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Experiences with IWRM in the Central Asia and Caucasus Regions

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Abstract: *The Soviet period of the command system left a legacy of under-funded multilevel bureaucratic structure of water administration and planning for the Central Asia and Caucasus countries. The existing administrative system of water management is unable to cope with inter-sector, dynamic, and versatile character of current water management problems. Therefore, the situation calls for principles of integrated water resources management (IWRM) in the region. This paper presents some ideas about institutional reforms in water sector started in Central Asia and Caucasus regions. It describes the key IWRM principles and how these principles are being implemented into practice.*

Keywords: *integrated water resources management, governance, institutional reforms, water user association, water productivity*

Introduction

The Central Asia and Caucasus (CACENA) region (Figure 1) has two specific features regarding water resources formation, management, and use. First, due to geographic position and geopolitical processes, there is a clear division into two sub-regions: Central-Asian and Caucasian. The nations of Central Asia (Kazakhs, Kyrgyzes, Turkmens, Tajiks, and Uzbeks) were always united around water use in the Aral Sea basin. Similarly, Caucasian nations (Azerbaijans, Armenians, and Georgians) were united around water of the Kura, Araks, and other rivers in the Southern Caucasus. There always were certain close water-related economic and political relations. At first, it seems that geographical remoteness and previous problems with economic relationships hamper water partnerships. But it should be noted that people survived for centuries on the basis of common water use when different groups of water users made decisions about water resources governance, and there were not any serious conflicts in the region over water. The second and more common feature for the region is that it is a basis for collaboration around water since the most fertile lands are located within arid and semiarid climatic zones.

The actual state of water sector in CACENA region is complicated and determined by the transition from the old command governance system based on administrative principles to a democratic system within hydrographic boundaries and open for public participation. Some changes in water use structure, such as slowly implemented market relations between supplies and consumers, have already begun. In conditions of independence and common social-economic degradation, there are some destabilizing factors that resulted from weakness in water governance organizations and in water users. Among these factors the following are the most serious:

- high rate of population growth (1.5 to 3.2 percent per annum);
- low national income per capita;
- growing water deficit due to growing needs and poor demand management;
- significant environmental damage due to lack of attention to water requirements for ecosystems (upper watershed, deltas, Aral Sea, Sevan Lake etc.).

Water resources management is an art that delivers the required water volume with the acceptable quality to the proper place and in proper time. A few interrelated elements are needed to implement this approach. On the one hand, engineered water delivery infrastructure (reservoirs, canals, control structures, drainage systems, etc.) should be constructed. On the other hand, the institutional infrastructure (water governance institutions) is needed to maintain the engineering infrastructure and to provide water supply and other related services. For successful performance of the institutional infrastructure, management tools should be provided. In addition, a proper sys-

Figure 1. Location of the Central Asia and Caucasus countri**es**

tem of financing and initiatives is to be established. Thus, it is clear that the art of water management is an integrated (multi-faceted) process, which in the current practice is referred to as integrated water resources management (IWRM).

IWRM is a process based on accounting of all available water sources (surface, ground, and return waters) within the hydrological boundaries; it integrates the interests of different sectors and hierarchical levels of water use, it involves all stakeholders into decision-making; and it promotes efficient water use for the sake of the sustainable public welfare and environmental stability.

The IWRM process includes a few key principles, which specify its practical context. In general, key principles of IWRM are as follows:

- Water management is implemented within the hydrological boundaries in accordance with geomorphology of the specific drainage basin (catchment);
- Water management provides for the water inventory and involvement of all available water resources (surface, ground, and return waters) taking into account climatic features;
- Close coordination of the water use process and all involved institutions over horizontal links between sectors, and over vertical links between hierarchical water use levels;
- Public participation not only in water governance and management but also in financing, maintenance, planning, and development;
- Public awareness, openness, and transparency of the water management system;
- Priority for nature requirements in activity of water institutions;
- Incentives for water saving and control of unproductive water losses (at the water users' and water institutions' levels).

A backbone of each key principle is described below. It is important to understand what measures are needed for their practical implementation.

Catchment Elements of IWRM

As is well known, water does not recognize any boundaries. According to the laws of physics, water goes through the complicated hydrological cycle: water falls to the Earth in the form of precipitation forming streams (rivers), from which water can be withdrawn for the needs of human beings, and then it evaporates and enters the atmosphere, transforming into precipitation again. Water from precipitation partly seeps into the ground forming bodies of groundwater (aquifers), which are, nevertheless, in close interrelation with surface streams. The area, where a surface stream is formed and the complete water cycle takes place, is called a hydrologic basin (a drainage basin or catchment). Water within the hydrologic basin circulates regularly and naturally crosses administrative boundaries, which are delineated by human beings on the basis of geopolitical considerations. According to the conditions of formation and transformation of water runoff, the catchment territory can be conditionally subdivided into three main zones: (a)Runoff formation zone (its recharge zone in upper/mountain areas); (b) Zone of transition and dissipation (runoff use); and (c) Delta zone.

