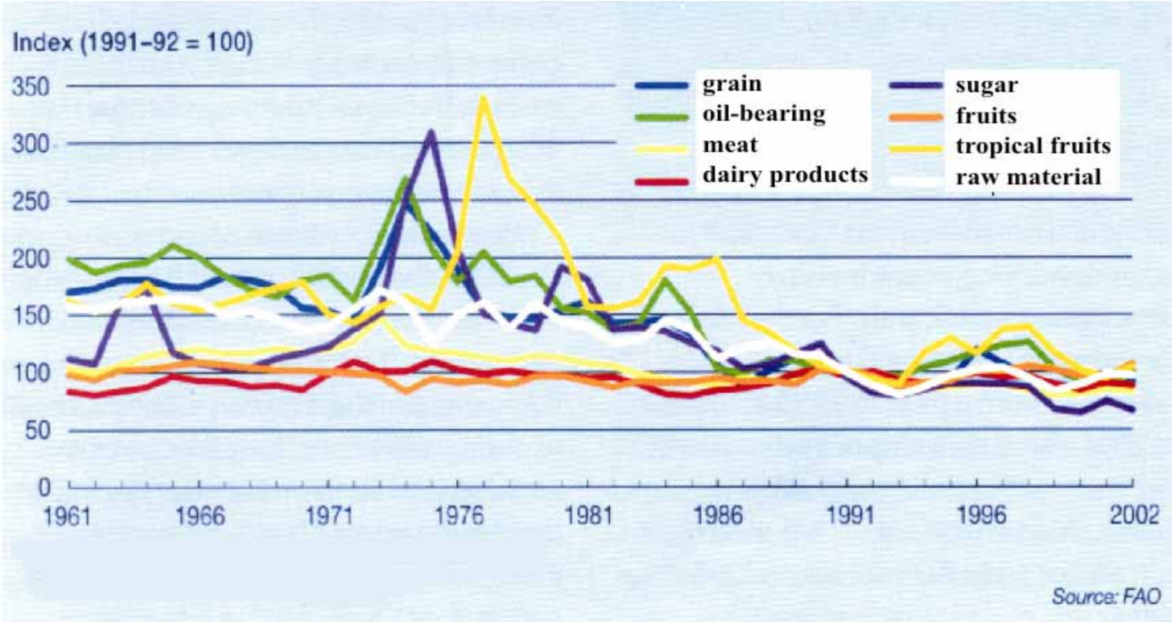


**Figure 6. 11 Trends of Prices on Agricultural Output (1961 to 2002)**

**Table 6.6 Comparative Data on the Gross Revenue in Irrigated Farming**

| Country | Revenue, $/ha | |
|---|---|---|
| | 1996 | 2002 |
| Kazakhstan | 982.0 | 356.0 |
| Kyrgyzstan | 759.9 | 578.9 |
| Tajikistan | 719.2 | 334.6 |
| Turkmenistan | 483.0 | 296.0 |
| Uzbekistan | 250.7 | 151.4 |

At the same time, calls for full payment for irrigation water-supply services and transferring responsibility for O&M of irrigation and drainage systems to farmers have resulted in the fact that farmers and water management organizations were unable to maintain the required operability of the irrigation and drainage systems, in particular, sprinklers and drainage tube-wells. Consequently, some irrigated lands were abandoned (about 1.0 million ha in Kazakhstan and 260,000 ha in Kyrgyzstan).

The case of Makhta-Aral District in South-Kazakhstan Province is typical. Here, based on efficient operation of drainage tube-wells, cotton yields averaged 3.5 tons/ha over the period of 1980 to 1999. However, over the period of 1991 to 1997, drainage tube-wells have failed over an area of 90,000 ha because of lack of control and maintenance by operational services, followed by soil salinization. The Kazakh Government has taken loans from the Asian Development Bank (ADB) and the World Bank for the rehabilitation of drainage systems, over an approximately 35,000 ha. However, after the rehabilitation, they are again not operable since 2003, due to lack of maintenance as farmer's net income of 250 to 300

US$/ha cannot cover the required maintenance costs of 60 to 80 US$/ha. As a result, during the recent decade, cotton yields amounts to 1.7 to 1.8 tons/ha, less than half of former yields.

The water sector faces a similar degradation. Budget deficit and the tendency to cover this deficit at the expense of fees collected from water users have led to the situation, where over the last 15 years, financing of main water infrastructure was substantially reduced (up to 14 to 15 US$/ha against former 80 to 120 US$/ha). At the same time, a greater share of finance is covering consumption of electric energy, with dramatic rise in price.

Thus, in economic terms, increase in the regional openness for the world tendencies had a negative effect and even, to a certain extent, became destructive for the sustainability in the water sector and irrigated agriculture as a whole. At the same time, it would be incorrect to forget about the great positive effect of increased attention to water in the world during the last 10 to 15 years. Undoubtedly, this should have an effect on Central Asia.

### *Water is a definite subject of world attention*

Awareness on growing water deficit in the world has stimulated active establishment of international organizations and initiatives that involve many governmental and non-governmental organizations, decision-makers, intellectuals, water professionals and promotes water-related intellectual, ethical, informational and technological development. The World Water Council, four World Water Forums, the Global Water Partnership (GWP), Kyoto Protocol, the World Water Vision Report (Cosgrove and Rijsberman, 2000) at the Second World Water Forum in the Hague and the Resolutions of the Bonn Conference (Ministerial Meeting, 2001) have played an immense role in focusing the world attention. The attention of policy-makers (and not only in water management organizations but also in nature conservation agencies) to the need for a radical reorientation of water sector, from meeting water demands towards managing water demands and achieving the potential productivity of water in all economic sectors. Dissemination of advanced approaches and methods, addressing water issues, and their popularization have facilitated practical steps towards IWRM in many countries. It is very important to understand that there is a possibility to meet the needs of society at the rates of water consumption amounting to 250 to 450 m3/year/per capita even in arid areas of Jordan and Israel, based on the modern technical decisions. Also, the comprehensive policies of these states, which stimulate water conservation and supports financially and legally, the systems of upto-date water use and management, demonstrating a participatory approach in the governance of the water sector. Activities of the Global Water Partnership, ADB, Swiss Agency of International Development and Cooperation (SDC), EU with its Water Framework Directive (the European Commission, 2000) has promoted, first of all, the professional understanding of Integrated Water Resources Management (IWRM) and then its political support. Study tours, training seminars and advanced courses have rendered great assistance. Instructive examples have been demonstrated during visits to the French basin water management organizations; the water confederations in Spain having more than 70-years experience of integrated water resources management, and water communes in Italy. All of them use the combination of hydro-geographic principles of water resources management with active participation of water users and their representatives in these activities (see Introduction).

