IWRM IMPLEMENTATION: EXPERIENCES WITH WATER SECTOR REFORMS IN CENTRAL ASIA

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1 Introduction

Water resources management is an art to supply the required water volume with acceptable quality at the proper place and in proper time. This is process which includes a few principal components: available water resources, engineering infrastructure, demands, allocation procedure, delivery service and finally – use of water. Each component addressed to certain task, implementation of which could be evaluated by proper indicators (see Table 1).

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In the reality water resources management process is not so simple. Try to imagine: is it easy to coordinate available water resources with demands within one hydrographic basin? At first glance, – yes, it is the proper engineering task. On the one hand, it is necessary to estimate available water resources such as precipitation, surface runoff, groundwater storage, return water, and on the other hand, water demands of different economic sectors such as municipal water supply, irrigation, industry, hydropower generation, recreation, navigation, fishery, and of ecosystems. However, each component of the water balance is related to both the social situation and economic and political conditions (see Figure 1). Diverse water sources, their interrelations, different sector interests, different impacts and consequences, various management tools and mechanisms,

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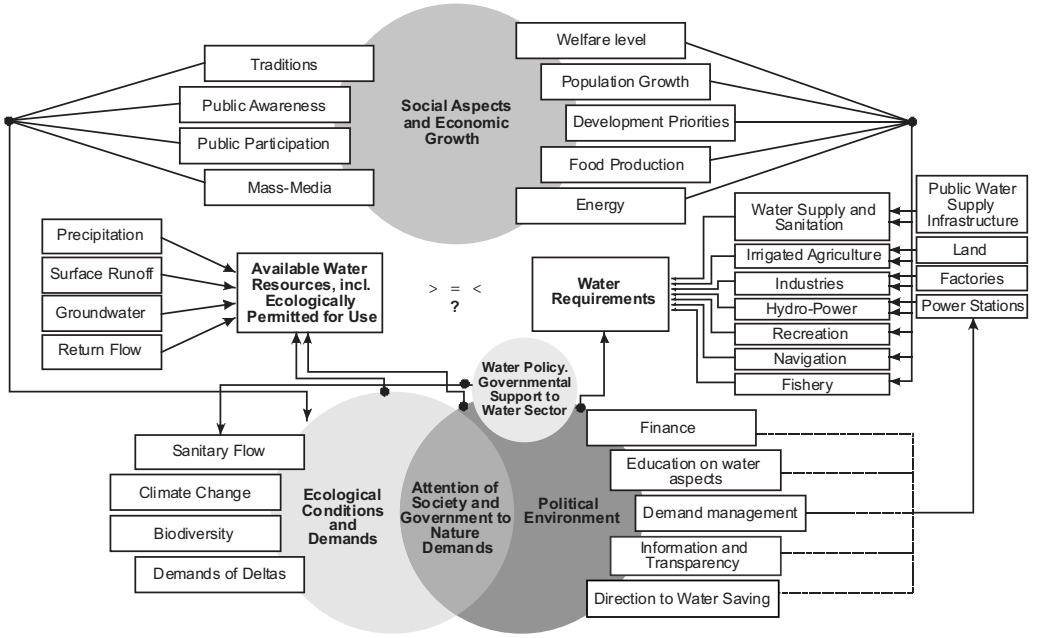


Figure 1. Interacting Factors within Water Resources Management Process

and complicated water infrastructure – all these components transform the proper engineering task into the very sophisticated co-ordination of huge number of links and providing the balance within this system. If we want to provide the balance of different interests, current and long-term goals, economic development and conservancy etc, then it is necessary to apply a holistic approach for solving this task.

Have a look to the Table 1, and you can see that monitoring, assessment, protection and development of available water resources (surface and ground water available for use) are key objectives of the first IWRM component. A key indicator to demonstrate the progress in achieving established objectives is a renewability of water resources in regard to their reserves or level in a source, water quality, and variability of these parameters over time. One of key objectives related to water infrastructure (reservoirs, irrigation and drainage canals, hydraulic structures, water supply network etc.) is proper operation and maintenance (O&M), including maintaining necessary operational regimes and design parameters of structures; their repairing, up-grading, and, if necessary, reconstruction. At present, a quality of O&M is defined by such indicators as costs (financial and material), cost recovery, efficiency and operational life of infrastructure. Next component of water governance (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 of all points for water delivery, required amount and time of delivery (some water users may be interested in maintaining necessary water level or 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 demand. Here, major objectives are maximum possible involving all stakeholders in the process of negotiations (coordinating water allocation) and development of acceptable for all procedures (rules) for water allocation. A proposed indicator for this component is criteria of equity and rationality for establishing quotas or limits of water

Table 1. Components of the water resources management process and their indicators of implementation.