Construction of large dams and reservoirs has been implemented in the runoff formation zone, therefore, in this zone, the runoff regime is considerably transformed, but water quality is stable. In the zone of transition and dissipation, the runoff regime is completely different from the natural one and conforms to the needs of human beings. Here, the hydrological cycle and water quality are changed due to interaction between rivers and adjacent areas. This interaction is characterized, on the one hand, by water withdrawal from rivers to meet the needs of human life, industry development, and irrigated agriculture and, on the other hand, by return water disposal into rivers, which contains salts, agricultural chemicals, and other pollutants. A delta zone is an accumulation zone of residual water resources within the river basin. Here, the water is mainly expended through evaporation.

Thus, it is clear, in order to control all possible factors affecting the hydrological cycle, the whole catchment should be under the jurisdiction of a single system responsible for water resources governance. The institutional framework within the administrative boundaries, not coincident with hydrological boundaries, results in loss of controllability of some components of the hydrological cycle that impacts on stability, assurance and evenness of water distribution i.e., on implementation of the main management target. The administrative principle of water governance creates opportunities for some pressure from local administrations on the principle of equitable and uniform water distribution along catchment.

It should be noted that sometimes a single water management organization is not able to cover the whole basin when the river basin area is too large (see Figure 2, as an

Figure 2. The Syr Darya River basin (Eleven administrative units - provinces of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan are located within the hydrological boundaries of the basin), which sub-divided into 19 water-economic zones. (Source: GIS Database of SIC ICWC)

example) or its geomorphologic pattern is very complicated. In this case, a hierarchical framework of water governance system should be established within the basin, but with observance of the hydrological principle. Its subdivisions can control separate parts of the basin-sub-basins or sub-systems.

Available water resources within the catchment are formed from surface and underground sources. The current problem is that different authorities keep records of these sources, but the main issue is that different authorities without proper coordination also manage their utilization. This results in information disorder concerning water resources and a certain anarchy in water use. As a result, unproductive water losses are increasing, while water supply irregularity and an artificial water shortage occur in some areas within the catchment basin.

Most of the naturally-renewable water resources is formed on the catchment area surface and flows down into the hydrological network. Hydrometeorological services are keeping record of runoff formation and transformation along the rivers. Water governance organizations are responsible for water withdrawals from rivers and water delivery to water users. However, in recent years the hydropower authorities interfere in this process, and they manage water filling and release at the key reservoirs of the basin in the interests of the hydropower generation. It should be noted that the hydropower schedule of water releases collides with the irrigation regime, and sometimes it negatively affects ecosystems. Dissociation of sectoral authorities in use of allocated water (drinking water is controlled by the communal services, industrial water use is controlled by respective industrial authorities, and irrigation is controlled by water managers) is the main problem.

The second constituent of renewable water resources is phreatic (ground) water, which according to its genesis can be subdivided into two groups: phreatic water is naturally formed in the mountains and over the catchment area, and phreatic water is formed due to deep percolation in the irrigated areas. Phreatic water resources within a catchment are usually estimated based on the hydrogeological survey, following which aquifer storage available for usage is approved. Assessing storage and use of aquifer is carried out by the Departments of Geology without clear-cut coordination with authorities responsible for water resources management.

Return water, i.e. water that is returned again to the natural system after anthropogenic use, is a part of the available water resources within the catchment. Return water can form due to both surface water releases and underground inflows. Owing to its higher salinity, this water is the main source of pollution of water bodies and the environment as a whole. Under current conditions in basins with arid climate, drainage water of the irrigated areas forms about 90 percent of the total return water volume, and the rest is sewage water released by industrial plants and public utility companies. The water management organizations and hydrometeorological services are mainly

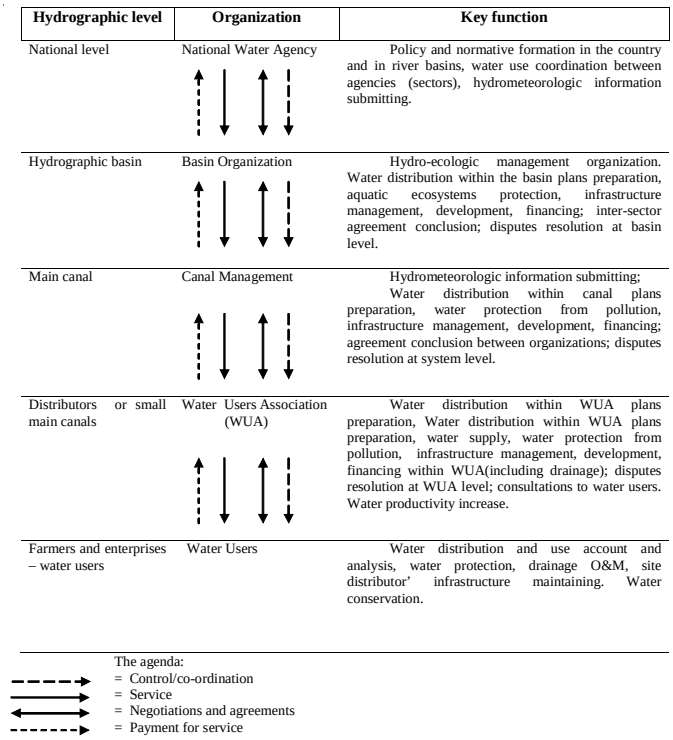

Figure 3. IWRM Institutional Framework within the Catchment (IWRM-Fergana Project document, 2004)

keeping record of return water, but nobody controls reuse of return water. Although, much of the research and promotional work is carried out to assess the scope of the return water use, there still are not clear-cut documents and regulations how to reuse return flow. As a result of unsystematic application of this water for irrigation, secondary land salinization takes place and land productivity (fertility) drops considerably in many parts of the region.