The Japanese experience is worthy of praise, in particular the way that country manages to harmonize interests of nature and society under an immense population density. The same careful and respectful attitude to water is in the Netherlands, Canada and Switzerland and rudiments of hydro-environmental basin management is in the USA, are demonstrating the expediency to follow these practices and applying the instruments of rational natural resources use in developing countries and countries with transition economies.

### *A role of international financial institutions*

At the first stage of transition from the former soviet system to market relations, the World Bank and other international financial institutions made positive contributions. Highly qualified professionals from these organizations selflessly and driven by high human aspirations rendered assistance to local specialists in coping with rules and regulations of these institutions. It took ten years to introduce appropriate advanced technologies, equipment, computerization, informatics and sophisticated methodologies. After 15 years of donor involvement, water management organizations and conservancies in Central Asia have managed to understand differences in approaches of various donors and their ways of collaboration with partners.

In quite a number of cases, donors' have supported local beneficiaries. These supports were in the manner that created opportunities for self-expressions, sustainability and use of democratic approaches to tackle problems, at the first stage with donors' support and then with their monitoring and participating. They mobilized the preparation of strategic approaches on a long-term basis, training of local specialists in advanced methods and practices, manpower development and raising awareness in western "approaches" as well as developing our own approaches adapted to new conditions. This is demonstrated in projects such as IWRM-Fergana Project being implemented by the SIC-ICWC together with the IWMI with the support from SDC (Switzerland), Canal Automation Project and SIC-ICWC Information Exchange Project, the SIC-ICWC Training Centre Project under supporting by the CIDA and McGill University. Such projects have laid the stable foundation for survival and effective functioning. In this case, donors acted in the interests of local needs and tried to satisfy priorities and tasks of beneficiaries without any political, economic and other preconditions under full mutual confidence in the project implementation. At that, local specialists are considered as equal partners and executives. Such donors are represented by Switzerland, Canada, the Netherlands, the NATO's Program "Science for Peace", the ADB, the EU with its programs FP-5, FP-6 and the International Association for the Promotion of Co-operation with Scientists from the Newly Independent States (INTAS). Another group of donors imposes their own priorities on beneficiaries, doesn't trust local specialists, delays fund allocations for longer times and puts conditions under which practically 70 to 80% of the funds return to the donors themselves in the form of paying for their consultants, equipment, etc. In addition, their projects usually are not aimed at final results, and in this case, the funds allocation is more important than its effectiveness.

It is necessary to consider separately the cooperation with the World Bank in the Aral Sea issues. The World Bank represents the complicated bureaucratic system where decisions on selection, preparation, approval and acceptance of projects by Bank officials take several years, even for projects, which are supported in principle and rather low-cost. For example, the strategic project: "Water Resources and Environmental Management in the Aral Sea Basin" (its total cost of US$ 12.2 million; with the participation of five Central-Asian countries) that was financed by the Global Environment Facility (GEF) took four years for preparation and also four years for implementation. The project was completed in 2003. Selected Consultants did not fulfill the Terms of Reference, but the money was spent and all were satisfied - the consulting company obtained money, the World Bank closed the project, however the region did not receive the expected strategy.

Meanwhile, during the first stage of the ICWC and World Bank's cooperation, the work was well organized. Then the project "Principal Provisions of the Water Management Strategy in the Aral Sea Basin", as the inception of the above-mentioned project was implemented by local specialists with one moderator from the World Bank (Professor Janusz Kindler). However, further, the World Bank predestined to local specialists (no the institutions) a role of helpers doing the legwork and obtaining salaries ten times lower than salaries of foreign specialists. Because of the limitations imposed by borrowers and donors, local organizations could not independently take part in the biddings, resulted in drastically reducing the capacity of national research and design institutes in the region.

One of examples of high efficient assistance is the SDC donor support. The SDC has allocated funds for establishing the automation and monitoring system at waterworks of the BWO "Syr Darya" in the Fergana Valley. The Kyrgyz Company "SIGMA" was contracted to equip water infrastructure with SCADA under the supervision of the SIC-ICWC. Earlier this company had worked for the space industry. The "SIGMA" has executed the works related to automation of all structures in a short period of time at an average cost of US$ 6,000 per one automated point (see Chapter 5). The accuracy of water distribution has risen from ± 10% to ± 2% under extremely variable flow regimes of the Naryn River downstream of the Toktogul Reservoir with changes in daily flows up to 200 m3/s. For comparison, the same work done by French companies on the Southern Golodnostepsky Canal (Uzbekistan) has cost almost three times higher. The well-known French automation expert, Mr. Hervé Plusquellec gave the following assessment of works made by "SIGMA": "According to actual data on automation system performance at the Uchkurgan Hydroscheme, one can note that the system operated stably and performed key functions of automation and data collection on waterworks technological parameters over the period of 2002 to 2006. This system, providing automated regulation of water and flow rates in the Additional Feed Canal (AFC), the Big Fergana Canal and Northern Fergana Canal, ensured stable water supply under considerable fluctuations of flow rates and water levels in the forebay of the waterworks due to the daily power-generation regime of the Uchkurgan Hydropower Station. At the same time, it is necessary to note that costs of installation and O&M of this system were much lower than those in western countries" [38]. Thus, the effectiveness of donors' assistance could be increased largely in the case of raising the trust to the local capacity of beneficiary countries. Analysis of donors' contribution to the Aral Sea Basin Program, Phase 1 (ASBP-1) and a number of other projects implemented together with ICWC institutions (Table 6.7) shows that, on average, only 30% of the funds that were declared in IFI reports as the assistance to developing countries actually reaches the beneficiaries.

