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Strategy of transboundary return flow use in the Aral Sea basin

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Abstract

The Aral Sea Basin, which is shared by 5 countries of the former Soviet Union — Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan is well known to the world due to the large scale water development in the Soviet period, which caused many ecological problems in the region. One of them is the problem of return waters, which are unmanaged and unused in now acceptable form. The total Transboundary Return Water (TRW) volume formed in the territory of 5 states is 36–40 km³. The two main reasons for the worsening of water quality in the major rivers of the Aral Sea basin – Amudarya and Syrdarya are: water withdrawal from the rivers for irrigation purposes and release return flow to the river of a large content of salts and other pollutants from irrigated lands. Spontaneous formation, dissemination and accumulation of return waters can, and already have caused considerable negative effects in environment and social development. For the development of a program for the use and management of these waters and its approval by the region's countries, measures preventing these effects must be taken in order to be of mutual benefit to all the countries involved and, simultaneously, to transform these waters into a source of life, biodiversity, sustainability and prosperity in the Aral Sea basin on a scale, that would influence the world community. For stabilization of these water bodies at the regional, and, thus at a global scale, it is necessary to eliminate the following threats: instability of whole scope and especially TRW regime in terms of quantity and quality; uncontrolled allocation and use of such waters; injurious use, including poaching. It must be taken into account that transboundary waters' sustainable development and use require permanent monitoring and management over a range of criteria, providing their ecological stability and safety as well as long-term bioproductivity and biodiversity of ecosystems supported by them. The principle provisions of management system on TRW are proposed for each stage: type of return water use; direction of possible use; stability criterion; restrictions; control.

Keywords: Aral Sea Basin; Transboundary; Flow; Ecological; Problem; Desalination

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The Aral Sea Basin extends over 700,000 km² and is shared by 5 countries of the former Soviet Union — Kazakhstan, Kyrgyzstan, Tadjikistan, Turkmenistan and Uzbekistan. Several transboundary rivers cross the Aral Sea Basin. Amudarya and Syrdarya are the main and the biggest rivers. Annually average water resources of the region are 130 km³ from which 90% is surface water.

The basin's water is the source of irrigation and a base for crop cultivation since most of the agricultural lands are irrigated. As a result of irrigation and water use in other branches return flows are formed.

Total return water flow is 36–40 km³, most of it is transboundary, from which collector-drainage waters constitute 32–35 km³. These waters are subdivided into 3 parts:

- Released to the rivers about 50%, 18–20 km³, returning used water resources for its re-use, but simultaneously bringing to the rivers 100–115 million ton of salt and other harmful components that dramatically deteriorate water quality; used for irrigation in places of its origin, 13%, 4–5 km³/y;
- Released to natural depressions feeding different water bodies, 36%, 14–16 km³/y. As a result of centuries-old exploitation of the Amudarya and Syrdarya rivers, especially more intensively in the 2nd half of the 20th century, new man made systems were created on a base of return waters, that include broad collector-drainage network, consisting of hundreds of water bodies with a capacity amounting to 30 km³, and wetlands with an area of tens of thousands of hectares, Fig. 1. Due to full stream flow regulation, the natural hydrological regime of the large rivers is violated. In some rivers after huge withdrawals, permanent water flow is often not available and is supported only through small sanitary releases, emergency releases and return waters.

Transportation of return waters creates substantial problems (flooding, water logging, salinization of adjacent areas, erosion of river bed and banks, destruction of engineering structures). Uncontrolled outflow of these waters into natural sinks and to pasture areas leads to landscape degradation, propagation of insects and weeds. The Aral Sea shore, an area of several millions hectares of land, is located within the semi-arid zone of 3 states and has a unique combination of delta (tugai, wetlands), seashore, and desert ecosystems, which result in a diverse fauna and flora composition; numerous examples of fauna species such as Bukhara deer, the Usturt Sheep, the Usturt Caracal, the little Amudarya Shovel-nose are either unique to this region, globally endangered, or both. The flora displays a high level of endemism with up to 176 endemic plants identified and its significance for agrobiodiversity with 33 wild species of plants recorded. In addition to these endemic, rare or globally endangered residents of flora and fauna, the area is also of global importance for migratory birds of the Central Asian, Indian and East African flyways as it is the convergence place of these two major world flyways. More than 3M migratory waterfowl and over 300,000 birds are supported in this area during the winter period.

