THE ARAL SEA BASIN AND IRRIGATED AGRICULTURE IN CENTRAL ASIA IN THE 21ST CENTURY

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ABSTRACT

The Aral Sea Basin covers the five states of Central Asia: Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan. Since the 1970s, it has experienced a huge ecological and social catastrophe affecting millions of hectares. It has now been realized that the cause of the crisis has been the irrational and unsustainable water use and absence for the due respect for nature. As a result the Heads of the five Central Asian states have made a decision to develop a Program for stabilizing the socio-economic and ecological conditions by implementing a range of agreed measures, including (as a priority objective) the development of the regional and national strategies for rational water and land use taking into account the needs of future generations. The Program aims at the proportional and coordinated development of the region, at the same time conserving water and increasing efficiency of irrigated agriculture in general, and especially per unit of water consumption. Water resources for the environment is, therefore, the main aspect of the strategic vision for the first part of the 21st Century. Development of the vision in the start of the strategy is very important step in preparing a society to reorientations on other philosophy to the nature. Instead of natural resource control an ideology of requirement to nature use and their maximum conservation for future generations should be accepted by all society. Motivation of the vision enables by widescale brainstorming of leading specialists of the region to mark real variants and future horizons. These ways, in the future, can be perfected in mechanisms and forecasts of the strategy

1. INTRODUCTION

The crisis of the Aral Sea, its basin and the surrounding area is well-known, and no detailed description is necessary. As a result of the excessive water consumption for developing the irrigated agriculture and other water-consuming sectors during the last 30 years, the Aral Sea has lost its fishing, transportation, biological and natural capacity. Its volume has decreased by 3 times, its area – by 2 times and water salinity increased by 5 times. At the same time, the deltas of Amu Darya and Syr Darya rivers, which flow into the sea, have been affected by degradation. The dry seabed has become a center for spreading salt and dust over thousands of kilometers from the shore line. River water pollution especially in the middle and lower river reaches has exceeded maximum acceptable concentrations.

After independence, the five Central Asian States founded the Interstate Commission for Water Coordination (ICWC) responsible for the management of joint basin water resources with the help of two BVOs (River Basin Authorities). In 1993, the International Fund for Saving the Aral Sea and its Executive Committee was founded to coordinate development and implementation of the 'Specific Action Program for Stabilizing the Environment in the Aral Sea Basin' approved by the Heads of State on January 11, 1994, as well as to attract donors and the whole world community to this issue.

The 7-year joint activities of IFAS and ICWC have considerably increased the awareness in the coordinated national actions for rational water use, reduction of water wastes (by 8% in contrast with 1990), as well as the development of the common policy for rational water management in the region. The integrated regional information system for water and land resources (WARMIS) has been established and is now being improved. However, there are certain difficulties in developing this program and it is necessary to analyze them.

2. FEATURES, TRENDS AND DESTABILIZING FACTORS IN THE REGION

Forecasting of future development of the region is a very complicated process, even in developed societies. Although past trends can be used as the basis for predicting future trends, combination of trends can causes qualitative changes in predicted trends and trend dynamics (see, for example, D. Forester). Forecasting under the transitional economic conditions (as in the Aral Sea Basin) is more complicated as the political systems are changing and environment degradation is increasing. It will be too difficult to forecast the definite future conditions of the five Central Asian States, which used to be under the tough political pressure of USSR, and their unpredictable neighbour, Afghanistan.

In spite of the political, economic and ecological differences in each state of the region, there are certain common features, which would influence possible scenarios of development in the region. Central Asian States have common natural and geographical interrelations and certain factors of destabilization. They are:

- a strong arid climate (natural deficit of water consumption is 700-1,400 mm per year), hence, importance of water resources not only for irrigation, but for all activities related to water use and water consumption;
- the Aral Sea is a landlocked lake and this causes a risk for water transportation and transfer of pollutants from upstream countries to downstream countries and accumulation of toxic pollutants there;
- common water resources (as of Mr. V.I Sokolov investigation, 70% of water resources are transboundary), hence, interdependence of water management activities throughout the basin, affecting stable water supply of states and zones of the region.