The extremes are represented by SDC, INTAS, and ADB projects where 70% of the funds are directly allocated to the beneficiaries (Table 6.7) and the assistance of the USAID and the EU TACIS program, where these funds amount to only 10 to 25%. There is no doubt that donors must retain functions of supervision over the final results and overall monitoring of project progress, but shouldn't be engaged day-to-day supervision over every step. To ensure successful implementation of the integrated regional programs there is a need of establishing a Board of Donors that will address the coordination and interaction issues. Such an arrangement will allow the international donor community to utilize funds in the efficient manner and to avoid the dissipation of resources, duplication of advertising campaigns and rivalry among donors. At the same time, this might enhance the prestige of donors' community, concentration on joint efforts for providing assistance to developing countries and improving local living conditions.

**Table 6. 7 Use of Donor's Funds by Beneficiaries Themselves**

| Project | Donor | Project amount, 000'USD | Including: used by beneficiaries |
|---|---|---|---|
| Principal Provisions of the Water Management Strategy in the Aral Sea Basin | Global Environmental Fund (GEF) | 540.0 | 420.0 |
| Evaluation of Previous Pilot Projects on Irrigation and Drainage in Central Asia | WB | 100.0 | 100.0 |
| Water Resources and Environmental Management in the Aral Sea Basin | GEF | 22,500.0 | 5,200.0 |
| Developing Recommendations on Distributing Costs and Incomes under Joint Inter-State and Cross-Sectoral Use of Irrigation and Hydropower Schemes on Transboundary Rivers | USAID | 22,160.0 | 204.0 |
| Automated System of Management and Control of the Dustlik Interstate Canal Headwork | CIDA | 1,520.0 | 600.0 |
| Water Resources Management and Agricultural Production in Central Asia | EC TACIS | 10,781.0 | 2,796.0 |
| The Aral Sea Basin Development Program, Component "Creation of Model Instruments on the Basis of Interaction of Water Resources, Socio-Economic Development and Nature in | UNDP | 220.0 | 104.0 |

| Project | Donor | Project amount, 000'USD | Including: used by beneficiaries |
|---|---|---|---|
| Central Asian States for Training and Use by Decision-Makers" | | | |
| The System of Automation and Dispatching of the Uchkurgan Hydroscheme on the Naryn River | SDC | 5,954.2 | 4,116.0 |
| Integrated Water Resources Management for Wetlands Restoration in the Aral Sea Basin | NATO Program "Science for Peace" | 240.0 | 195.0 |

### *Monetization of the Water Sector*

The significant deficit of investments in water resources development has resulted in arising two negative tendencies in the global water sector. The first tendency is the concept "water is an economic good" pushed by many monetarists who called for full payback for water storage, extraction, delivery and use, and the second one is privatisation of water infrastructure.

The slogan stated by the former World Bank Vice President Mr. Serageldin "water is the oil of the 21st century" gained the great support from financial circles. They saw in this approach the way to water monetization and making it a source of profit like other global goods - oil and gas. The legislations of some USA states widely support the water right to be going public. In regions of intensive development like Denver (Colorado), where all water resources have been distributed during the 19th century, this has led to monthly auctions where the cost of one share for the perpetuity of 1 m3 of water increased up to US$ 20. Stakeholders firstly sold shares for saved water and then water from all irrigated areas. If this trend would expand all over the world, mankind might lose up to 40% of the food being produced by irrigated agriculture due to competition of industrial and other economic sectors. It is not a real threat to America - this rich country will provide food for its population but what can developing countries do? Who will buy water to support the poor and the environment?

However, water (in contrast to oil) is a vital element of the noosphere[59] - it is "blood of life", natural essence and social security, non-observance of which will result in death of most of the global population. Only air can be equated with water in its value for human beings, because nothing can replace water and air. People can live without oil and gas over a period of all their life but without water only during one week! Oil can be replaced by coal, firewood, hay or electricity. Brazilians already successfully use bio-ethanol instead of oil, but nothing can replace water. The principle of water has an economic value that was stated in the Dublin Declaration should only support its rational use but not its trade, in any way. Water can become an economic good only after satisfaction of social and environmental needs under certain conditions: lack of water scarcity, possibility of its delivery at any time without damage to basic needs and in case of the capability of competing uses to pay for delivery of excessive amount of water.

Attempts to legalize the trade of water as a commodity were undertaken in the North American Free Trade Agreement (NAFTA) and in the World Trade Organisation (WTO). The new General Agreement on Trading Services (GATS) indicates the water supply services under the category "environmental services". Kavanah and Mander (2002) are absolutely right, proving that water monetization and privatisation according to free market laws deprives water of social properties since, in this case, access to water is ensured only to those who have money to pay.

Unfortunately, these trends affected the Central Asian region as well, when upstream riparian countries provoked by some donors began to compare water with gas and oil and to require from downstream

[59] The noosphere is 'the sphere of human thought' in addition to atmosphere and biosphere

riparian countries not their share of costs in maintaining common water infrastructure but charges for water as an economic good.

Fragmentary awareness of international experience by poorly-educated representatives of “a new democracy”, with support of some international consultants, have initiated the campaign for sale of natural waters of transboundary rivers to downstream riparian countries, for example, Naryn River water to Kazakhstan, Tajikistan and Uzbekistan at the rate of US$ 0.12 per m3! Water sales by the Imperial Valley System to Los Angeles and San Diego or water auctions in Colorado are taken as the precedent, but it was forgotten that not the water but the licenses (the right for water within the state) were sold.

At the same time, sale of free water within WUAs and between them, as well as creating economic incentives for water conservation should be supported and expanded.

Another side of the conception “water is an economic good” consists in the fact that the mega-companies with their aspiration for privatisation were attracted to the market. Though this was camouflaged by noble objectives - covering deficit of funds for water resources development by means of private investments, however, it at once resulted in an increase in water charges, decrease in cost recovery and, in turn, in investment outflow from the water sector.

Fortunately, the experience of privatisation was limited to activities of the only one Company “Tractebel” in Kazakhstan - this company was forced to go away because the social potential for water and power consumption was found completely unprofitable for such methods.

Discussions on issues of private participation in water management are still “seething.” However, one thing is clear - water management in itself, being the element of state security, cannot be handed over into private ownership; the private sector may be involved only for providing certain services in water management under strict state supervision. Participation of companies and their capitals in water management improvement, water infrastructure development, water conservation and wastewater recycling should be supported by the state because the experience of water managers can help in raising the efficiency of water conservation.

