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BY THE ESTABLISHMENT OF ECONOMIC OPTIMAL AND ECOLOGICALLY SAFE LEVEL WATER IN SYRDARYA BASIN

The article describes the background to the establishment of economically optimal and environmentally safe water level in the Syrdarya river basin.

Water resources of the Aral Sea were formed mainly from Syrdarya - 39 km^3 and Amudarya - 81 km^3. The irrigated lands in the Syr Darya basin amounted to 3.5 mln. hectares, and the upper reaches of the Syrdarya solved hydropower problems. The total capacity of 25 relatively large district and dozens of small hydropower plants accounted for more than 775 ths. kW of electricity. In addition, the 0.6 ... 0.8 km^3 of water per year used in the domestic economy, industrial and agricultural water supply. It should be mentioned that the use of water on the Syrdarya basin has uncoordinated appearance, and sometimes contradictory nature of both the countries located in the basin, and in the economy. Among the negative facts should be referred the reduction of mean values of flow and change its intra-distribution.

For an objective assessment of human activities, it is necessary to introduce a number of specific indicators to assess the level of water use, such as for hydropower purposes.

The level of influence on the flow of the river is usually more appreciated by indication of regulation (regulation degree or level of use) of the flow rate α

$$\alpha = P / Wo, \quad (1)$$

where P – the amount of water consumption for a given period (usually one year); Wo- annual flow (runoff rate).

However, this figure does not reflect the impact of energy use of the river flow and is not possible to take into account the impact on the flow of the energy use of the river regime (regulation of river flow). It should be noted that the use of water resources and the level of regulation for hydropower purposes up to 100% foreign. Therefore, it is proposed that a new indicator - the level of use of the river flow for hydropower purposes αe, type:

$$\alpha e = We.i. / We, \quad (2)$$

where We.i.- consumption of water for hydropower purposes (the volume of water regimes and sent for energy purposes); We - the volume of river flow for the natural period.

Accordingly, this value can be separately identified and during the winter and summer periods. During winter αe.w:

$$\alpha e.w = Ww.i. /Ww.e. \quad (3)$$

where Ww.i .; Ww.e.- respectively volumes of water distorted regulated flow (energy - water discharge modes through the turbine reservoirs) and natural river regimes for the winter.

Similarly αe.s for summer:

$$\alpha e.s = Ws.i. /Ws.e., \quad (4)$$

where Ws.i., Ws.e. - accordingly the volume of water distorted regulated flow (energy - water discharge modes through hydroelectric turbines) and the natural conditions of the river for the summer.

Accordingly it is possible to determine their absolute value, for winter and summer:

$$\alpha e.w = (Ww.e.- Ww.i.) /Ww.e. \quad (5)$$

$$\alpha e.s = (Ws.e.- Ws.i.) /Ws.e .. \quad (6)$$

In the same way, sets the values and their relative percentage.

For areas of the distorted flow regime of the river is necessary to determine the level of reduction of surface runoff for any analyzed alignment, such as the regulation of the flow rate

$$\alpha s.i = Wo.i.i /Wo.e.i, \quad (7)$$

where Wo.i.i, Wo.e.i - accordingly the volume of river flow in the present i-th alignment between distorted and natural river regimes.

Then, the overall combined effect on the flow of the river (level of use of the river's flow, taking into account the energy) will be

$$\alpha ob.s.i = \alpha \cdot \alpha e \quad \text{or} \quad \alpha ob.s.i = (P / Wo) \cdot (We.i. / We). \quad (8)$$

The decline of mean values of flow and change its intra-distribution should also be considered when establishing a secure and optimal water level.

Location of Syrdarya River Basin in the territories of four countries: Kyrgyz Republic, Republic of Tajikistan, Republic of Uzbekistan and the Republic of Kazakhstan, imposes certain complexity in the joint management of water and its resources. At the current level of the water resources of the Syrdarya river up 37.203 km^3. The level of water use for a long time already exceeded 100% mark, that is, from 59% in the 1931-60 years to 120% in the 1981-1985.

In this regard, appropriate alternative way to solve the problem of water management, where the basis for the rational use of water resources should be made optimal economic and environmental safety levels of water in the river basin.

The forecast of natural waters of Kazakhstan in terms of changes anthropo-genetic and environmental factors.

The decision in the field of natural resource management tasks, the priority is the approach in which problems are solved jointly, that is, problems of the economy are not detached from the problems of ecology. This should be based on the conditions that society prefers the issues of environmental protection.