The creation of a stable network of well-managed water bodies and wetlands on the basis of TBRW will guarantee the increased capacity of this natural biowater complex. It will save for future generations such globally significant, threatened species such as *Pelicanus crispus*, *Oxyura leucocephala*, *Authia hyraca* and others.

New natural processes should be developed on a large scale in these water bodies. These processes will cause the growth and reproduction of fish, fur-bearing animals, aqua tie and coastal vegetation, birds and even arid forests. As a result, fauna, flora, climatic conditions, bird migration routes, could be changed over huge areas under the influence of annual formation of these waters



Fig. 1. Scheme of transboundary return flow in Aral Sea Basin.

exceeding 40 km^3 in the basin. In addition, 35–40 billion m^3 of water used in an ecologically acceptable and economically efficient way will have regional and global importance for decisions concerning water scarcity problems in the Aral Sea basin in the interest of the riparian states. Specific environmental and social situations should be enforced around the water bodies, since they are of interest to a number of social groups, such as fishermen, cattle-breeders, hunters, etc., settled nearby.

Return flow existed in the basin's long history, but as a result of intensive development of irrigation from 1940–1990 and the construction of huge collector-drainage network, the volume of return flow increased sharply and its influence on the water quality became drama-

tically and critically unstable in its formation and interrelation with freshwater. In the Soviet period all trans-republic waters were under the control of the federal government. However, now the situation has changed and caused water deterioration in the delta of both rivers, as well as land degradation, reduction of natural biological resources, increasing poverty and reduction of the economic ability of the people who are now living in disaster zones.

Uncontrolled return waters create instability in the region.

The Central Asian countries will be joining the Ramsar Convention and it is assumed that measures will be taken on transboundary waters. In particular, new legal provisions in international water law in respect to country obligations on

cooperation in transboundary return water use and management, will be elaborated.

For the solution of this problem it is necessary to decide on the following:

1. Assessment of TRW of the basin, as an object of use and management.
2. Elaboration of TRW management system.
3. Preparation of management strategy in general and its specific aspects, an example of demonstration pilot plots.
4. Assessment of the potential for real improvement of environmental and socio-economic situation within the basin on the basis of this strategy.

Expected outputs from each of these components are the following:

- 1.1 Preparation of the scheme of water streams and water bodies, which were and will be created, based on return waters.
- 1.2 The methodology of volumes, defined in 1.1, separation into the 3 types now and in the future.
- 1.3 Definition of possible return waters release into the rivers for different periods over zones.
- 1.4 Definition of possible return water volumes use for irrigation and other needs for different periods of development over zones.
- 1.5 Definition of return waters volume release into water bodies, wetlands and changes for different years.
- 1.6 Definition of water bodies' inventory where sustainable ecological profile could be created. Terms of reference for its development. GIS database preparation for these water bodies.
- 2.1 Transboundary return water management's regional strategy preparation including: a) establishing transboundary return water release limits on volume of pollutants for the countries and their separate zones; b) sanctions for agreed limits violation;

c) establishing borders of responsibility for transboundary return water management between regional, national and local entities; and d) balance of salts distribution involved by return waters between zones of their accumulation.

- 2.2 National system of transboundary return water management includes: a) establishing inventory of return waters' bodies protected and order of their transfer under administration of local and provincial water entities or/and nature protection bodies; and b) development of rules and order of national organizations' work in return water management.
- 2.3 Creation of new (or extension of existing) regional and national organizations to strengthen "capacity building" of water-ecological organizations responsible for transboundary return water management.
- 3.1 Transboundary return water management models' system with certain strategy adaptation on these models.
- 3.2 Strategy of transboundary return water use for irrigation and other needs.

In this direction 3 types of use are suggested:

- in place of origin for irrigation and leaching;
- creating protection forest strips with simultaneous wood processing;
- technical use in industry, agriculture and municipal needs.

The major of part this strategy is preparation of transboundary return waters management policy.

Its goal is to create a system of transboundary return flow management within the framework of existing regional and national structures; development of institutional and technical principles and their interaction in order to reduce in the future, the negative effect of wastewater on surface and ground waters quality and on the

land, and, at the same time, to ensure the rise of bioproductivity and biodiversity in these man-made systems. The paradox of the situation is that though 5 countries have undertaken joint management over the transboundary river waters of the Aral Sea basin, and carefully control their allocation, return waters are not taken into account, and polluting waters are becoming an uncontrolled source of land degradation.