### *Globalization of Water Resources*

Can we speak about this process in principle? For instance, availability of water resources at the rate of 17,000 m3/ person/year in Brazil cannot cover water shortage even in northern district of Mexico, where amount of available water resources makes up 1,400 m3/person/year, let alone shortages in the Sahel region or the Takla Makan Desert [46]. Water demand of mankind is so huge and water conveying is so expensive that transfer of water from water-rich Turkey to money-rich Israel mainly remains as a subject of feasibility studies rather than of real actions.

Nevertheless, thanks to Toni Allan and Michael Rosegrant, many publications that treat water as a resource of global character have appeared [50]. According to the very interesting generalization made by Ashok K. Chapagain [46] water globalization reveals itself in:

- establishing many global and regional institutions that are aimed at tackling challenges of transboundary water use and developing the policy coordination of governments. In confirmation his words, he gives the examples of the Mekong River Commission, the Regional Commission for the Okavanga River, and the Nile Basin Initiative;
- diversion of runoff from one river basin to another one;
- bottled water trade;
- privatisation of water based on recognizing it as an economic good; and
- virtual waters as a tool of global influence on the water use efficiency and covering an water deficit.

The first two facts are of the regional nature, rather than of the global one. According to P. Gleick [50], a sales volume of bottled water of 144 million m3 is insignificant to speak about the ability to cover the water deficit on a global scale. In addition, nobody can make an example of export-import of bottled water between countries. At the same time, the technology of water bottling, as well as equipment for this production can be easily procured and installed; therefore, this is a local process for meeting the demand of either country or any region suffering from shortage of safe water.

Privatisation of water based on recognizing it as an economic good, as mentioned above, is rather a tool of financial and economic pressure; and the number of its supporters, especially, in light of water conservation for the environment (who has to pay for water for nature?) is decidedly reducing. There are more realistic mechanisms to affect global processes in terms of water resources use:

- output prices of irrigated agriculture as the main water consumer in the world;
- electric energy prices and their trends due to the price growth of energy resources and the attempts to transform hydropower generation into a geopolitical tool similar to gas and oil production; and
- the growth of "virtual water" pressure as the incentive for international competition in contrast to the need of developing and supporting the irrigated farming sector in developing countries and countries with transitional economy.

*Recent prices on agricultural output* at the world market are far from reflecting the actual crop production costs of irrigated farming. The disintegration of the USSR concurred with an abrupt landslide of agricultural output prices, which was mainly caused by subsidy policies of the world leaders such as the USA and the European Community. One cannot better describe this process than A. Shady [44] did: "Subsidizing the national agricultural sector by developed economic systems causes considerable distortions and lack of support to billions of the poor. These systems can assist the rich to become richer based on subsidies to agriculture currently reaching US$ 300 billion a year. Major actors are the EU through its Common Agricultural Policy, which amounts to half of the EU budget, from which US$ 100 billion were allocated to European farmers in the form of subsidies in 2002, and the USA with its subsidies reaching US$ 40 billion in 2002 and ever growing. At the most, 10% of subsidy recipients, accounting for 313,000 farms, received more than US$ 104 billion of subsidies in the USA in the period of 1995 to 2004. This is 72% of the total subsidies during this period. When considering all OECD countries, this form of support is evaluated as 31% of the total farmer's receipts, including: 18% in the USA; 36% in the EU; 70% in Japan and 75% in Switzerland."

An example of the cotton prices is typical. The USA, while producing 3.6 million tons of raw-cotton, grants almost US$ 4 billion a year to cotton-growing farmers, i.e. US$ 1,000 per ton. This means that production of each ton of raw-cotton for American farmers is half the price of that for Central Asian producers. The USA, being one of the leading world cotton suppliers after China, has set dumping the world cotton prices during the last 10 years of the 20th century (the landslide of prices from US$1,750 to 1,880/ton up to US$ 880 to 1,200/ton).

Western subsidies practically made it impossible for the Central Asian fruits and vegetables to compete with the European ones in the Russian market, and Russia is buying cheaper fruits and vegetables with much worse taste. Thus, developed countries protect their national markets and agricultural production and, concurrently, promote the commodity invasion into developing countries. As mentioned above, this resulted in landslide of world prices on agricultural output nearly two times in comparison with 1980 and in *stagnation of developing agricultural production in many developing countries that became unprofitable without vigorous state support*. Roughly speaking, developed countries stimulate the dependence of developing countries from import. Today the consequences of this dependence can be not as painful as in the future when domestic commodity producers will be winded up and world prices again will go up resulting in still worse living conditions for the poor in these countries.

When any country imports more than 30% of food products, it is at the risk of the food security. However, agricultural production is closely linked with overall economic development of each country, since the agricultural sector obtains its resources from 8 sectors of economy, and at the same time, provides inputs necessary for functioning of sixty other economic sectors. According to data of the Russian Academy of

Agricultural Sciences, each employee in agricultural production provides job for five employees beyond the agricultural sector.

Adherents of globalization convince that powerful large-scale agricultural and industrial production and unlimited trade would become the determinants in fighting against famine and environmental degradation. They forgot that capital's egoism and its derivatives, as well as aspirations of the rich to be richer while they get away from real tackling the global famine and poverty challenges by means of granting "crumbs" of welfare, block these good intentions. Such a charity has also created the global network of quasi-philanthropic lobbyists, which capture a substantial share of funds into own pockets under the pretext of helping the poor and starving people.

Hydropower generation prices are another factor of global impacts on the water sector, in particular on irrigated farming. The fact that key power-generation facilities are usually located in upper courses of rivers creates competition regarding flow regimes with irrigated farming most areas of which is mainly located along the middle and lower reaches of rivers. There is a risk that two tendencies - the growth of energy costs (Figure 6.12) due to the increase in oil prices and the drop in agricultural production prices - can create unequal, in economic terms, conditions for compensating the so-called "loss of profit" to the upstream countries by the downstream countries.

Up to now, this problem has arisen only at the Naryn-Syr Darya cascade. Kyrgyzstan and Tajikistan utilize their water resources, first, in the interests of meeting their own energy demands and in expecting some benefits from the downstream countries. An intention of upstream countries to utilize their hydropower potential that is partly developed to obtain the maximum profit is quite understandable.