Sustainable development is understood as economic and political well-being and ecological safety in the region and its states as a part of the global system. From these positions the region is characterized as the region of stable degradation:

- economic capacity of all five states has decreased from US$2,000-2,500 per capita by the gross domestic product to US$ 400-1,100 (in comparison with 1985), and the decrease has not liquidated fully;

- production of all agricultural crops has reduced rapidly, in comparison with 1990; the agrarian sector of the states which is important for direct and related sectors (production for agriculture and product processing, transport, supplying) provides 40% of the total gross domestic product. The size of both the whole economy and agricultural productivity are still reducing. Once these have been stabilized, work can start on their rehabilitation and reconstruction;

- agrarian capacity, especially in terms of land fertility, is constantly degrading, land reclamation is worsening and facilities (machines, equipment) are obsolete and almost have not been updated; transition to the market economy in these countries (with participation of the government or without it) has not been successful in involving private initiatives, because the village infrastructure is not sufficiently developed for free market competition;

- because of the decreasing productivity of the irrigated agriculture, the actual water use has also decreased, and at the same time, the water losses are increasing;

- the capacity of water management organizations (both structures, systems and staff and their qualifications) have become obsolete and weak and do not accurately reflect the water and ecological conditions;

- the quality of natural water resources is deteriorating, toxins are accumulating in bed deposits and estuaries; land fertility even on irrigated areas is decreasing as measured by humus contents, phosphorus, potassium, soil depth, soil structure etc.

Besides, it is necessary to note the following destabilizing factors:

- permanent growth of population (by year 2050 the population will double in comparison with 38 million of present population) and, will accordingly result in increased pressure on natural resources;

- the rural population constitutes most of the population in the region. There is growing unemployment in rural areas;

Though it seems that in the Aral Sea Basin there are large areas and spaces, but most of them are mountainous and desert. The industrial, agricultural and residential developments are concentrated at ancient oases including Fergana, Hyssar, Zerafshan, Tashkent, South Kazakhstan, Surkhandarya, Kashkadarya, Merv, Ancient Khorezm and Lower Syr Darya oases, and new irrigated areas which have become centers of agricultural and industrial development: Karakum Canal, Golodnaya and Karshynskaya steppes, Navoy agglomeration etc. As a result human activity is concentrated over the area of 150,000 km^2. The present population density is 220 people/km^2, and this will increase up to 450-480 people/km^2 over the next 20 years.

Consequently, the environment is under threat from the:

- intensive use, redistribution and pollution of water resources;
- increases in natural salinity intensified by human activities(irrigated farming);
- widespread aerial and water-borne movement of pollutants both within the basin, outside the region and beyond.

3. Future Prospects of Development

The above comments may give the impression that it is hopeless to expect future improvements in the region. However, the chosen action program is based on the following:

- Ancient water use was based on deep respect for water and water use for the benefit of the whole society. Unfortunately, the traditions and customs in water allocation, use and conservation have been partially lost. Now in the irrigated agriculture a strict control should be established ensuring equal access to water for everybody and proper operation and maintenance of the infrastructure. Historically water use was based on economy and the prevention of pollution.

- Water use in the region can be improved through analyzing the best methods water use and management under similar conditions abroad (Israel, Jordan, western states of the USA, Spain), regional experience on some irrigation schemes on base of phased analysis of water allocation and water losses at different levels of management. These methods show that it is possible to set a strict limitation of water use for all countries according to the 'criterion level of best water use'. This level is calculated as the largest possible specific volume of water diverted per unit of water use production, multiplied by the volume of this production. If future annual water use is 400 m^3 per capita, even with total losses of 0.5, the population of 50 million expected by 2020 will use not 96-100 km^3 of water per annum but 40-42 km^3. Even if number of population increases up to 70 million people by 2020, water use will be 50-65 km^3 which is less than the ecological limit of water diversion in the basin equal to 74 km^3 (Dukhovny and others, 1994).

- At present and in the next 20-30 years agriculture will be the largest water user diverting up to 85-90% of the total amount of water. However, the system of former demonstration pilot plots and WUFMAS monitoring system supported by EU show that up to 30 % of diverted water is efficiently used for moistening the upper soil layer and establishing conditions to prevent salinity in the aeration zone. To cut water losses by half, capital investments are required (for lining of canals, improvement of irrigation techniques, upgrading the distribution network), but losses can also be reduced by low-cost organizational and technical decisions.

- Modeling shows that reduction of inefficient water losses and excessive water diversion will result in significant improvement of river water resources, reduction of drainage water volume and salinity and environmental stabilization in the region.

- Involvement of direct water users in water management will raise their responsibility and (that is more important) water using bodies which will become a part of an open society. Besides, they will pay for water supply and distribution, reducing state share.