COMPONENTS	OBJECTIVES	INDICATORS
Available water resources	Monitoring Development Protection	Amount quality regime renewability variability
Infrastructure	O&M	Costs / efficiency/ cost recovery
Water requirement	Evaluation Demand management	Level/amount/quality/time/place
Water balance and allocation	Participation Plan (schedule) Regulations	Norm for flow rate Equitability & rationality criterion (share\quota\limit)
Water supply	Secured water supply	Sufficiency of water supply, uniformity, sustainability, minimum unproductive losses
Water use and productivity	Output and water saving	Productivity (more crop per a water drop)
Water use effects (MDGs)	Sustainable development	Sustainable use index
Management assets	Maintaining waterworks in operable conditions	Operability 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

GOVERNANCE

use. A next component of the water governance process – water delivery from a source to water users (water supply) – is water delivery services. Proposed indicators for evaluating a quality of these services are a uniformity and sustainability of water supply under minimum non-productive water losses. Finally, a last key component is water use, including irrevocable water consumption. Here, a major objective is to produce output by using water or its maximum utilization. A proposed indicator is a specific water productivity i.e. an amount of water consumed per unit output. 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, exceeding of which is inadmissible.

The IWRM is not already just an engineering task – we need to establish proper "water governance" system as a basis for proper water management process. The "governance" specifies rules of game and provides encouraging (regulative) mechanisms, when water managers are in charging for detailed elaboration and implementation clear

principles for water allocation, conservation, and monitoring while water users are responsible for rational water use in their practice. Interrelations related to water resources management and use between water management organizations and water users (other stakeholders of the process) are included into the IWRM system, and the political "superstructure" provides establishing the mechanism of "governance."

The main goal of governance system is to provide equal democratic opportunities for all stakeholders involved into water resources management process. The main components of the governance system are the following:

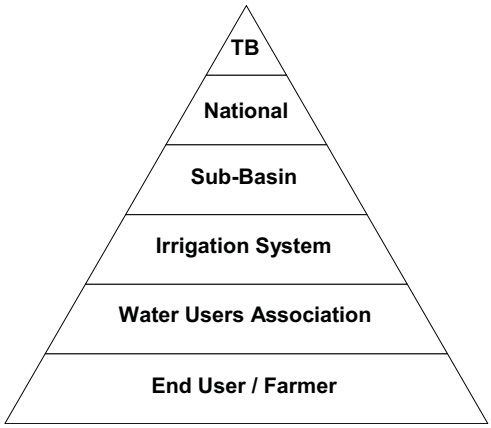
- Political commitment
- Institutional arrangements
- Legislative framework
- Financing and Incentives
- Public participation
- Managerial tools and instruments
- Capacity development

2 Hierarchy of Water Governance

The governance system is not static in time – it should be permanently adapted to changes: natural, political, social, economic, technological. In the large extent, this can be referred to management rules that are the most vulnerable part of the modern management system, and require paying the most attention of all specialists of the water sector because each basin, each sub-basin, and each water management or irrigation system, as each man, has its own features. This is predetermined not only by specific landscape, configuration and lithology of a watershed, but also by conditions of water withdrawal and distribution (surface water sources or groundwater; regulated or unregulated flow), parameters of water distribution system; the combination of hierarchical water management levels, composition of operational works and conditions at different levels of the water management hierarchy.