At any level of use of the river's flow, it is necessary to establish siting water resources in the whole river basin. Under the siting of water resources are understood, the water resources of transboundary rivers less mandatory water consumption (water loss for additional evaporation, highly saline wastewater, etc.). Water loss by evaporation, to the territory of the above Kairakum reservoir at 1980 levels are 2.4 km^3. For Uzbekistan and Kazakhstan are 0.9 km^3. Including Uzbekistan and Kazakhstan 0.3 - 0.6 km^3. The same value is extended to the year 2000 -3.6 km^3 of water per year. Sanitary releases to 1980 equal to 1.6 km^3. This value is extended to the year 2000. Dimensions of sanitary releases on perspectives depend on the will of the peoples living in this basin. Is it acceptable, maintaining the present situation in the lower reaches of the Syrdarya River Basin - the preservation of the Northern Aral Sea (NAS) at the level equal to 42,0 m and possibly in the long term at the level of 46,0 m. To save the

NAS at the level of 42,0m and 46,0 m respectively requires 2.72 and 3.32 km3, an average of about 3.0 km^3 of water per year. For irrigation of fishery reservoirs in the lower reaches of the Syrdarya River is required, and about 3.0 km^3. Then for the Conservation of Nature in the lower reaches of the rivers, in the truncated version needed 6.0 km^3.

Table 1 – Water resources of Syrdarya River along the length of the watercourse, km^3

Rriver Land	State	Cross-sections	Water resources, km^3	Restoration of natural resources
1	2	3	4	5
Upper	China		0,75[1]	
	Kyrgyzstan, including:		25,9-26,8 (accepted 26,0)[9] 26,85[1] 27,52[6] 27,605[7]	28,4
		Naryn	14,544[7]	
		Karadarya	3,921[7]	
Average (From the confluence of the Naryn and Karadarya rivers to the border of Kazakhstan)	Tajikistan and Uzbekistan, including		8,9-10,4 (accepred 9,5)[9]	
	Tajikistan		1,00[1] 1,6 1,005[7]	1,0
	Uzbekistan		6,17[1] 5,66[6] 6,167[7]	10,2
Lower	Kazakhstan		2,1-2,6 (accepted 2,4)[9]	2,4
		Kokbulak	18,3[4] до 2000г.	
		Shardara HPP	13,6[4] до 2000г.	
		Tyumenaryk	15,6[4]до 1960г. 11,4[4] до 2000г.	
		Kyzylorda	21,2[4] до 1960г. 8,24[4] до 2000г.	
		Zhusaly	9,54[4] до 1960г. 8,24[4] до 2000г.	
		Kazalinsk	16,0[4] до 1960г. 9,95[4] до 2000г.	
		Karateren	5,41[4] до 2000г.	
Syrdarya river basin			36,9-39,8 (accepted 37,9)[9] 37,2[1] 36,6[6] 37,203[7]	42,0
1 - Korenistov etc .; 4 - Zaurbekov etc .; 6 - Bogolyubov, etc .; 7- The union of hydro water industry; 9 – The union water project				

Table 2 – Compulsory cost flow in the Syrdarya River Basin

Indicators		Years	Kygyz stan	Tajiki stan	Uzbek istan	Kazakh stan	Syrdarya River Basin
Compulsory runoff costs km^3	Water loss through evaporation	1980*	1,8	0,3	0,3	0,6	2,4+0,9 (RUzb+RK) =3,3
		2000	2,0	0,4	0,5	0,7	3,6
		2020	2,5	0,5	0,6	1,0	4,6
		2050					
	Sanitary outflows	1980	1,6	1,6	1,6	1,6	1,6
		2000	1,6	1,6	1,6	1,6	1,6
		2020	6,0	6,0	6,0	6,0	6,0
		2050					
	Highly mineralized wastewaters	1980					-
		2000	0,1	0,1	2,0	0,3	2,5
		2020	0,2	0,2	2,5	0,4	3,3
		2050					
	Total	1980	3,4	1,9	1,9	2,2	4,9
		2000	3,7	2,1	4,1	2,6	7,7
		2020	8,7	6,7	9,1	7,4	13,9
		2050					
Excluding highly mineralized water		1980	3,4	1,9	1,9	2,2	4,9
		2000	3,6	2,0	2,1	2,3	5,2
		2020	8,5	6,5	6,6	7,0	10,6
		2050	8,5	6,5	6,6	7,0	10,6
Note: * -Syrdarya River Basin for 1980 [15]. Other data - expert assessments.							

Since the average annual flow of the river Syrdarya equal to 37.203 km^3 established for a period of two cycles of water availability years 1951-1974 cannot be regarded as a natural drain, due to the fact that they are established for the period the presence of human activity. The water resources of the Syrdarya River is : 30.4 km^3 of water in an average water year.

In the future (2020 -2050 years) mandatory costs flow in the Syrdarya river basin will be - 11.6 km^3. For the development of scientific and methodological foundations of rational use of water resources of the Syrdarya River, it is necessary to establish the natural water resources.

In turn, the methodology of study of social, environmental and economic performance and environmental protection measures carried out in two stages. In the first stage, based on the analysis of criteria for assessing the level of atmospheric pollution of air, water and soil is chosen the most common.

