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IMPROVEMENT OF THE METHODOLOGY AND SCIENTIFIC-TECHNICAL BASIS OF THE ADJUSTMENT PARAMETERS OF RESERVOIRS IN THE POOL OF UNDRAINED RIVERS (CASE STUDY OF ILE RIVER BASIN)

Abstract. The starting points. The basic principles of the UN Rio Declaration, 1992 [1]. Maintaining the water level in Lake Balkhash at the mark of 341.0 m. Ensuring sustainable development of economy and preservation of environmental sustainability in the basin of the Ile River in Kazakhstan.

This article presents the methodology, scientific and technical bases, and results of research on the Kapshagai reservoir adjustment parameters in the following order:

- Analysis of the current status of water and land resources use in a river basin in the Republic of Kazakhstan (RK);
- Water resources and water use by the economy branches for water areas within the Ile River basin in Kazakhstan;
- Methods and scientific-methodological basis for identifying the inflow of water to various targets in the Ile basin relevant to different scenarios of industries development both in Kazakhstan and in the People's Republic of China (PRC);
- Recommended water management measures adopted in accordance with the «Sustainable development scenarios by the Russian State Institute of Hydrology» (SDS RSIH);
- Hydrological and water calculations to identify the Kapshagai reservoir parameters.

The adopted methodology and the scientific-technical basis for the study of social, environmental and economic performance measures to adjust the operating parameters of reservoirs were carried out in the following three stages

• the first stage was finding the alignment of the inflow to the reservoir for a variety of long-term periods based on the analysis of the volume and modes of water on the border of a Kazakhstan;

• the second stage was finding the adjusted parameters of the reservoir through comparing the water inflow into the reservoir;

• the third stage is a socio-ecological-economic assessment of optimal variant of the water management system parameters.

Keywords: volume and modes of inflow water, inflow into the reservoir target, return water from the reservoir, the reservoir parameters, water management system, water balance, ecology of water.

1. Introduction. Reduced water flow into Lake Balkhash is due, as noted in paper [2] to the construction of Kapshagai hydroelectric power station, to uncontrolled use of water resources of the rivers Karatal, Lepsy, etc. For example, the Ayaguz river got to the lake until mid-1950. Regulation of the flow of the Ile River by the Kapshagai reservoir and lack of counter-regulator led to a dramatic change in its hydro-regime, sudden floods affecting the cattle.

The Ile River delta has been decreased by more than three times. There are only five of the 16 delta lakes, while the fishery demands are being ignored completely. The area of grasslands and riparian forests has been significantly reduced and this resulted in the biodiversity reduction. Total number sheep and goats decreased by more than three times due to the excessive use of pasture capacity and the consumption of meat per capita has fallen from 77 to 45 kg/year. [3]

The Ile River delta is a part of a large and unique ecosystem of the Ile-Balkhash hydroeconomic complex. It is a system of lakes, branches, channels, former riverbeds, interspersed with thickets of reeds and dry valleys, which are the ecological environment of the lake, providing habitat and reproduction of fish, muskrat, wild animals and various biotic complexes. In addition, the delta is important as an economic entity. The humidified delta areas are floodplain grasslands that make up the main base for fodder farms located both inside and outside the delta [4].

The problem of providing the rapidly growing population and rapidly growing economy with water is becoming more and more urgent for most countries of the world. Reservoirs, distributing the flow in due time and space and meeting the water needs of water users are of great importance in solving this problem [5].

Construction of regulating reservoirs allows to eliminate all or part of disasters associated with floods for the river sections located below the dams, to engage new lands in agricultural use and improve the use of available agricultural land, to reduce the cost of building economic constructions in various sectors of the economy [3, 4].

This implies that the reservoirs can reveal their environmental impact both in the nearby and remote areas, including even the lower atmosphere and what is more all the layers of air and all the environmental components of the biosphere.

Therefore, the problems of improvement and adjustment of the parameters of functioning reservoirs in the basins of the sewer or undrainage rivers require first and foremost analysis of river basin water resources use patterns for the current and future periods. Most important is finding out the possible volumes of water inflow to the reservoir alignment against the analyzed calculated levels of economic sectors development. In turn, the calculation of potential water inflows to the reservoir alignment can be done given to economic development analysis both in the Republic of Kazakhstan and the neighboring States, for various prospective periods.

2. Materials and method. ***2.1. Principles of water loss calculation in the Ile delta and of water inflow into Lake Balkhash.*** In calculating the parameters of the reconstructed reservoirs, it is necessary to identify the dependence of water releases from the Kapshagai reservoir on water inflow to Lake Balkhash, figures 1 and 2.

Based on figures 1 and 2 possible values of inflow to Lake Balkhash were found. The calculations were summarized in Table 1.

Based on calculation results, a chart was compiled, figure 3.