From the above mentioned view point, the governance system should cover the hierarchy levels of water resources management The governance system covering the hierarchical levels should facilitate to achieve those indicators of water resources management process shown in Table 1. To put IWRM into practice it is necessary to develop specific mechanisms providing incentives for water users and water management organizations in increasing the water productivity, and at the same time to assist them in achieving this goal. These mechanisms should take into account specific factors causing unproductive water losses, instability in water supply, and unevenness of water

Table 2. Principal Indicators for Different Levels of Water Governance Hierarchy



INDICATORS
Minimum of Unproductive Losses
Contribution of Water Sector to GNP
Aggregated Basin Productivity
Aggregated System Water Productivity
Aggregated Water Productivity in WUA
Water Productivity in Field / Farm

distribution. As a whole, the ranking of causes of water productivity reduction that arise within the irrigation system promotes the development of practical measures for achieving the basic criterion of IWRM – provision of "potential productivity" of the water by all water users or, at least, approaching to it (see Table 2).

3 Improve Water Productivity

As shown in Table 3, the most approaches to improved water productivity are based on the engineering measures and IWRM tools in combination with organizational, legal, and financial measures. To implement these measures in the first place it is necessary to combine efforts of all stakeholders of water provision process starting from water management organizations, WUAs and ending by farmers themselves. Such joint efforts need agreed procedures and methods for stabilizing water provision, providing equitable water distribution, and establishing a proper public control by water users themselves. At the same time, the technical and financial assistance of the State and local governments is necessary. Finally, it is important to gain a general understanding of the importance for proper co-ordination of all water management hierarchy levels.

4 Sectors and Stakeholders Coordination

Important that governance system should provide horizontal integration among different stakeholders and sectors. A platform for effective participation in decision-making process of different stakeholders (government, NGOs, science, private sector, professional organizations) and sectors (agriculture, hydropower, nature, water supply and sanitation and etc.) should be created. The main criteria for evaluation success of this integrity are: inclusiveness (each stakeholder can show its interest); equity (opportunities – rights for equal access to water); transparency; effectiveness; accountability; coherency (to listen others); responsiveness; comprehensiveness; ethical considerations. Unfortunately, the listed criteria could not be assessed by numerical indicators.

The Government should those frames, within which water management agencies should operate for the interests of all economic sectors and stakeholders. The management system should provide conditions for achieving (or approaching to) the maximum water productivity and economic value by all water users (in irrigated farming, industry, and domestic water supply) and for successful livelihood. It means that the minimum water volume should be used to fulfill biological demands for production or technologically needed water consumption. At the same time minimizing water losses over all the technological cycle including water intake, water conveyance, water supply, and water use (so-called potential water productivity). Such an approach needs in the clear-cut co-ordination of all technological processes as well as the observance of other technological requirements (non-related with water resources).

For instance, in irrigated farming it means the need to follow all procedures of land reclamation, soil treatment, soil fertility conservation, selection of crop variety etc; correspondingly in the water supply sector - the rules and regulations of sanitation, combination of wastewater treatment and use etc; and in industry – introducing the advanced production technologies, regeneration (cyclical) water use, wastewater disposal and recycling etc. Thus, activity within IWRM often goes beyond "pure" water resources use and conservation, and includes all water-related spheres.

5 Water Policy and Legislation

It is obvious that the political environment using specific financial instruments (tariffs for water and the system of penalty sanctions and incentives) is encouraging all water users to reduce their water demand. At the same time, "governance" encourages to use social instruments – traditional methods of economically sound water use, and public participation in decision-making. All these and other factors should be taken into consideration for establishing strict rules of game. No doubt, that the effective water resources policy should be based on strong legislative framework, including:

Table 3. Causes for water productivity loss within irrigation systems and mitigation measures

HIERARCHICAL LEVEL	THE PROBLEM EXISTING	MITIGATION MEASURES	
	Instability of head intake and water disposal due to the following causes:	**Type**	**Brief description**
Basin	Political tensions	legal	Agreements
	Breach of the water supply schedule	organizational	Establishing a management body or developing the regulations
	Excessive water diversion at upstream intakes	legal	Agreements and fines
		technical	Distribution accuracy due to applying SCADA
	Underestimate of water losses at upstream river sections	technical	Monitoring and evaluation of flow rates and water losses
	Unstable flow modes in rivers	technical	Runoff control use of drainage water
	Uncontrolled water distribution	technical	Improving the water management system
Irrigation system	Lack of the system of water resources planning, distribution and dispatching	technical	Developing and putting operational rules into practice
			Drafting the plan and its adjustments
	Lack of water distribution discipline	technical	Regulations for water monitoring and records, Introduction of the GIS and water use plans
	Water over-diversion against schedule	organizational, economic	Applying of penalty provisions
	Lack of water keeping records	technical	Improving the water monitoring system
			Introduction of the SCADA
			Establishing the management information system
	Lack of the proper water distribution procedures	technical	Introduction of water rotation
			Use of all types of water resources
Farm	Lack of the water use plan	technical	Water use planning and training
	Improper irrigation methods	technical	Recommendations on irrigation technique and methods
	Lack of adjustments in accordance with weather conditions	technical	Extension services