Taking into account sustainable development and use, transboundary waters require permanent monitoring and management over a range of

criteria, providing their ecological stability and safety as well as long-term bioproductivity and biodiversity of ecosystems supported by them.

The management system should include development of the set of principle provisions on TRW as for uses as indicated in Table 1.

- definition of possible TRW release limits into the rivers, taking into account pollution limitation for different river's sites in order not to exceed allowable concentrations of pollutants and establishing, on this basis, limits for countries;

Table 1
Development of the set of principle provisions on TRW

Type of use of return waters	Direction of possible use	Stability criterion	Restrictions	Control
1	2	3	4	5
Release to rivers	Water resource enlarging	Prevention of exceeding allowable limit of pollution	Maximum limit of flow pollution over time	River water quality and salt accumulation in planning zones
Use for irrigation and other needs	In upper watershed for agricultural crops irrigation; On desert massifs for salt-resistant plants irrigation; For saline lands leaching; To feed root zone by backwater in collectors; For industrial needs	Preventing land salinization; Economic and ecological stability; Land desalinization; Preventing land salinization and waterlogging; Preventing machinery corrosion	Maximum flow pollution limit over time; Water resource availability; Seasonal salt balance is negative; Seasonal salt balance is negative, ecological expediency; Water resource available	Soil salt composition ions; Soil salt balance on anions; Desalinization process; Ground water-table control; salt balance on ions; Water salt and ion composition
Release to water bodies and wetlands	Wetlands creation; Fish production; Fur-bearing animals breeding; Livestock forage; Hunting and tourism; Birds migration; River deltas restoration	Sectors' requirements to salinity, discharge, flowing, oxygen exchange changes	Return water salinity and volume; Possibility of mixing with fresh water	Stagnant zones; Salt concentration; Oxygen concentration; Biological oxygen absorption

- Definition of design parameters of ecological and sanitary releases of fresh water over control sites, taking into account the expected regime of TRW release into the rivers;
- Development of the principle of crop pattern and zonal measures selection for different soil conditions where TRW use is recommended for irrigation;
- Recommendations for the preparation of a feasibility study on collector-drainage water use for irrigation, leaching, etc;
- Development of methodology of water bodies and wetlands regime prediction, providing ecological sustainability and the definition of necessary regime improvements;
- Definition of the set of organizational-technical measures on preventing lands reclamation state worsened by TRW;
- To define a set of organizational-technical measures to prevent the use of objects aggravating the ecological-reclamation state of the bodies which based on TRW.

This should allow:

- Elaboration of the policy for transboundary return water management and use in the Aral Sea basin, ensuring preservation and sustainable maintenance of a wide network of environmentally significant water ways, water bodies and wetlands emerged on a base of these waters, as well as radical improvement of water quality in the basin's rivers;
- The preparation of an institutional and legal base of such management and use at transboundary and national level, including use of transboundary return waters in food production;

- Demonstration, on example, of pilot projects, the expediency and simultaneously potential for increase of new water and water-land ecosystems' natural productivity;
- Enlarging the water resource and turning it into stable elements of a sustainable ecologically natural, anthropogenic complex of rivers, water bodies and wetlands of the Aral Sea basin.

The first step in this work is being doing now in 2 projects:

1. "Improvement of water and environment policy of the Aral Sea basin", funded by GEF and the World Bank, where in component "E" attempt is done to prepare an environmentally sustainable profile of one from the wetlands in Amudarya delta, Sudochie lake. This project at a cost of ~\$6 M is now in a stage of tendering for construction work. Environmental, hydrological, social-economic assessment and survey showed that for achievement of sustainability of this water body created on the base of collector-drainage water we need not only to manage this return flow, but release to the lake the proper quantity of fresh water (~30% from the total volume), that permits the support of the proper regime of water required by ecologists, for fish, muskrats and birds. It will cause the necessity to construct the dam, outlet and special water derivation, which will allow the management of all this system over an area 40000 ha of wetlands.

2. Project "Right Bank Amudarya collector", which will prevent the release of collector-drainage water of the middle river reaching the river channel and permit to reduction of water salinity in the river down 1 g/l.