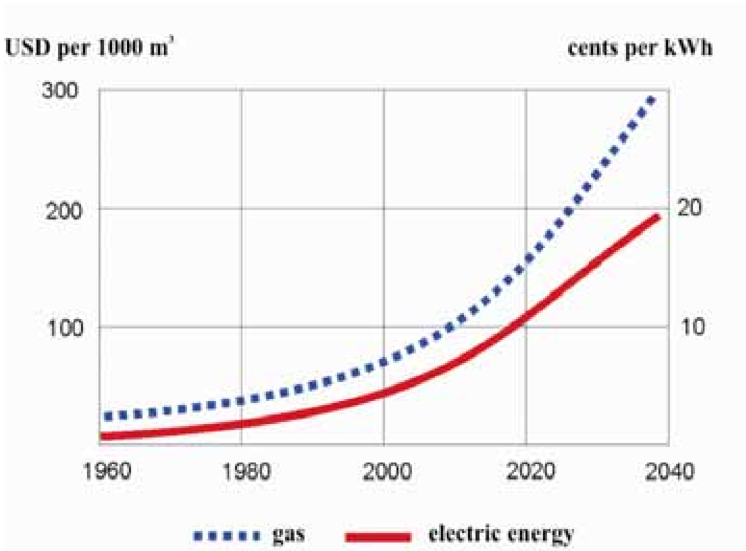


**Figure 6. 12**

**The Global Growth of Gas and Electric Energy Prices**

Besides, in the Soviet period, the principle of the common international law: "do not harm, otherwise pay" was applied in Master Plans developed for the Amu Darya and Syr Darya basins. The integration that is in fashion now was provided for by means of using the hydropower potential in such a way that would allow avoiding conflicts with interests of irrigated farming in the middle and lower parts of river basins and with deltas' demand. At present, all countries in the region exploit their hydropower potential only on the basis of the large water infrastructure constructed during the Soviet period but under departure from the principles established at that time - transition from water releases from upstream reservoirs in line with the irrigation-oriented schedule towards mainly the power-generation-oriented schedule.

This problem was partially solved by signing the Agreement of 1998. According to this agreement the excess electric energy generated above the demand through summer releases should be compensated by countries located along middle and lower reaches of rivers at agreed prices. Currently, electricity prices (US$ 00.2 to 00.3/kWh) are still comparable with market prices (thermal energy costs US$ 00.45/kWh) but what is expected in the future? Therefore, Uzbekistan is already striving for almost full satisfaction of its demand for additional water through use of releases from the Andijan Reservoir and, partially, through construction of in-channel basins. Such an approach is possible in wet and average years relative to water availability but fails in dry years.

In addition, prospects of developing hydropower sector in the region, including an opportunity to construct the cascade of the Kambarata Hydropower Stations (HPS) on the Syr Darya River, Ragun HPS on the Vakhsh River, Dasht HPS and Juna HPS on the Panj River attracted attention of the World Bank and even of the large financing actors in USA, Iran, China and Russia. A possibility to export hydropower to Pakistan, Afghanistan, China and other energy-deficit countries will create commercialism for the hydropower sector and ability to establish, as a lost profit, higher prices of winter electric energy 2 to 2.5 times. A solution should be found using different instruments acting at the regional level, such as:

- Signing the new Agreements on the Syr Darya and Amu Darya rivers, as soon as possible, which have to state the provisions for new construction and operation regimes of reservoirs taking into consideration the interests of hydropower, irrigation and environmental flows. In particular, this Agreement should clearly set obligations of the parties regarding the rivers' demand as the natural object and of other riparian countries' demands. The principle "do not harm, otherwise pay" implies that any country that causes damage or is planning to undertake actions that may cause damage should enter into negotiations with the neighbouring countries and will have to implement a set of measures to prevent the expected changes, or compensate losses or pay for damage;
- Thus, agreed actions are needed to prevent probable damage. At the same time, one should bear in mind that the successful parity management of transboundary waters is feasible only if all the countries are not aimed at maximum effect for one country, and observing the so-called Pareto's principle, according to which every party can get a maximum effect without damaging another party;
- The present system of relations concerning the Naryn-Syr Darya cascade result in regular neglect of the environmental flows through the Syr Darya River in summer and in floods in the lower reaches in winter. If to evaluate the social and economic losses and to counter-claim to the hydropower sector, then it would be hardly advantageous for the latter to strive for maximum profit. Thus, if the consensus regarding equal profits will be achieved then the solution could be found: the effect of hydropower development while meeting the clear-cut reasoned social and environmental demands with specified compensations;
- Riparian countries by uniting with the countries interested in electricity supplies should establish the water-power consortium for constructing and operation of hydropower station cascades that would balance the demand of electricity supplies proceeding from the demand of country-recipients and satisfy irrigation, nature and other downstream users' demands as specified by the ICWC;
- Establishing the River Basin Council in each river basin as the public body for governing activities of the BWO, which along with ICWC members, i.e. representatives of the national Governments responsible for water supply will include representatives of all provinces located in the basin and large water users such as the hydropower sector, delta management organizations, and conservancies. Their involvement and public control over management will promote equal and equitable water use and allocation on transboundary rivers.

It is advisable to consider and apply the experience of Canada and the USA, where hydropower station management is separated from river water management, and those in charge of hydropower buy water from the US Bureau of Reclamation or from Canadian provincial water organizations.

### *The Concept of "Virtual Water"*

Thanks to Tony Allan's publications, the concept of virtual water has been recently developed. According to this concept a volume of water required to produce commodities or services which are exported from one country into another one creates an opportunity to reduce water demand in country-importer, especially in countries with scarce water resources. In the case study of the Middle East countries, such as Israel and Jordan, the concept was demonstrated as the means for country survival when water availability was less than 500 m3/year/capita. A. Hoekstra [47] and especially recently A. Chapagain [45] made a great contribution to the dissemination of this concept.

The approach is quite interesting for researchers and analyzing redistribution of water used for producing various commodities and services among countries. However, it doesn't discover any new fragment in the general picture: taking into account virtual water, water consumption per capita in countries of the G8 amounts to 1,676 m3/year whereas in other countries only 1,160 m3/ year.