- Definition of roles and responsibilities of the Government, water governance institutions, stakeholders, users;

- Definition of social, economic and ecological value of water;

- Definition of strong position concerning institutional reforms, privatization, roles of local administrations and stakeholder participation;
- Definition of water rights, WUA roles, rules of game among sectors;

- Definition of interrelations between sectors – agriculture, energy, environment and others, and links with general socio-economic development.

It is important to note that in the process of IWRM implementation, there is not any need to seek universal and stereotyped approaches that are acceptable for different stakeholders (this principle is clearly stated in the GWP IWRM ToolBox, 2003) however, at the same time, more or less general rules regarding the institutional framework should be formulated. To put IWRM principles into practice indisputably should be based on the political will and appropriate social environment in the country. Its initiation cannot be an instantaneous action and has to develop gradually and quite systematically. Therefore, transition towards IWRM requires ensuring the thorough understanding and through developing an action plan.

6 IWRM Planning

A policy of water resources development should be built based on the strategic planning in order to predict and mitigate destabilizing factors such as the population growth, climate changes and their impacts on availability of water resources and water demand, changes in the set-up and development of water-consuming sectors, and especially dynamics of market relations (prices, global impacts etc.) in timely manner. It is necessary to keep in mind that owing to a complexity of water infrastructure and numerous actors in the water sector (water management organizations and water consumers) practically covering the whole society it is impossible to obtain a fast result of water sector reforming. Therefore, the reforms require a certain time and funds that has to take into consideration also the use of transboundary water sources and forecasting the policy of riparian countries (the co-operation with other riparian countries should be built up on the basis of the interstate agreements, joint plans and actions in conformity with the international law and regulations).

Transforming the IWRM concept into a national action plan is based on the following fundamental activities:

- Developing the strategy for IWRM implementation;

- Establishing the training system for improving the understanding of IWRM principles at first among water professionals and then among communities' leaders (especially NGOs' leaders), and for disseminating knowledge at first among those people who involved in the pilot projects and then among proper stakeholders at all levels of water management hierarchy;

- Social mobilization of water users and other stakeholders; and

- Drafting the national IWRM plans and their approval by the governments.

7 IWRM Progress in Central Asia

A move of Central Asian countries towards IWRM principles (rather than towards new programs of technical rehabilitation since it was before) is based on the following regional "Road Map" (see Figure 2):

1. Mandatory preparation by each country the National IWRM and Water Efficiency Plans in co-ordination with Strategic Planning provisions. Under financial support of the Norway International Development Agency through the GWP and UNDP, Kazakhstan commences such activity, and by the end in

mid 2007 it will be a good example for other countries in the region. The principal goal of preparing the National IWRM Plan is to develop the efficient framework for putting IWRM into practice and to specify objectives, tasks, phases and scope of works, impacts, and mitigation measures combating destabilizing factors.

2. The sub-regional component for Central Asia has been developed by UNEP Collaborating Centre for Water and Environment (UCC-Water) and UNEP in close consultation with GWP CACENA (and coordinated with UNDP and UNECE). The programme intends to involve the IWRM National Councils established under the "IWRM Fergana Valley" Project supported by Swiss Development Cooperation. The development objective of the sub-regional work programme is: acceleration of of the implementation of the IWRM 2005 target in three countries of Central Asia. The outputs foreseen are:

   - Sub-regional report on progress on IWRM 2005 Target and IWRM Planning
   - Completed national road maps/work plans for implementation of the IWRM target (for three countries: Kyrgyz Republic, Tajikistan and Uzbekistan).
   - Needs assessment for support to implementation of IWRM reforms as identified in road maps and work plans.
   - Capacity built on IWRM planning for key water managers and decision makers