As follows from the chart, there are incremental losses of water in the Ile delta. Negative loss of water in the delta is observed when more than 13.0 km^3 of water releases per year from the Kapshagai reservoir. On the contrary, when less than 13.0 km^3 of water releases from the Kapshagai reservoir per year, there is a positive increase of water loss in the delta. Thus the volume of water inflow into Lake Balkhash is found (figure 6).

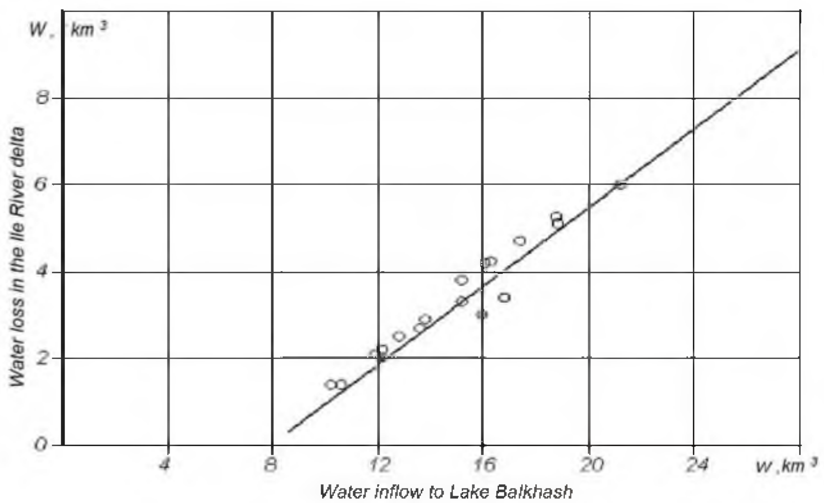

Figure 1 – Interdependence of water loss in the Ile delta and water discharge from the Kapshagai reservoir [7]

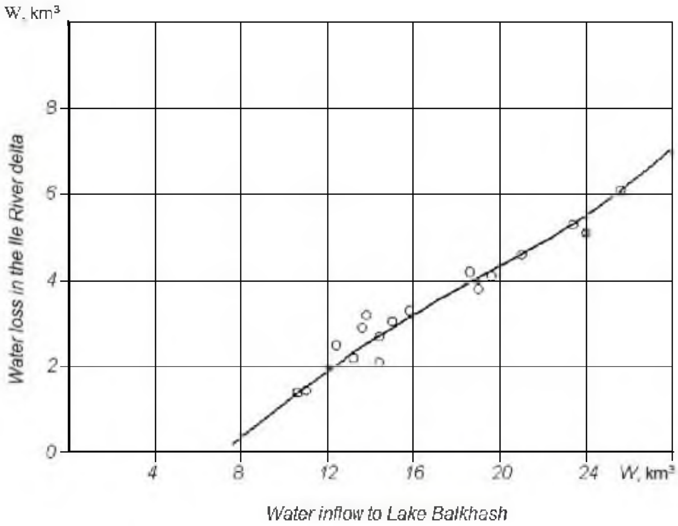

Figure 2 –
Interdependence of water inflow
to Lake Balkhash and water loss
in the delta of the Ile River [7]

Table 1 – Calculation of water losses increase in the Ile River delta depending on water return from the Kapshagai reservoir and inflow of water to Lake Balkhash

№	As of data from Fig. 4		№	As of data from Fig. 3		Water loss increase in the delta
	Discharge from the Kapshagai reservoir	Water loss in the delta		Inflow to Lake Balkhash	Water loss in the delta	
1	29,0	9,6	1	29,0	7,0	+2,6
2	27,0	8,7	2	27,0	6,4	+2,3
3	25,0	7,8	3	25,0	5,8	+2,0
4	23,0	6,8	4	23,0	5,2	+1,6
5	21,0	6,0	5	21,0	4,7	+1,3
6	19,0	5,0	6	19,0	4,2	+0,8
7	17,0	4,0	7	17,0	3,6	+0,4
8	15,0	3,2	8	15,0	2,9	+0,3
9	13,0	2,2	9	13,0	2,2	+0,0
10	11,0	1,4	10	11,0	1,6	-0,2
11	9,0	0,4	11	9,0	0,8	-0,4
12	8,0	0,0	12	8,0	0,4	-0,4