However, the USA with a consumption of 2,483 m3/capita/year is on the top of water users' pyramid, and at the same time, in China a minimum amount of water is consumed (702 m3/capita/year). A very interesting situation is observed: the USA consumes more than 330 billion m3/year of foodstuffs produced using alien water and, hence, is responsible for pollution and depletion of almost 8% of the global "blue" water resources. In the similar way, A. Chapagain has estimated that EU countries consumed 20% of water taken out of the Aral Sea. This estimation did not consider losses in the irrigation systems, with accounting of which "the EU's share in depleting the Aral Sea would exceed 30 to 35%"!!! From this point of view, undoubtedly, the approach of "virtual water" is interesting for estimating the profitability of cultivating various crops under different conditions, for selecting the most profitable crops and comparing their potential sale at international or domestic markets. However, all authors make estimations only in terms of water, forgetting at all about economic indicators that are derivatives of income, especially in such areas as processing, marketing, consumption, as well as about economic benefit of agricultural production in itself, the role of associated effects and the social value of irrigated farming.

In addition, a water-dependency index taking into account virtual water is introduced in contrast to the food independence notion. A water-dependency index, as proposed, and assessment of water deficit based on virtual water create distorted picture of national food self-sufficiency. J. Worner [51] correctly noted that under the conditions of price fluctuations at the international market, an opportunity of developing countries to provide their population with food at reasonable prices may be lost due to a jump in import food prices or a great drop in export food prices. Therefore, the index (a water-dependency index as the ratio of the net virtual water import and the total national water resources use as proposed by A. Hoekstra and I. Hung [47]) that seems to be satisfactory may react to any landslide of prices of export showing the need to reduce food import for enhancing "own water security" while the food self-sufficiency can considerably decrease.

Therefore, the national food security is more important than fictitious water security. An index showing a share of consumed food that is produced in a country will guarantee that jumps in prices at the free market will not create the critical social situation in the country.

All publications make casual mention of the very important aspect of irrigated farming in developing countries, i.e. its social value as one of key factors of rural employment and a source of incomes for those who are directly engaged in irrigated farming and for employees in associated sectors, services, etc. In this context, the analysis conducted in the frame of the RiverTwin Project (www.cawater-info.net/rivertwin) is representative regarding a role of irrigation in generating the GDP in rural areas in the Tashkent oasis. A size of income generated on large-scale irrigation areas is comparable with that obtained from crop production and consumption at own small holdings. The latter sometimes exceeds the first mentioned component of rural incomes. Appeals of some globalists to head for the experience of countries ensuring employment in the industrial sector are hardly feasible for developing countries with low incomes, taking into account that the costs of job creation in industry (US$ 10,000 to 16,000 per one jobsite) is several times higher than in agriculture (US$ 1,000 to 2,000 per one jobsite).

Thus, virtual water as an indicator of food production profitability or its non-profitability in any country is just a potential theme for researches and macroeconomic exercises. As applied to countries with the transition economy, deficit of available assets and poor purchasing power, virtual water is a counterweight of national or regional self-sufficiency of food or agricultural raw materials. The policy of subsidizing in developed countries along with propaganda on the virtual water concept can also undermine the financial potential of local producers in the future when food and agricultural production prices will increase (this is quite realistic due to the WTO policy), and then famine challenges will be exacerbated owing to destruction of the national infrastructural potential.

### *How to withstand the global challenges? National policies vis-à-vis globalization*

In our opinion, in such areas as information, scientific-technical and know-how exchange, the openness and opportunities to apply institutional, managerial, communication and other innovative advances, the global tendencies need to be widespread in the water sector and water-related sectors, first of all, in irrigated farming. At the same time, the specific “spirit of water” needs to be created. This implies the spirit of sanctity, free access to safe water, and overall responsibility of communities regarding water resources and water users regarding supporting its exclusiveness and rational use, as well as the overall understanding of impossibility of monetizing water and transforming in an economic good, its pollution and depletion. It seems that there are good lessons learnt from such countries as Japan, Canada, The Netherlands and Switzerland. These water-abundant countries have created the perception of uniqueness of water as both nature component and a public good. This does not mean that water should not be evaluated in economic terms; moreover, only a stable and reliable financial basis aimed at conserving and enhancing the water potential may serve as the cornerstone for the future sustainability of society under the conditions of imminent water shortage.

Water ethics, which was developed in all religions and ideologies, have to be put into practice in the form of specific culture of water perception, awareness of all generations that water is unique for both a human being and nature and of elaborating the global water code as the statute-book with indisputable rules of water relations in the context of water right!

From this point of view, the international water law and UN documents (human rights, international conventions) don’t state clear-cut recommendations, guarantees and mechanisms for enhancing the rights to access to safe water, water for food production and water for nature. This implies that these documents cannot be used as the basis for future sustainable water supply for population and society as a whole. On the one hand, the vagueness of many provisions in the international water law that may be interpreted by any country to its own benefit is certain impediment and, on the other hand, the lack of understanding of the enforcement mechanism as a chain of obligations and rights of actors and an opportunity to avoid the bureaucratic influence of national, provincial (governor) and local hydro-egoism at all levels of the water hierarchy from a basin to a water consumer. Understanding the need for elaborating strong and obligatory rules and regulations in the frame of inter-state agreements and the principles of water management at the national level should withstand new regional challenges. In Central Asia, water-related, transport, energy, economic and other interests are closely interlinked, especially taking into account certain geographic isolation of these nations, and only cooperation - and water as its pivot - may ensure the sustainability and long-term prosperity and peace in this region.

The most reliable “compass” for this cooperation is the efficient regional legal and institutional frameworks coupled with a present-day national systems of water governance, which include the National Water Codes and future development strategies stipulating efficient and rational water use, wide introduction of integrated water resources management (IWRM) at all levels of the water management chain, along with public participation and water users’ initiatives based on local traditions of careful attitude of all our nations to water.