At the same time the governments are responsible for satisfying basic water demands, and should take part in the financing of central and local water bodies and subsidizing irrigated agriculture. As water use efficiencies increase, this support can be reduced. It is natural that the governmental responcibility for water resources management and support to water structure maintenance is important for maintaining the capacity of the water sector under the conditions of the market-oriented economy.

Though the current net production (income plus expenses) of the irrigated agriculture varies from $150 to $500 per ha, in some of the most efficient regions and farms it is $700-1,000 per ha. Farms can not spend more than 10% of their net income for O&M, but a minimum $100 per ha is required for O&M of the irrigation network. The government must cover 50-85% of all costs, but as water use efficiencies increase, then the amount paid by water users should be

increased. If the efficiency of agriculture increases in proportion with the increase of the gross internal income, 1990 levels will be reached by 2007 (optimistic forecast) or by 2015 (pessimistic forecast). The government will manage to reduce its financial support to 20-25%. For this purpose state and borrowed funds will be invested in 8 million ha of irrigated lands. Minimum state investments of $550-600 million per annum are required at Year 2000 prices. As agricultural productivity increases back up to the 1990 level, water users will be able to contribute more to O&M, and costs to the state will reduce to $100-160 million. These figures are very high, but they are required for the benefit of future generations.

Several new principles can ensure future progress in the water sector and irrigated agriculture:

1. Water conservation by all water users at all levels should be based on the principle of maximum water efficiency. At the first stage this can be achieved by reducing water losses which amount to 20% of the total diverted water. Later more expensive methods of water conservation will be used when the financial capacity of water users and the government increases.

2. In terms of the ecological safety of the region, now when natural resources have already been unbalanced, their rehabilitation to the original state is impossible. We can only minimize their further deterioration and hope to create sustainable and economically achievable productivity similar to natural conditions.

3. Integrated water management by interconnected river basin authorities and system consortiums coordinating water supply at all levels will raise their responsibility for accurate water allocation and water supply and preventing organizational water losses.

4. Involvement of population in water saving and environmental conservation for the benefit of future generations. In Central Asia the most important component of the environment is water as in the arid zone landscapes, biodiversity and further environmental stability all depend on water resources. Water conservation and prevention of water pollution should be a key principle of the ideological program in the region regardless of the national and social particularities. The welfare of the region depends on the success of joint water management in Central Asia. The public should understand that not only water organizations but everybody should be responsible for economical water use.

Specific actions can be carried out with low-cost methods (supervision of the activity of all water users, strict limitation, water metering, establishment of Water Users' Associations, activities on irrigated lands, better crop techniques etc.)

Water is more dangerous than air as it can transfer pollutants and toxicants regardless of the borders and administrative division. Broken natural biological and hydrological cycles and processes of river basins and constant connection between the upper and lower catchments promote pollution of natural water resources. Therefore, the states using transboundary water resources are responsible for establishing the mechanism of strict joint water management. This mechanism should be based on the equality, consensus, clear rules of collaboration of regional and national organizations and the strengthened role of the regional organizations. Moreover, association between states should be based on open relationships and awareness.

4. Action Plan and Vision for the Next Century

On the basis of this requirement the key stages of the action plan can be presented as follows:

1. Short-Term Action Program

- Development, exchange of opinions and approval of the water use strategy at the national level in coordination with the regional strategy; strengthening the collaboration and mutual approaches; joint activities to improve the ecological conditions in the Aral Sea Basin.

- Development of agreements and regulations establishing the order of collaboration between national and regional organizations and coordinating joint activities on water conservation to reduce water use by 1-2% per annum.

- Establish annual limits of water use for all water using countries, including limits for water diversion and pollution. Breaking the limits will be fined progressively. This will encourage water saving and prevent pollution, and water diversion limits for the Aral Sea and the surrounding area will increase over time.

- Development of the system of water conservation competitions which will promote involvement of water users in water saving. Encouraging water saving farmers and water enterprises by tax and other privileges.

- State support of the irrigated agriculture and water management activities in creating favorable conditions for the development of private and cooperative land use and support of the existing infrastructure.

- As the real profitability of agricultural enterprises increases, the need for subsidized (state) investments in agriculture and irrigation will be reduced.

- Establishment of a network of Water Users' Associations at the former state in-farm level; introduction of incentives through a financial mechanism for encouraging efficient water use with a differential system of payment for water.

- Organizing water saving services at the local level.

- Establishing the Basin Water Users' Councils in the River Basin Authorities (BVOs). They will jointly solve the principal problems of basin management and supervise the BVOs' activity.