Implemented assessment of the level of pollution and environmental damage are determined. This assessment of the state of environmental pollution set by means of an integral criterion:

$$EPI = (WDI + WPI) + API + (0.2\text{-}0.5)\ SPI, \quad (9)$$

where WDI – an index of water depletion; the rate of irreversible withdrawal of surface runoff, constituting 10 - 20% of the average annual value of natural runoff;

API – air pollution index;

SPI – soil pollution index.

At the second stage is chosen criteria of social - ecological - economic efficiency

$$SSER_i = I_i - D_i - C_i + EED_i, \quad (10)$$

where $SSER_i$ - total income as i - th version of flow regulation (as i - th version of the integrated use of water resources of the river basin);

I_i - income sectors of the economy as i - th version of flow regulation (as i - th version of the integrated use of water resources of the river basin, taking into account the positive spillover effects);

D_i - damage from depletion and pollution of water sources as i - th version of flow regulation (as i - th version of the integrated use of water resources of the river basin, taking into account the negative spillover effects);

C_i - construction costs of water protection and water management facilities (as i - th version of the integrated use of water resources of the river basin, taking into account the negative spillover effects);

AEB_i - additional economic benefit arising from the increasing value of natural resources (as i - th version of the integrated use of water resources of the river basin, taking into account the negative spillover effects).

Produced technical and economic calculations for justification of social and ecological - economic efficiency of water management, water protection and water saving measures.

Principles of allocation transboundary rivers. Changing the water regime in one country inevitably affects the interests of other countries. Currently, water allocation and water allocation issues are resolved on the basis of interstate agreements, developed as early as the 90s of the last century. A feature of the regime of water resources of the Syrdarya River is the fact that more than 70% of the flow is formed on the territory of Kyrgyzstan. Basic arrays is suitable for irrigation of agricultural lands are concentrated in the lower reaches of these rivers - in Kazakhstan, Tajikistan and Uzbekistan. Moreover, the upper reaches of the rivers used for hydroelectric purposes, and downstream - for irrigated agriculture. Therefore, there are contradictions between the neighboring countries in the sharing of river runoff. Justification questions of economic sectors development and environmental issues are considered separately, in isolation from each other. Does not comply with the fundamental principle of the Declaration of Rio de Janeiro, nominated in 1992, which states that "in order to achieve sustainable development, protection of environment should become an integral part of the development process and can not be viewed in isolation from the him. "

A new principle of allocation flow of transboundary river basins, based on the preservation of the natural regime of water sources, or compliance with the agreed between neighboring countries mode releases from the reservoir and the water quality of the background. The main thesis of the proposed allocation of the principle of the flow of transboundary rivers - the "polluter-pays".

In international practice, there is a suggestion that the amount of water allocated to each state depends on the population living in this area. However, this thesis requires its improvement. Taking into account the international practice, the two variants of calculation can be identified.

I.Specific water consumption value for the whole river basin remains constant and is taken to the value of the corresponding period in 2015 or 2020.

II. Specific water consumption value for the whole river basin is taken in the context of differentiated states and the value equal to the corresponding period in 2015 or 2020. Limits of water allocated for conservation of natural complexes varies according to the hypothesis, and formed the development of industries in the territories of neighboring states.

The principal position to meet the requirements of natural systems can be of the following two options.

First option. All States shall take as a basis for the position that you want to save: all natural complexes, including the Aral Sea. In this case, also, two approaches: a) Saved in full natural complexes requirements b) natural complex requirements stored in the abbreviated form. (Conservation of Small North Sea in the Syrdarya river delta).

The second option. Natural systems requirements are not saved.

Modern views on the problems of the Aral Sea shows that: in the first stage in the Syrdarya river estuary to save small North Sea at 42,0-46,0m. Then, the inflow to the Small Sea approximately - 3.0 km^3 of water per year. Taking into account the amount of water to fill the system of delta lakes and water loss through seepage in the sections of the river in the Republic of Kazakhstan will amount to 3.0 km^3 of water per year. Further, this problem can be solved as follows. For example, in terms of average water content. Natural water resources of the Syrdarya River in the years of average water content - 42.0 km^3 of water per year. There remains small North Sea in the delta of the Syrdarya river (3.0 km^3) the requirements of natural systems in abbreviated form 3.0 km^3 of water per year. Loss of water from the reservoirs - 4.6, as well as the requirements of the lake Aydarkul-1.0 km^3 of water per year. Total costs of the mandatory runoff in the Syrdarya River basin - 11.6 km^3 of water per year. Install water resources, which must be distributed between the states (the siting of water resources: 30.4 km^3 of water per year. Determine the share of each State to water. Establishes requirements for the regime and the water volume of each state for the perspective period, table 3.