At the same time, one should also bear in mind that the forces of monetary globalization and egoism will seek various forms and loopholes to exert their pressure on the spheres of economy, policy, culture and education in order to perpetuate the power of money and the permanency of social stratification. As A. Shady underlines in the above-mentioned summary: “One cannot ignore those actors who are driven by their mercenary interests are present at the “water scene”. These are large corporations that actively operate in the global food production chain: industrial contribution into agriculture (incomes from sales of ten best goods amount to US$ 370 billion), among which Syngenta, Bayer, BASF, Monsanto and DuPont; food companies of the processing industry and traders (incomes from sales of ten best goods amount to US$ 363 billion), among which Nestle, Cargill, Unilever, Midlend Arkera Daniels (ADM), Craft’s foodstuff; food retail dealers (incomes from sales of ten best goods amount to US$ 777 billion), including Wal-Mart, Carrefour, Royal Ahold, Metro AG, Tesco.” In addition, there are great interests of hydropower corporations, manufacturers of hydraulic machines and their accessories, financial corporations of “selfish nature.”

How to withstand these phenomena? There is only one way. It is necessary to strengthen the national and regional policy that should be opposed to global tendencies and simultaneously make use regional capabilities and globalization advantages. John Ralston Saul in his book: "The Collapse of Globalization" [52] shows that the theory enunciating the freedom of market and competition as key driving forces of the economy and progress has led to a chain of crises like the collapse of the Asian economy in the late 1990s, recession of Canadian development over the same period, and the growth of unemployment even in OECD countries in absolute terms. In contrast to that, China and India, by adapting to globalization trends, are dictating to the world their own rules of play and demonstrates their high and stable development rates. The basis of their success is the national strategy and purposeful policy that take into account market's driving forces and global challenges.

Some peculiarities of the modern market are driving forces of globalization: in particular, at the market of food, fuel and energy resources; deficit of some natural resources; respective natural and social phenomena. One may literally say that these forces, besides apparent management mechanisms and tools, are controlled by "invisible submerged parts of icebergs" such as international financial institutions and international financial and business monopolies reproduced by the globalization. Protectionism, subsidies, public relations and even the fight against international terrorism appear now at this scene as "pros-globalization", while trade barriers, customs fees and liberties, international unions and agreements, and wise national policies are the sides of "cons globalization" that defend national rights, food self-sufficiency, etc.

China showed an excellent example of benefiting from its anti-global strategy in cotton production and processing. Taking into account low cotton price, China processes all of its own cotton, 4.5 million tons a year, in textile manufactured under support by the Government and buys about one million ton of cotton a year at low prices for following processing. At present, China is the world supplier of textile at the expense of advanced technologies and cheap labour. In contrast to subsidies in developed countries, China has developed its own system of supporting agriculture and the water sector. As a result, these two sectors achieved the highest level of development according to both growth rates and crop yields, thus allowing to feed China's population and to provide export of goods.

A role of subsidies in irrigated farming and the water sector depends on those forces which manage these subsidies invisibly for us. Whereas subsidizing of food and technical crop production in developed countries is aimed at market penetration into developing countries, the latter have to protect their own commodity producers. Domestic subsidies or protection of national producers through setting custom and tax barriers for foreign importers can become the only response to backing of foreign producers. However, it is necessary to avoid the influence of personal interests of local bureaucrats, intermediaries, lobbyists who are eager to make money at any cost and often promote import to the detriment of fellow-countrymen instead of supporting national producers. Consequences of such harmful actions are affecting not only agricultural producers; they exert negative impacts on the whole social sphere in rural areas, development and maintenance of transport communications, secondary processing industries and supplementary enterprises, etc.

All these actions tangle a knot of incompetent solutions, which sometimes look like helpful ones, but often end up in failure on the national level. Let us consider the subsidies of the water sector. After independence, the World Bank and other international financial institutions, all the time, were urging on Central Asian countries to refuse from supporting the water sector. To their credit be it said that Uzbek, Kyrgyz and Turkmen leaders have not allowed to do this. Kazakhstan has decided to liquidate almost completely all sources that were formerly used for supporting the water sector and especially land reclamation activities. Initially, everything went well in this country, the Ministry of Finance was pleased, but drainage tube-wells, in particular in southern areas of Kazakhstan, went out of operation. Farmers could not afford to cover operation and maintenance costs of drainage tube-wells at the expense of their incomes. Gradual salinization (that had been forgotten in the nearest past) has now proliferated like a cancer all over Southern Kazakhstan, and crop yields on lands, which formerly used to produce 3 to 3.5 ton/ha/year of cotton, have reduced up to 1.7 to 1.8 ton/ha/year! At present, the Government of Kazakhstan has launched an impressive program of subsidizing the agricultural and water sector that provides considerable support to these sectors in Kazakhstan.

Along with improving the national policy, the co-operation of regional communities, which will enable to develop joint measures for ensuring the regional security including water, power, food and environmental aspects, should become the response to globalization. Regional co-operation allows smoothing the regional differences in demography, availability of land and water resources and ensuring peace and prosperity in the region. The results obtained at our demonstration sites in all countries of Central Asia show that the cheapest grain is grown in Kazakhstan, most cost-effective sugar and potatoes are produced in Kyrgyzstan, fruits and vegetables in Tajikistan and Uzbekistan and maize in Uzbekistan. When an agreement (like in the EU) on domestic and regional foreign-trade prices on agricultural output will be reached, the region itself will be able to supply all necessary foodstuffs in full. By the way, the forecast up to 2025 allows making the conclusion: if this will not be done then Kyrgyzstan and Tajikistan will fail to meet their demands for food products even in the case of planned development of irrigated farming.

Co-operation of Central Asian states based on the understanding of mutual interests should become a barrier for harmful hydroegoism; since 60% of the rural population in Central Asian countries and 100% of total population, directly or indirectly, depend on water and irrigated farming, and the latter, as in other countries, is related to the sustainability and security of water supply.

Without negating positive implications of global challenges for our countries, it is necessary to note that there are threats related to apparent or latent tendencies of globalism that must be taken into account by Central Asian governments under strategic planning and decision-making. In Central Asia, nations united by centuries-old common cultural, human, social, legal and religious traditions need to use positive factors of globalization and to withstand its negative consequences based on the regional co-operation.