- Start development of the network of independent consortiums. They will be responsible for coordinating the activities of the Water User's Associations and the BVOs, transboundary, internal and drainage water use with monitoring of the ecological conditions in irrigation schemes.

- Development of the common information system on water use and management including the network of interconnected regional and national centers and monitoring stations.

- Introduction of computer systems for the management of the hydrological infrastructure at the interstate and intersystem levels.

In case of successful implementation of the above measures, water use will not exceed 90 km^3 per annum by 2010 while the average profitability of irrigated lands will be $600-700 per ha.

2. Medium-Term Action Program (2010-2025)

- Finish equipping all gauging stations on transboundary water resources with automatic stations for the monitoring of water quantity and quality within the common system of water forecasting, operational management and use.

- Develop the regional information system at the level of irrigation and drainage systems up to the level of Water Users' Associations. This system will assess and develop recommendations for the improvement of water and land use and environmental monitoring.

- Start developing the irrigation of crops grown in greenhouses.

- Finish establishing independent consortiums at the system level, stabilize their activity; coordinate water allocation and water supply with river basin authorities at the upper level and Water Users' Associations at the lower level.

- Achieve field water use efficiencies of 0,75 level, by managing the interaction between surface and ground water resources, establishing strict water supply schedules, organizing water rotation between fields, introducing low-cost irrigation methods (basin method, dispersion irrigation, including furrow irrigation; basins of daily regulation, correction of water supply depending on the water availability and climate).

- Establish national water diversion limits in line with to the critical levels for ecologically safe water consumption. Exceeding these limits will be permitted, but each state would have to pay for it, to the Fund of Basin Ecological Stability. Activities aimed at conservation and rehabilitation of the environment will be financed by the Fund.

- Coordinate gradual development of a system of mutual benefit and regional cooperation in agricultural production aimed at distribution of the most effective system of agricultural production (grain in Kazakhstan, beet in Kyrgyzstan etc.)
- Create a technical base which will promote creation of a local (drip, microsprinkler etc.) irrigation system during the period from 2020 to 2025 with proper fertilization and changing the crop water requirements

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- Develop the management systems for water allocation in the upper catchment.

- Wide use of waste and saline drainage water for irrigation.

In case of successful implementation of the above measures, water diversion will not exceed 75-80 km^3 per annum, while the average profitability of irrigated agriculture will be $800-1,000 per ha.

3. Long-Term Action Program (2025-2050)

- Automation of water allocation, water supply and drainage flow management.

- Using the indicators of the information advisory systems, developing the system of strict distribution of drainage water between: using on fields, mixing in canals and discharging to rivers and outside the rivers into sinks.

- Management and use of drainage water by cascade management for growing salt-resistant crops and forestation of unproductive lands;

- Developing full irrigation facilities over the whole of the irrigated area;

- Developing methods for the control of changing soil conditions and assessing the consequences of these changes.

In case of successful implementation of the above measures, water diversion will not exceed 75 km^3 per annum, while the average profitability of irrigated agriculture will be $1,200-1,500 per ha and the population will number 120-130 million people.

Expected development scenarios:

Vision-21 should be oriented for several possible options of development:

1. Optimistic under close collaboration
2. Intermediate
3. Option of current tendencies

Calculations for all 3 options are executed using computer program for period until 2030; results are enclosed in appendix as graphs. Main provisions of scenarios are presented below.

1. Optimistic scenario under close collaboration

1.1 Region will develop on the base of integration processes which are being elaborated by the governments of all countries including:

- mutually beneficial use of transboundary water resources on base of water saving and common environmental approach;
- mutually beneficial development of agricultural sector with maximum stress on beneficial crops specialization;
- agreed processing of agricultural production

1.2. Population growth rate reduces by 2025 down to 0,99%, whereas population of the region will be around 60 mln. people; average annual GNP for period of 2000-2010 will be 4-6%; for 2010-2015 around 6%; 2015-2025 not less than 5%. Region‘s GNP is expected about 140 bln.USD or 2425 USD per capita. Thus, according to given scenario this indicator will increase by 3 times.

1.3. Energetic will develop on base of hydropower and their joint construction in order to create

sustainable priority of ecologically, clean energy.

1.4. It is supposed that the following indicators of water use efficiency will be achieved: specific water consumption for irrigation –10,1 th.m^3/ha; specific water use for population - 0,08 m^3 per capita per annum; water use productivity – 1,51 \$ /m^3.