3. Providing the political will and commitments regarding IWRM and settling water-related problems. As a practical matter, the proposal of water professionals from Kazakhstan and Kyrgyz Republic regarding establishing the Coordination Water Committees at the level

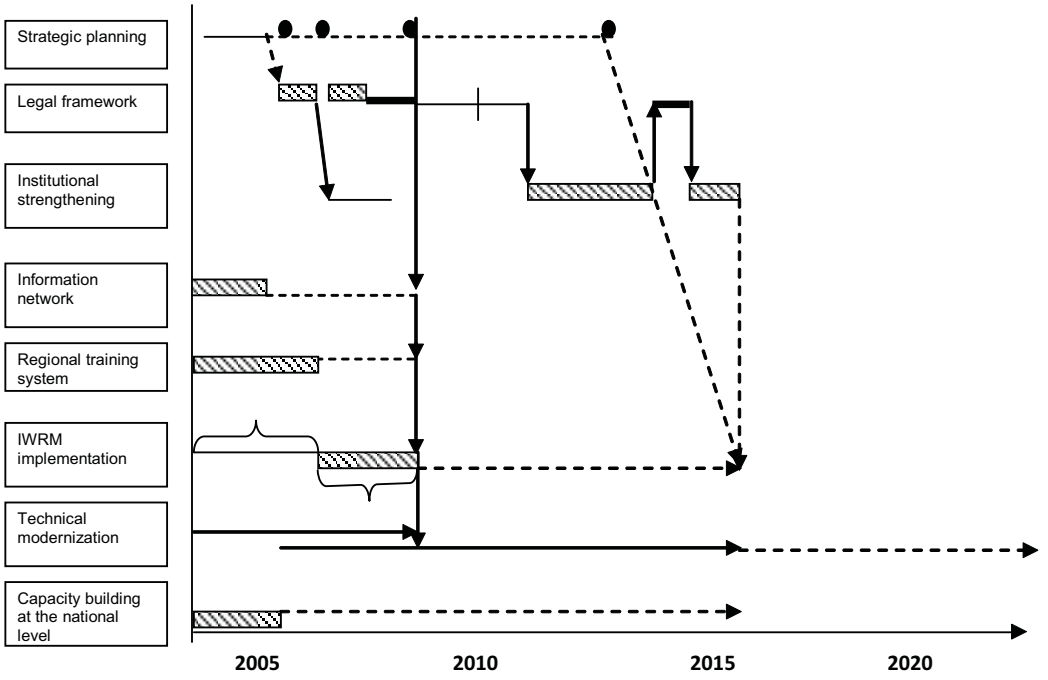


Figure 2. Regional Road Map to support IWRM implementation

of the Government/the Parliament under the direction of Vice-Premier with involving NGOs seems to be the sound decision.

4. Wide public participation in water management at all hierarchic levels. To this end, it is necessary to ensure the legal registration of the Public Water Bodies and WUAs, to develop the financial mechanisms for their involvement, and to provide training and wide popularization of IWRM principles and achievements with water users' participation.

5. Establishing the network of training centers and managing the coordinated training process over the region.

6. Legal and financial justification of IWRM and establishing its legislative basis, improving water charging mechanisms, legal and financial coordination of efficient water use aspects at all hierarchic levels; specifying the role of the Government in the case of WUAs, etc.; establishing water-saving funds; elaborating the environmental water requirements and ensuring nature priority under water allocation procedures.

7. Technical measures:
   a. Introduction of water record keeping;
   b. Participation of hydro-meteorological services in IWRM;
   c. Establishing the extension service for improving the water productivity;
   d. Computerization of managing the irrigation systems; and
   e. Water-saving interventions.

At the same time, the mechanism of interstate consultations to coordinate water sharing, a regime of water use at transboundary rivers, and further economic development keeping in mind the regional interests was established. An analysis of the water management situation in the region has revealed the following destabilizing factors:

- Demographic growth and stability of rural population (the poorest part);
- Applying the water-sharing principles developed by former centralized water management agencies of the USSR that were included into the Basin Master Plans of Complex Water Resource Use and Conservation – they neglected the needs of ecosystems;
- Disputes among the countries regarding water and energy resources and lack of mechanisms to tackle this issue;
- Uncertainties related to global climate changes;
- Lack of conflict resolution mechanisms and procedures to recover losses due to breaching the existing agreements on water sharing;
- Insufficient information interchange among riparian countries, first of all, exchange of hydro-meteorological data to ensure the more accurate forecast of water availability and to improve transboundary water management;
- Lack of policies and programs for regional economic integration, and insufficient co-operation to improve the irrigated farming productivity on the basis of a model that enables optimizing the rural labor in the region; and
- Vagueness of information sharing and consultation about prospects of water use by Afghanistan etc.