A huge amount of return water, released back into rivers without any limits and restrictions, transforms good fresh water into brackish water, which is difficult to use for any needs. Water bodies in the desert zones and at the periphery of irrigated lands are fed by drainage water without any planning, and as a result, these water bodies are losing their environmental and nature-stabilizing value. For instance, in Central Asia a few artificial lakes with different capacities and sizes were created in natural depressions on the basis of drainage and waste water. The largest water bodies are Lake Aydar-Arnasay with a capacity more than 30 km^3 and Lake Sarakamish with a capacity of about 100 km^3 of brackish water. As a rule, these water bodies have no through-flow; flora and fauna are not developing in them due to the unstable water and salt regime, which is formed without any control under influence of casual factors.

Thus, the above description of the problem clearly shows that clear coordination is necessary in order to keep record of and to manage different types of water.

From the point of view of cross-sectoral (horizontal) integration, water management bodies should take into consideration equally the water use interests of all sectors and provide a priority for water saving and the environment within one hydrological unit. As mentioned, the problem is that different authorities manage different waters and uses. At the same time, the all public/governmental authorities, as a rule, do not coordinate their activity with each other. If during the Soviet period there were statistics on water use by all sectors (2-TP vodkhoz), then currently nobody has even general information about the catchment.

At the minimum, three components are needed in order to coordinate cross-sectoral interests: a unified legislative basis, the institutional framework, and water management tools. It needs to be noted that there is the positive experience of partial cross-sectoral integration in Armenia, where the single public authority (Armkomvodkhoz) simultaneously maintains the irrigation and drinking water supply systems within the country.

From the point of view of vertical integration, to implement the IWRM principles at the national level, the hierarchical institutional framework has to be built according to the following chain: the water management authority (the Ministry or Department); the basin water management administration; the irrigation scheme/canal administration; WUA (water users association); and water users. The institutional framework, covering the catchment area, is shown in Figure 3. Both the irrigation canal and the inter-district canal administration established according to the hydrological principle could be taken as the separate management units. WUA should replace the pre-existing governmental organization responsible for operation and maintenance of on-farm irrigation and drainage systems.

The crucial issue at the stage of establishing the WUAs, is the terms of transfer of secondary canals and on-farm infrastructure, which in the past were funded by governmental water management authorities. Here, two different approaches are possible: (i) transferring of the infrastructure to WUAs for temporary use on a contractual basis with annual financing for operation and maintenance of this infrastructure from the state budget; (ii) a public/governmental water management organization becomes one of the WUAs founders.

The main aspect of necessary reforms consists in minimizing hierarchical water management levels and clear cross-sectoral coordination, which enable decrease of unproductive water losses.

Bringing in Water Users

An extremely important element of the IWRM process is wide involvement into this process the civil society and public opinion. Water use management issues need to be considered in the context of interactions between a civil society and the state. The state (in narrow sense: government) is a superstructure over a civil society in the form of the authority structures (political and administra-

tive institutions), which have occurred in the course of the historical development in order to rule a civil society. Subdivision into the state and a civil society is conditional. In specific cases, the same persons or organizations can be representatives of the state or a civil society. Heads of district administrations or heads of district water organizations, as landowners, are often members of water users associations. The state is represented by officials of the authority structures and departments and a civil society by members of public associations, trade unions, political parties, or non-governmental organizations (NGOs).

The main problem is that personal interests of decision-makers often do not coincide with the interests of a civil society. Particular examples of negative internal purposes can be aspiration to overestimate a budget, unjustified application of expensive technique, and neglect of direct duties. First, when profit is not an indicator of work capacity, instead of it a budget plays its own role. Institutions are provided with funds and staff based on their budget, and this intensifies distortion of incentives. Secondly, the institution's objective can become a striving to high-tech solutions or (technological quality). Sprinkling or drip irrigation systems could be recommended where application of less expensive and more reliable irrigation methods are justified. "Extra-modern" management systems (for example, automatic control systems) can be designed and even installed in spite of the fact that installation of less complicated systems would be more efficient from financial, social, and technological points of view. Finally, officials of water management organizations can be inclined to infringement of existing rules for a few "favorites" by means of corruption or another subjective reason.

Public participation has to create an environment of transparency and openness, under which the likelihood of decisions not corresponding with public interests is decreased. The more intensive the public participation the less favorable conditions for corruption and ignoring public interests.

In the Soviet period, public participation, which was represented by trade unions, people's delegates, etc., was officially assessed as very high, but was, in fact, paltry. Currently, there are certain positive changes in some countries of the region (Armenia, Kazakhstan, and Kyrgyzstan), but as a whole the role of socially active members in water management is obviously insufficient for the time being. The state has to watch over the public interests, but often in pursuing of political and economic goals, it ignores social aspects, and therefore socially-active members should have the opportunity to participate in the decision-making process concerning matters of principle.