1.5. Set of measures on water consumption for irrigation reduction will allow to increase area of irrigated lands up to 9,1 mln.ha against actual 7,9 mln.ha. Substantial increment of irrigated area is expected after 2010, that is caused by common improvement of economic situation in the region and availability of investments for big scale water saving measures. Set of measures on agricultural productivity increase will permit to improve population provision with food. Average consumption about 3000 calories per capita per day is expected under fruits and vegetables prevailing. Optimal combination of food and non-food production under wide regional cooperation well allow to cut import of grain and milk products under increase of vegetables and fruits and products of their processing export. Under planning water use efficiency and crops yields there is no any food deficit.

1.6. Considerable growth of GNP will be provided at expense of outstripping growth of industry. Taking into consideration industry growth and water recycling it is expected, that water use in industry will reach 4,11 bln.m^3 per year instead of 2,3 bln.m^3 per year in 1990.

1.7. Under planned water use efficiency in different branches of economics total water use will account for 92 km^3/ year. For irrigation 83,4km^3/year will be used, for industry and municipal needs - 8,6 km^3.

1.8. Supposed that differences between available water recourses and water requirement in the region will be around 30 km3 to 2025. This amount of water could be use for Aral sea.

2. Intermediate scenario

2.1. Integration process in transboundary water management will develop slowly. There is no crops specialization and agreed processing of agricultural production.

2.2. Population growth rate will reduce negligibly: by 2010 - 1,7%; 2025-1,55%. Population will equal to 62,01 mln. GNP growth rate will be 2-4% and will account for 76 bln. USD by 2025 or 1222,6 USD per capita. Taking into account calorie demand as 3000 to 2025 the deficit is possible after 2020 and to 2025 may reach 1,13 mln.ton in grain equivalent.

2.3. New lands development is limited not only by water resources availability and their quality, but investments as well. Taking into account insignificant economic development and limited financial resources for water saving measures to be undertaken, water use efficiency will be as follow: specific water use in irrigation - 12 th.m^3 /ha; specific water use for population - 0,079 m^3/year per capita; water use productivity in industry - 0,76 \$/m^3. Irrigated area will increase on 500 th.ha and account for 8,4 mln.ha in 2025.

2.4. Total water consumption under its use given efficiency will be 100,2 km^3/year. Water demand for irrigation will be 91 km^3/year, for industry-4,4 km^3/year and municipal needs - 4,8 km^3/year.

2.5. Water recourses available to Aral will be around 22,1 km3 to 2025. But taking into account available water resources we could avoid the food shortage. And water to Aral will reduce and will be 19,2 km3 to 2025.

3. Scenario of current tendencies

3.1. Region's development under current tendencies in joint transboundary water resources management and integration of agricultural sector. Main efforts of the states will be directed to local water sources conservation.

3.2. Population growth rate will remain the same -1,7%, population number will be 62,7 mln. GNP average annual growth will not exceed 4%. GNP value for the region will be 92,56 bln.USD or 1476 USD per capita. This indicator is better to compare with pessimistic

scenario, because at present time GNP growth rate is 2-7%. From the 2020 we will face the food shortage, because of efficiency of water and crops yields.

3.3. Water use efficiency indicators are expected as follow: for irrigation - 15,7th.m^3/ha; for population - 0,078 m^3/year per capita; for industry - 0,73 \$/m^3.

3.4. Irrigated area will remain the same by 2010 and by 2025 it is planned to be 8,2 mln.ha.

3.5. Total water resources consumption will be 126, 8 km^3/year including: for irrigation - 117,6 km^3/year; in industry - 4,24 km^3/year; for municipal needs - 4,9 km^3/year.

3.6. Water resources deficit is expected as 1 km^3 from 2010 and will reach 4,5 km3 to 2025. But as under Vision Aral Sea Document the water resources to Aral is 20-25 km3 to 2025 than the total deficit will reach 25-30 km3 to 2025. Beside, to cover the food shortage water demand will rapidly increase and total water deficit in the region will be around 40-45 km3 to 2025 (with Aral ecological requirement).

CONCLUSIONS

1. Using a new philosophy ("water is sacred") the society can survive, by rehabilitating its ancient traditions and using international experience in efficient water management and use.
2. Under the conditions of the market-oriented economy, great attention should be paid to low-cost activities and reducing organizational losses through the introduction of the appropriate economic, information, legal and organizational mechanism for water conservation.
3. Public awareness should become a basis for society to influence and change the attitudes of water users and government bodies