Table 3 – Social and water characteristics of the Central Asian states into modern and promising periods

Indicators	Years	Republic of Kyrgyzstan	Republic of Tajikistan	Republic of Uzbekistan	Republic of Kazakhstan	Syrdarya River Basin
Population, million people	2000	3,933	1,902	12,876	3,491	22,202
	2010	4,241	2,206	14,301	3,657	24,405
	2020	4,707	2,566	16,060	3,937	27,270
Water use, km3	2000	5,39	3,50	33,40	10,00	52,29
	2010	5,81	4,06	37,12	11,0	58,00
	2020	6,45	4,73	41,89	12,0	65,07
Mineralization of water, mg / l	2000	0,3-0,5	0,60	0,72	1,3	0,3-0,5 ... 1,3
	2010	0,3-0,5	0,65	0,80	1,6	0,3-0,5...1,6
	2020	0,3-0,5	0,68	0,85	1,8	0,3-0,5...1,8

Establish a stake in water use of each State of the total water volume in the river basin, table 4.

The analysis of Table 5 shows that both the modern and perspective periods, the share of water consumption of each state remains practically constant.

It determines the share of each state in km3 or million m3 of water resources of the Syrdarya River for each respective border alignment, Table 5. When establishing water use limits the development of measures to comply with them in each state will be on their own. For the rational and economical use of limited water resources depends on the further development of economic sectors and economic power of the state. And they would be interested in carrying out a water saving and other advanced water technologies. Because, already established levers or the same as the possibility to control the generated water, and the

accuracy of the use of water resources in the region, or within a given state. If implemented, the new water-use technology, it will be an opportunity for the further development of industries in the states. In the future, the same way you can solve the allocated water resources, and other conditions of water availability in the Syrdarya River.

Table 4 – Percentage water use of each State as a percentage of the total water volume in the Syrdarya River Basin

Indicators	Years	Republic of Kyrgyzstan	Republic of Tajikistan	Republic of Uzbekistan	Republic of Kazakhstan	Syrdarya River Basin
Water use, km3	2000	0,10	0,07	0,64	0,19	1,00
	2010	0,10	0,07	0,64	0,19	1,00
	2020	0,10	0,07	0,64	0,19	1,00
	the average for 2000-2020	0,10	0,07	0,64	0,19	1,00

Table 5 – Water consumption limit and consequently skipped beyond each state and controlled the water resources in the Syrdarya River Basin during the average water availability km^3

Indicators	Years	Republic of Kyrgyzstan	Republic of Tajikistan	Republic of Uzbekistan	Republic of Kazakhstan
The accepted value of each State share	0,10	0,07	0,64	0,19	1,00
The generated amount of State Water	3,0	2,1	19,5	5,8	30,4
Sanitary releases	7,0	7,0	7,0	6,0	7,0
Compulsory costs of water	2,5	0,5	1,6	1,0	5,6
Natural water resources	28,4	1,0	10,2	2,4	42,0
Water skipped out of the State	22,9	21,3	10,4	6,0*	-
Controlled value of water resources, the underlying state	22,9	21,3	10,4	6,0*	-
Note: * Of these, 3.0 km3 in the delta lakes in the lower reaches of NAS and NAS 3.0 km^3. Water overlooked outside the state, must be greater than or equal to the sanitary releases.					

The only difference in the values formed by water at different water rivers and natural systems account requirements for the hydrological regime. Special conditions of water allocation in wet years and flood protection.

Selection of water facilities for interstate water resources management. You must select one or more of water facilities allow you to integrate to manage shared water resources of the river basin and to transfer them to the jurisdiction of ICWC. And do not disturb the activities

of bodies formed by water resources of interstate management. Since, they are entrusted with and solve problems of water management in any water content of the year.

Underlying principles in controlling work mode "interstate facilities sharing" following.

- Preservation of the environment adopted in 1995, that the Aral Sea is the "sixth water user." Compliance with the requirements of international instruments for the rational use and protection of water resources.
- Compliance with the principles of allocation and subsequently develop the principles of allocation of cross-border rivers, taking into account water quality.
- Development of a methodology to monitor the formation of the drain and monitor the implementation of the adopted rules and allocation principles.
- Guide the principle that water resources of transboundary river basins belongs to all people living in the basin of the river.
- Monitoring the use of planning flow within the neighboring state and within its limit of water consumption.
- Assign the value of the water (water charges), taking into account all the positive and negative impacts on the river basin, taking into account their effect on the components of the biosphere, and in view of global climate change.
- Guidelines for the development of rules and methodologies for assessing the state of the environment and the principles of compensation for damages in case of violation of the rules of use and protection of water resources of the river basin.
- Improved scientific - methodological basis for the development of new criteria for the justification of the socio-environmental and economic efficiency of natural and water resources, including water availability at different river.

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