The nature of water itself defines the necessity of public participation in water use management. Depending on the goal of water use, the water, as natural resource, can be: a) private or b) public good (Dukhovny, 2000). For example, as a private good, water is used for municipal water supply (drinking water, food preparation, sanitary needs, etc.); fishery; irrigation of crops and leaching of salt affected land; hydropower production, etc. Examples of water use as a public good are sanitary water releases, water-reserves for conservation of flora, fauna, and natural habitats, and water bodies for recreation and entertainment purposes.

Water management in the CACENA countries is set in such a way that water is supplied to some consumers in the first place, i.e. they are high-priority water-consumers (communal, industrial, and technical needs), and others receive water according to a residuary principle (maintenance and rehabilitation of ecosystems, sanitary water releases), which causes damage to the nature (the Aral Sea tragedy is an example). Public participation is a factor that could change this situation, prevent further degradation of ecosystems in the region, and facilitate rehabilitation of those ecosystems, which could be yet rehabilitated. How to arrange public participation it depends on management methods.

Management Methods

From the view point of recent socioeconomic approaches, there are the following water use management methods, which could be used in the region (Solanes, 2002; Mirzaev, 2002):

- *Centralized (public*) method, when the management is controlled in the strictly administrative-mandatory form and public participation is reduced to the minimum;
- *Decentralized (market)* method, when decision-making concerning a matter of principle in water management at different levels is possible with public participation, including water users themselves.

Both methods have virtues and shortcomings. A market is required because without it there are no incentives to reduce water demand and to increase water productivity. However, it is also impossible to manage without the state and public participation, due to the peculiarity of a market to forget about social problems, which the state takes upon itself.

In their purest form, these management methods are almost never met in current practice. As a rule, there is a combination of these methods as the shortcomings of one method are virtues of the other, and they can supplement each other. Until now, the first method was typical for CACENA countries. At present, a process of decentralization is in progress. Decentralization is implemented through application of market management methods (privatization, introducing water charge and payable water services, etc.) and transfer of the rights to make decisions on issues, which can be more efficiently solved *in situ*, to the local water management bodies.

In respect of the aspects to be controlled, water use management includes: (i) water resources management,

Table 1. Management functions distribution at the catchment level (IWRM-Fergana Project document, 2004)

Functions of the Water Committee (Public body)	*Functions of the Executive Body (Governance and Management)*
1. Approval of water allocation regulations, water supply and disposal plan; 2. Monitoring of water supply and disposal plan implementation; 3. Approval of quotas for pollutants disposal; 4. Approval of the maintenance plan; 5. Approval of funding; 6. Necessary funds formation; 7. Audit of financial activity; 8. Determination of water service prices; 9. Approval of the long-term development program 10. Implementation of water saving and demand control policy.	1. Annual planning: • Identification of water deman • Water allocation and distribut water quotas (limits) allocatec • Drainage and water protectior 2. Water use plans implementation 3. Implementation of monitoring: • Water records; • Water saving assessment. 4. O&M of water infrastructure; im improving irrigation system e 5. Involvement of water users and t water resources management 6. Establishment and maintenance 7. Support of consulting services. 8. Servicing charge collection. 9. As required, implementation of v consequences of emergency.

and (ii) water demand management. In the most developed countries, priority is given to water demand management. It is obvious that the water crisis situations are due to an increase in demand and reducing that demand would help greatly even though there would still be problems of existing levels of resources conflicts and environmental degradation. Demand for water can be reduced voluntarily by using many different technical, social, and economic tools. Regulatory instruments involving permits, restrictions, and allocations to various users and uses can also reduce water demand. For example, total water demand in the USA has declined from a high in 1980, despite large increases in wealth and population (Rogers and Hall, 2003).

In CACENA countries, attention was traditionally focused on water resources governance under conditions of water scarcity, and it is clear that the problem cannot be settled only by technical measures. It is also necessary to place emphasis on water demand management. Specificity of this approach is that it is focused not on technical infrastructure (reservoirs, canals, etc.), but on the people involved in the water use process, i.e. social impacts on the water use management process by means of institutional and cognitive factors have priority.

Thus, taking into account features of water use management methods based on the principle that water is not only a private good but also a public one, one may arrive at a conclusion that public participation is the major component of water use management. The role of the public increases due to "interpenetration" of representatives of different organizations into other institutional frameworks. For example, representatives of water users should take part in the activity of the water management organization, and representatives of the water management organization, local government, and clergy should take part in the activities of water users associations. In the first case, representatives of water users play the role of the public, in the second one, the same role play representatives of water institutions. These representatives can even be deprived of the right of participating in decision-making, but their presence and participation in consultations is anyway rather useful.

Under public participation, management functions could be distributed between policy-making bodies (Water Committees) and executive bodies (water management organizations) as follows (Table 1).

Another participatory issue is how to account for the interests of nature within the water management process. Only after independence did the CACENA countries begin to take into account the environment degradation due to anthropogenic impacts. They realized that the environmental degradation had become a factor for the social-economic destabilization in the region or in its separate parts. The main precondition providing sustainable natural and anthropogenic cycles is a minimization of negative interaction between water sources and economically-operated areas, as well as between surface and groundwater.