# CONCLUSION

The future of this region more and more depends on abilities of countries and their communities to cope with challenges of water deficit. While earlier, the impressions of forthcoming triumph of overcoming famine and poverty all over the world have grown, a few recent years have shaken these complacent convictions. Documents published by the FAO, IWMI (the IWMI Strategy for 2009 to 2011) and other international organizations also give evidence of this concern. As far back as 2005, we established linkage between rising prices on energy resources, and correspondingly on electric energy, and growing competition between such economic sectors as hydropower generation, nature management and irrigated farming. Today, a new aspect of the fuel and energy crisis – developing the production of biofuel and the increase in areas under appropriate non-food crops that earlier were sown with food crops – has emerged at the international scene. A new challenge has resulted in sudden, quite likely, speculative boom of world prices on provisions. Rice and wheat, major food of the underprivileged, have risen in price two and more times. While the population growth, due to its gradual rates, creates slowly increasing "headache" for the governments regarding food supplies to their citizens, such sudden global challenges forces decision-makers to come back to developing the strategy of food self-sufficiency i.e. the food security. Countries of our region face the same perspectives. Under aridness conditions of the Central Asia, the solution can be found only through the growth of irrigated farming output, reducing unproductive water losses i.e. due to further rise in water productivity.

One of the ways for comprehensive improvements in the water and agricultural sector is IWRM. The first wide experience of putting IWRM into practice was gained in the Fergana Valley on territories of Kyrgyzstan, Tajikistan and Uzbekistan, where pilot projects were launched in 2002. Analysis and findings of pilot activities presented in this book were prepared by the think tank of the IWRM-Fergana Project, key specialists of the SIC ICWC and IWMI, as the first generalization of seven-year adaptation of IWRM principles to the conditions of the arid zone in Central Asia. Along with the description of practical activities and case studies of improving the water sector, some theoretical provisions based on former and current studies of national specialists and scientists are given here. The key components of the IWRM concept that we have employed include water resources management based on hydro-geographical principles, broad involvement of stakeholders and water users into the decision-making process by different ways and at different levels, using various sources of water resources, as well as the combination of institutional and technical instruments of IWRM introduction. Integration of these activities has considerably reduced the total water withdrawal into all pilot irrigation systems, and raised their efficiency and productivity of water use. However, the main achievement of this project consists in the fact that IWRM, as the integrated approach, was welcomed by the broad circle of stakeholders. Essentially, public participation, to a considerable degree, is the recovery of former, being existed prior to the colonization, management methods with employing water users' initiative, funds and self-discipline, as well as the traditional institutions such as "water resources management by mirabs (public irrigators)", "organization of khoshars (voluntary public works),"etc. Such an approach facilitates the creation of awareness of local population regarding suggested methods. Seminars, training courses, and conferences held at the regional and national level have shown the considerable interest in our experience of top and middle-ranged specialists in the water and agricultural sector. We have seen the interest of direct water users, whose number exceeds tens of thousands in the frame of this project. Just their attention and aspiration for innovations inspire the optimism regarding the IWRM introduction into the water sector practices in Central Asia.

Many planned tasks were not solved at the desired level including applying the IWRM methods at the basin level, the level of public participation, integration of irrigation and land reclamation activities, and involving non-agricultural water users. During the next phase, we should elaborate and proof in practice the clear-cut recommendations on putting IWRM into practice in the pumped irrigation systems. Many things have to be done for the improvement and adaptation at the governmental level the methods of financial and legal governance of IWRM in all three countries. At present, especially during the new project phase, one of key project activities is aimed at dissemination of IWRM methods, approaches and instruments over other regions of water use both in the Fergana Valley and beyond its boundaries. Initiating these activities, we have great expectations for close cooperation with other donors of the projects that are in progress in our region.

At the same time, it is necessary to keep in mind the introduction of IWRM in each water district or each new irrigation system, the experience learnt from pilot projects in the Fergana Valley cannot be blindly replicated. Just as each human being has his own traits, each new irrigation scheme can be quite specific in the morphology of irrigation network and water infrastructure or subjected to different economic, legal and financial circumstances in the country or its separate areas. Therefore, the approaches employed and tested by us should be adapted to the specificity of new natural, economic, and social conditions and the system of water resources management.

In the process of introducing new management principles at pilot sites it was revealed that simply "mechanical" transferring the hydro-geographical approach employed in Europe into our conditions with using only participation of local authorities' representatives in the community-based management bodies cannot provides good results in full. Many responsibilities lies with local, district and provincial organizations to implement production plans. At these levels, they manage the appropriate systems of resources supply, technical and ameliorative services, and financing the agricultural sector requirements. A certain combination of water resources management based on the hydro-geographical principles with the administrative management of land resources and nature management is required taking into account some marketing requirements. This approach will be developed during the new project phase.

This book brings to your attention and judgment not only the result of thoughts, ideas and works of authors mentioned at the front-page. This is the fruit of collective work of the great number of formal and informal participants of many projects related to developing the IWRM methods. First of all, it could not be possible to collect necessary information and data for writing this book without continuous not only financial but also technical assistance of the Swiss Agency on Development and Cooperation (SDC). Undoubtedly, active participants, advisors and managers of the IWRM-Fergana Project were Messrs. Juerg Kraenhiebuehl and Johan Gely, chiefs of the Regional Office and Headquarters in Berne, and Messrs. Markus Muller, Urs Herren, Hanspeter Maag. Regarding their participation one can say: "Thought thrives on conflict." The continuous support of Director General of the SDC Mr. Valter Fust, as well as direct participation of chiefs of water management bodies of three countries Messrs. D. Bekbolotov, B. Koshmatov, A. Nazirov, S. Yakubzod, A. Jalalov, Sh. Khamraev were the backbone for developing this project. The real co-authors of this book are most of our project colleagues and partners in all three countries whose input in developing IWRM in the Fergana Valley is hard to evaluate. These are also chiefs and officials of the BISA "Syr Darya-Sokh" (former "Fergana") Messrs. A. Rakhmatilaev, F. Rasulov, R. Rustamov, and O. Khalikov; specialists of the BISA "Syr Darya- Karadarya" (former "Andijan") Messrs. Sh. Ergashev and M. Dusmatov; specialists of Soghd Oblvodkhoz Messrs. Kh. Khojiev and A. Boboev, and the untimely departed Mr. Bakhit Matraimov, chief of BISA "Osh". Personnel of the Ministry of Water Resources and Ministries of Agriculture and Water Resources of Kyrgyzstan, Tajikistan, and Uzbekistan Messrs. A. Djaylobaev, A. Zairov, U. Azimov, and Kh. Umarov have continuously participated in implementing IWRM activities. Specialists of the CARWIB Project Messrs. I. Beglov and B. Turdibaev presented the project activities at the special website.

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