Also interstate consultations and exchange of experience regarding the following internal (national) water challenges are extremely useful:

- water scarcity and pollution at the national level;
- supplying the population with safe drinking water;
- low water and land productivity or low output of an irrigated hectare;
- insufficient developing of the national legislative regulations;

- high-accumulated depreciation of assets owned by water organizations;
- an insufficient material and technical basis of water organizations;
- inability of water users to pay for water delivery services;
- institutional issues (organizational and governing shortcomings);
- the poor cross-sectoral integration (between main water users);
- shortcomings of the personnel policy in the water sector;
- return flow management issues; and
- transboundary ground water use.

8 Indicators on IWRM Implementation at the Level of Irrigation System

In the frame of the IWRM-Fergana Project, 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) [Dukhovny, Sokolov, 2005] was developed. In particular, the following indicators:

$$\text{Water supply factor (WSF)} = \frac{\text{Actual water supply}}{\text{Planned water supply}} \quad (1)$$

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 different purposes of the analysis, a water supply factor[1] 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:

$$\text{DSF} = \frac{\text{a standard deviation of diurnal flow rates from an average daily flow rate}}{\text{an average daily flow rate}} \quad (2)$$

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)

$$\text{TDSF} = 1 - \frac{\text{A standard deviation of an average daily flow rates from an average ten-day period flow rate}}{\text{an average ten-day period flow rate}} \quad (3)$$

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

$$\text{WSUF} = 1 - \frac{\text{An absolute value of the difference between a WSF of an off-take (or a group of off-takes) and a WSF of an irrigation canal}}{\text{WSF of an irrigation canal}} \quad (4)$$

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

$$\text{A coefficient of water supply uniformity from a canal} = \text{an arithmetical mean value of coefficients of water supply uniformity to water users in the canal's command area} \quad (5)$$

A "from head to tail" uniformity factor - in the practice of water allocation, as a rule, there is

the 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) (6)

Technical efficiency factor (TEF)

$$TEF = \frac{\text{Water supply + transit flow + outflow}}{\text{Head water diversion + side inflow}} \quad (7)$$

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 assessing a quality of water management. In the frame of the IWRM-Fergana Project, such an assessment is conducted on the regular base. A fragment of such assessment is given below. This assessment is made by means of comparing key indicators over the period of 2003 to 2007 (Table 4).

However, all these indicators reflect water management at the level of irrigation canal, and even the irrigation system rather than the IWRM

Table 4. Water distribution indicators for pilot canals (IWRM - Fergana Project)

PILOT CANAL	YEAR	ACTUAL WATER SUPPLY mln. m^3	WSF %	WSUF %	DSF %	TEF %	SPECIFIC WATER SUPPLY 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
	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
Khodjabakirgan 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

as a general system. It is although necessary to carry out a comprehensive assessment of IWRM (its effectiveness, economic effects and impacts on achieving MDGs).

9 The Way Forward

The practical progress in reforming water management in Central Asia countries can be obtained by applying IWRM principles described in this paper and by resting on appropriate institutional, engineering, and other measures under sufficient funding that needs to be allocated. The main measures include the following:

- Providing sustainable water provision, equitable and regular water sharing between sub-basins and irrigation systems along with significant reduction in unproductive water losses on the way to water users;
- Introduction of the democratic principles into the water management practice by using a participatory approach and involving all stakeholders in the process of step-by-step transferring the governing functions to lower levels of the water management hierarchy as well as allowing active participation on an equal footing with the Government in supporting and developing of water supply systems;
- Solving of some social problems related to equitable water supply of the population, especially ensuring safe drinking water;
- Settling environmental problems related to water sector's activities; and
- As a final goal, increase in the efficiency of water and land use.

Endnote

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

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