With respect to environmental sustainability in the catchment, it is possible to propose an approach based on application of sustainability criteria considering two major interrelated components: water quality in a water source and accumulation of pollutants in economically-operated areas. In other words, criteria of welfare according to these parameters are represented as follows:

- Pollution in economically-operated areas and affected ecosystems should not exceed the permissible concentrations, and trends of accumulation of toxic pollutants are to be negative, i.e. pollution reduction is in process in the concerned area;

- Contamination of water sources over all zones of the catchment, from upper stream to the delta, shall not exceed the maximum permissible concentrations for all water-users using water from water sources.

A number of statements, which should be considered under water resources management, can be formulated based on these criteria. First, it is necessary to secure commitments of the government to take into account the environment requirements. Second, the equal rights to water use (which does not mean equality in a volume of water use in each basin) can be provided in such a manner that each water-user shall have equal rights to the minimum water use determined according to advanced water use norms or a long-term technological level of water consuming sectors. At the same time, equal opportunities and rights to normative-minimum water use, which meets the minimal needs of each person for existence, labor, and food, should be established. There is a social right of each person, which should be provided by the state, and the government should be responsible for observance of the water-use level that corresponds to the technological level of productive water use. Third, penalties for exceeding the level of ecologically-permissible water withdrawals by each water consumer can form a certain fund for environmental protection within the catchment, which could be used for implementation of routine works improving ecological conditions in the basin.

It is clear that recently the water requirements of ecosystems can no longer be satisfied according to the residual principle (as much water as remained after satisfaction of the economic needs). It should be one of the most important activities of water governance institutions within the IWRM framework.

Maximizing Water Productivity

Despite the overall reduction of water withdrawal in all countries of Central Asia and Caucasus in recent years (mainly due to the economic crisis), it is necessary to recognize that efficiency of water resources use is still insufficient.

Taking into account that after independence the single statistic water use system of record in all countries collapsed, outcomes of the WARMAP project implemented within the EU TACIS program in 1996 to 2000 may be used in order to analyze ways of water saving (Khorst, 2001). This is an excellent example of water use analysis for the main water-consuming sector in countries of Central Asia that is irrigated agriculture. According to the WUFMAS database created within the project, covering 22 farms over five countries of the region, water requirement in pilot cotton farms ("gross-field") was 7,240 m^3 per hectare, on average. This amount includes 2,040 m^3 per hectare of leaching and pre-irrigation as well as 5,200 m^3 per hectare of water applications itself within the growing season. The further analysis with usage of economic parameters has shown that under cotton-growing the productivity of irrigated land varies from US$ 650 to US$ 1,315 per hectare, under rice production; from US$ 675 to US$ 1,000 per hectare; and under wheat from US$ 150 to US$ 450 per hectare. It should be noted that price policy conducted by government in the agricultural sector has essentially affected cost indicators of land productivity assessment in different countries.

A dramatic feature of the current situation in water use in the region is that under conditions of water supply limitation (water quotes), the water deficit is aggravated by extremely irrational water use at the on-farm level. Basic water losses take place in the on-farm (former) irrigation network and in a field. At the same time, over-normative water losses at both levels, on average, amount approximately 4,440 m^3 per hectare or 37 percent of total water supply at farm boundaries.

According to tentative calculations executed within the framework of the above mentioned WUFMAS project based on direct measurements at the field level and involving "indirect" parameters, on the average, 21 percent of irrigation water, except for losses caused by current technical conditions of on-farm irrigation systems, are lost in the field.

In the irrigation areas with a rather high water table, approximately half of the water losses come back to the root zone in the form of capillary rise. This extra water slightly raises the overall efficiency of irrigation water use, but does not correspond to the optimum reclamation regime preventing processes of soil salinization and deterioration of surface and groundwater quality. Most of the "over-normative" losses (about 20 percent of water supply to farms in the Republic of Kyrgyzstan and the Republic of Tajikistan) are caused by irrational irrigation techniques in areas with steep land surface gradients. In middle and lower reaches of river basins, most of the irrigation water losses occur in the water-conveying system from farm boundaries to fields. Apart from water losses due to technical conditions of irrigation canals, these losses, so-called "organizational losses," are caused by the imperfect technological process of water distribution at the on-farm level and extremely irrational management of water applications at the field level. These water losses amount 15 to 35 percent of water supply to farms.

The correctness of conclusions specified in the project reports is justified with subsequent studies at the same fields when a goal of improving water use efficiency by applying elementary, and low-cost technologies in order to reduce unproductive water losses has been set. As a result of these works, only during the first year of this experiment, water productivity increased by more than 80 percent and water resources savings of 30 percent have been attained on all fields.

Based on the above practical experiments and taking into account that most of losses occur at the field level and under water distribution among new privatized farms,

Table 2. The reasons of water productivity losses and measures for their elimination (Dukhovny and Sokolov, 1999)

Hierarchic Level	*Reason*	*Measures on Elimination*	
		Type	*Description*
River basin (transboundary)	Instability of water withdrawal and disposal caused by :		
	• Political frictions among countries and sectors;	Legal	Agreements, regulations
	• Water supply schedule violation;	Institutional	Institutions and order of regulation
	• Water over-diversion by upstream intakes;	Legal Technical	Agreements and incentives Distribution accuracy increased by SCADA system
	• Upstream losses are not taken into account	Technical	Water and losses records
	• Instable water availability	Technical	• Water supply regulation; • Re-use of return water
	• Lack of control over water distribution	Technical	Organization of water supply and distribution control
Canal system	• Lack of planning, distribution and dispatch system	Technical	• Management rules; • Planning based on modeling with finite corrections
	• Lack of water distribution discipline	Technical	• Rules of water account and control; • GIS application for planning
	• Water diversion over plan	Institutional, Economic	Sanctions, incentives (payment for service)
	• Lack of water account	Technical	• Hydrometry, recording; • SCADA; • Information system.
	• Lack of distribution order	Technical	• Water rotation rules; • Use of all types of water
WUA	• Stochastic requirements	Technical	• Agreement on distribution among user groups; • Water rotation methods;
	• Lack of water balance and account methods	Technical	• Water accounting tools; • Information system; • Dispatching
	• Incentives for water saving	Financial	• Bonus system; • Fines and privileges; • System of payment
	• Lack of control over WUA and conditions prediction	Technical	• Water supply planning and correction; • Forecast of water demand
Water User	• Lack of water use planning	Technical	Training on planning skills
	• Impropriate irrigation scheme	Technical	Recommendations on irrigation technique and methods
	• No accounts of weather fluctuations	Technical	Extension services
	• Uneven moistening	Technical	GIS, recommendations on yield smoothing
	• Yield losses due to soil reclamation state	Technical	Drainage performance

establishment of the water users associations is the major mechanism to put in proper order water use and saving along with water charging. It is also necessary to note that the regional program of water saving should be differentiated for each state, each zone, and each water user. The certain mechanisms should be in compliance with reasons causing unproductive water losses, unevenness, instability, and low water availability of consumption (see Table 2).

Implementing IWRM

Taking into account the all-inclusiveness of IWRM, the given process cannot be implemented at the national or basin levels at one time (during a short time period). The IWRM principles should be put in practice stage by stage, based on gradual strategic and coordinated planning over a few years. The terms of practical implementation of IWRM principles depend on governmental support, the financial and economic situation in the country, as well as (for developing countries and countries with a transition economy) international assistance. Under ideal conditions, the implementation process of IWRM principles should pass through (at least) three phases:

1. Establishment of enabling environment for IWRM – the general framework of national policies, legislation and regulations, information for water resources management stakeholders, public awareness, and capacity building;
2. IWRM national plan – conditions analysis, priorities identification, and development of the Action Plan; and
3. Promotion of plan implementation – political support and strategy of financing reforms.

The first phase includes a number of certain steps. First, public awareness of the main IWRM principles and a political will to promote the necessary reforms are necessary for effective implementation of the IWRM principles. Information on the main IWRM principles should be, first of all, disseminated among key politicians, experts, and organizations in the water sector. It can be achieved through the disclosure campaign, which should pursue an overall objective of forming a political will and interest for implementation of the IWRM principles.

Secondly, it is necessary to create conditions for extensive participation of stakeholders. It is necessary to involve existing mechanisms (public councils, committees, etc.) for widespread consultations with stakeholders (departments, professionals - water management specialists, water users, local authorities, etc.) over all IWRM issues. If there are water users associations in a country, their role in the co-ordination process can be very important. Holding national or regional conferences or meetings concerning IWRM issues is a powerful tool establishing the basis for co-ordination.

Probably, under present conditions, the most important matter for the countries of Central Asia and Caucasus is capacity building for reforms. It is necessary to create and develop the training network in the water sector, to improve communications, and to expand publications on IWRM problems. It is necessary to resolve the crisis with keeping records of water resources and their use (including rehabilitation of interrelations between water management organizations and hydro-meteorological services). Finally, it is necessary to improve the existing information systems (databases, GIS, etc).

The principal element of enabling environment is a legislative framework for IWRM. Practically, in all countries of the region, the current water legislation (the Water Ñode or other similar laws and regulations) requires significant revision. The legislation is the basis for division of powers, identification of responsibilities and rights required for establishing necessary institutes and mechanisms for implementing IWRM policy. The legal regulations have to promote effective state policy in the water sector by:

- Formulating the role and responsibility of government, water management organizations, and other stakeholders with respect to water resources use, allocation, management, development, preservation, and protection;
- Precise definition of socioeconomic and ecological value of water;
- Forming specific attitude with respect to restructuring, division of powers, privatizations, strengthening the role of local communities, and public participation;
- Precise definition of the right to water, the WUA role, rules of co-ordination between sectors, as well as mechanisms for their implementation;
- Establishing liaisons with nature protection bodies, agricultural and local authorities, economic development bodies, etc.

IWRM planning needs to start with analysis of the current situation in the country. Generalization of available information and plans concerning IWRM frameworks enables to specify precisely, where at the moment this country is on the way to IWRM as well as to answer the following questions:

- Is there a national water strategy (The Master Plan of Integrated Water Resources Use and Protection) or a similar document at the national, regional or basin level?
- Is there a backbone to the national water policy?
- Is there a package of existing programs and projects for implementation of IWRM principles (as a whole or in part)?
- Are there other national plans (developed under assistance of the international organizations) - Sectoral Reforms, Infrastructure Rehabilitation Plan, Sustainable Development and Poverty Reduction Strategy (referring to the role of water supply and sanitation, and water resources), National Environment Action Plans, etc.?
- Are water supply and sanitation included in the strategy as priority matters and in what part of the strategy (health, manufacture, etc.)?

The second phase of planning is establishing/reforming the institutional framework of water management with regard to forms and functions necessary for IWRM. Here, it is necessary to formulate regulations for the following key participants of the planning process:

- National agencies, river basin organizations, regulating authorities and civil society groups, transboundary water organizations, statistical departments;
- Institutes (organizations), which should participate in

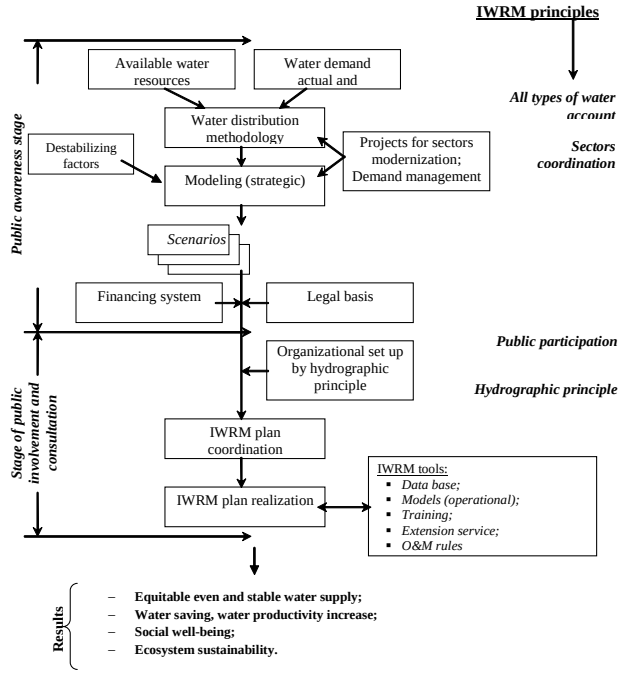

Figure 4. Layout of IWRM principles planning and realization

development of the IWRM National Plan.

To develop correct policy, in the phase of planning, it is necessary to determine precise priorities and likely problems of water resources management for the nearest and remote prospect taking into consideration: conflicts owing to water deficit among water users (at present and in the future); resources conditions under IWRM impacts; and whether the main hazards to resources are specified and taken into account?

One of the main results of planning is identification and distribution of functions of water resources management. Here, it is necessary to determine whether the key water organizations are allocated by functions and powers to cover all or some IWRM aspects and problems, including: resources management functions; water organization and infrastructure management functions; and fund management functions.

Another important result of planning is regulations for the financing and incentive framework, namely, precise identification of mechanisms of:

- Financing of water management and implementation of IWRM principles;
- Financing of water services (water supply and sanitation, irrigation, etc.),
- Investing in operation and maintenance of water infrastructure;
- Investing in water infrastructure development.

The water services financing framework with participation of all water users has to include the following components:

- Cost estimate of regulating and supervising activity of the water management organizations at all levels of the water management hierarchy;
- Cost estimate of water services;
- Identification of financial sources including a necessary fee size, local dues and fees, payments for services and/or taxes;
- Identification of regulations for fee collection, local dues and fees, etc., and also reporting forms;
- Acceptance of necessary procedures of conducting the financial account and carrying out of auditor checks.

An IWRM principles planning and implementation chart for the river basin is given in Figure 4 (adopted from the Hrami/Debed River Basin Integrated Planning, 2002). The logic sequence of necessary measures and the public participation phases are shown in this chart. The main sequence of implementation of IWRM principles is also shown in the right part of the chart.

When the IWRM National Plan has been prepared, it will be necessary to create all conditions for its practical implementation. At this stage, each state must make decisions in what way the political support of IWRM principles will be provided in the country, and what executive agency (ministry, government, parliament or another agency) will play a key role. Financial policy promoting implementation of IWRM principles needs to be developed in the country.

It is clear that apart from the institutional framework and enabling environment, a set of IWRM tools needs to be used for day-to-day water operation and improvement of the water management system itself. These tools shall include:

- Management tools (assessment, planning, water use efficiency indicators);
- Governance tools (water quotas under water shortage, water allocation methods, water metering);
- Economic tools (water/water services charging, subsidies and incentives, market, payment for pollution);
- Data exchange (database and a set of mathematical models);
- Social tools (education, training system);
- Conflicts resolution (public participation, consensus-seeking, arbitration).

Under transition to IWRM, water agencies, observing necessary conditions, have to provide equitable and adequate water allocation over all the irrigation system and set water supply to water users. Conditions for improving water and land productivity can be provided by supplying water to the direct water users (WUAs and others) in accordance with well-founded volumes, quality and time. This plan should provide for technical measures improving operation and maintenance including: (i) revision of the irrigation area and its water requirement; (ii) record of available local water sources (ground water, return water); (iii) water use adjustment depending on climatic and

economic conditions; (iv) water rotation, water supply and water allocation procedures; and (v) water record-keeping at all levels of the irrigation system.

Private sector development (including the agricultural sector as main water consumer) should be supported by state assistance, promoting each economic entity in both technical and technological issues. To solve such issues, it is necessary to establish extension centers, which will assist the water users to put in practice new technologies and state-of-the-art methods. An extension center is an organization, which works for the sake of producers realistically evaluating their needs and the capabilities of water management bodies in the water sector.

Water and Public Education

There is one important circumstance that unifies the current or recommended measures on implementation of the IWRM principles. Here, we came close to one very important factor, i.e. the human factor. Water may be and should be saved not only by provision of economic incentives for water users, but also by intensification of the human factor, i.e. by reorganization of the public consciousness in relation to water, by liquidation of the gap between "my" and "our." It can be achieved through introduction in consciousness of people, especially the young generation, such concepts as "water is the greatest good and simultaneously the greatest value granted to us," "a human being, like water, is a part of the nature, therefore he cannot be the master neither of the nature nor of water." Revival of the solicitous attitude of our ancestors to water is expressed by such statements as: "Water contamination is a great sin" and "Water is life." However, a few things can be achieved by slogans and appeals. The public consciousness can be transformed in the necessary direction only on the basis of purposeful and integrated training of people employing stored knowledge, of experience of water use by our ancestors and contemporaries, and of not forgetting omissions and mistakes of the last generations with respect to water and to nature as a whole. When asked "who is to be a student?" – the natural answer is, no doubt, schoolboys and schoolgirls as tomorrow, since in a few years, they become adults and become an actively employed part of the population. Generations competent in water issues should come to take our place.

At the moment, strong dependence on the educational programs developed and applied still in the Soviet period is being traced in educational systems of most countries of Central Asia and Caucasus. However, specific improvements of 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 GWP CACENA together with the SIC ICWC offer to introduce water problems into educational programs. The goal of this initiative is scientific and methodical assistance to experts of the national education, the training and methodical institutions to improve the existing curriculum for a number of school subjects (history, geography, chemistry, economic, and legal knowledge) with a objective of developing in pupils, by the moment of graduation, good knowledge of the complex of water problems in order to inculcate conscious and solicitous attitude to water.

Speaking about realization of this initiative, for instance, in the Republic of Uzbekistan, it is necessary to keep in mind that the proposed measures and recommendations should not contradict the laws adopted by the state (the Law on Education and the 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 general educational programs should be in the context of the state education standard and meet the principles incorporated in it.

One of the principles of the state education standard says that education should meet requirements of the state and society. Today, the range of water problems is a subject of special attention of the state and affects the interests of the society and personality more and more. Though curriculums of the above-listed school subjects contain elements covering those or other issues related to water, its properties, data on its formation sources, in its present form, it is absolutely not enough and does not meet requirements of the state, civil society, and ordinary people.

Creation of a separate topic "Water Resources" or "Water Problems" now seems to be impossible, though it would enable unifying of knowledge on water and its resources and focus attention of the pupil on concrete practical questions. It is necessary to find ways of integration of the topic "water resources" in curriculums of school subjects. Fulfillment of this task by means of including this topic into different subjects seems to be the most acceptable, but it actually creates difficulties and uncertainties. The following sequence seems to be logical: to identify what knowledge pupils have to learn in the complete set (as though there is a separate topic "Water Resources"), then to formulate what pupils have to know in 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.

As a minimum, students should learn the following:

- Natural waters of all kinds and physical states are, somehow or other, interrelated and are in permanent movement – large and small cycles;
- Mankind, for its purposes, uses waters of the rivers (big and small rivers), freshwater lakes, dynamic groundwater reserves;
- The 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 activity, disposal of waste water without treatment to water sources;
- Sustainable economic development of any country, hence well-being of each its citizen, directly depends on adequate provision of the country by fresh water resources. Therefore, water saving and its rational use attract the state attention more and more and gain in the practical importance for the society and people;
- Water is a valuable natural gift, an irreplaceable resource, and under specific conditions a good having a price. For this reason, use of economic mechanisms (purchase and sale) in water relations is quite natural and promotes search for solutions on water saving and protection;
- Water saving is a duty of each citizen, where qualitative fresh water is used. Water saving consists of personal savings and state savings;
- Deficiency of fresh water (under its quantitative constancy) is an irreversible process due to the population growth and development of water-demanding branches of economy in the country.
- The duty of every citizen is an understanding of decisions and measures of the state and the government directed to mitigation of stresses related to water, and strict fulfillment of their own duties regarding their implementation in practice.

Concluding Remarks

Due to transition to IWRM, based on the above-described principles, in view of implementation of institutional, technical, and other measures, as well as under condition of sufficient financing, important results can be achieved. The main results should be: (i) sustainable water supply; (ii) uniform and fair distribution of water resources over sub-basins under significant reduction of unproductive water losses; (iii) introduction of democratic water resources governance principles owing to involvement of all stakeholders and economic sectors, interested in water resources use, into water management; (iv) the solution of social problems related to fair water supply of the population, drinking water, and poverty reduction; (v) the solution of the environmental problems occurring due to economic activity; and (vi) as an ultimate goal, improvement of general water and land productivity.

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