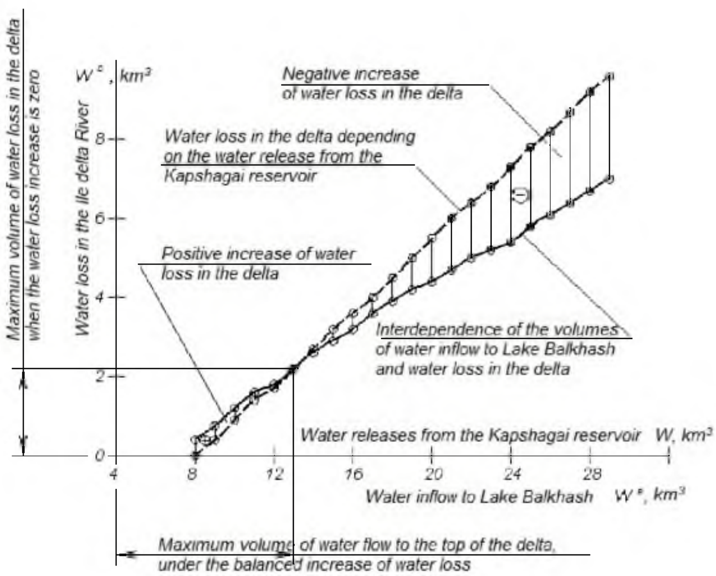

Figure 3 –
Calculation of water
loss increase
in the Ile River delta

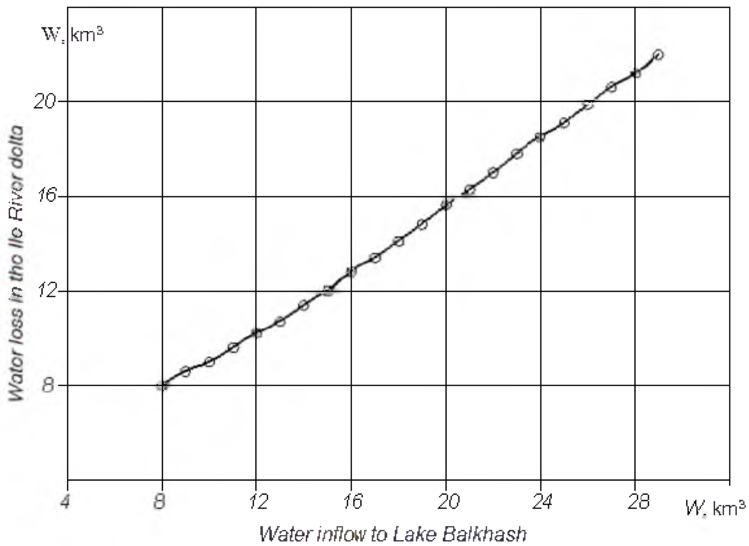

Figure 4 – Volumes of water inflow to Lake Balkhash depending on the volume of water return from the Kapshagai reservoir

In general, it is necessary to clear out the dependence of the water releases from the Kapshagai reservoir and water inflow into Balkhash Lake taking into account the loss of water in the Ile delta, figure 5.

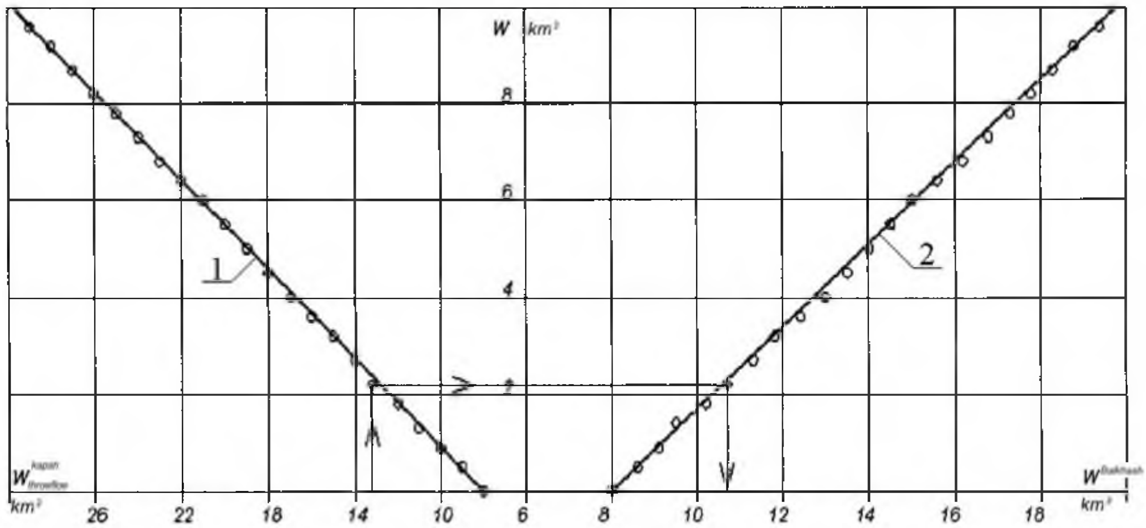

Figure 5 – dependence of the water flow to Lake Balkhash on water releases from the Kapshagai reservoir and water loss in the Ile delta: 1 – loss of water in the Ile River delta depending on water releases from the Kapshagai reservoir; 2 – inflow of water into Lake Balkhash, depending on the water release from the Kapshagai reservoir and water loss in the Ile delta

3. Principles and calculation of the inflow into the Kapshagai reservoir target. According to [7, 8], the flow of water in the border target is 11.4 km^3. For comparison, see the flow of water to the border target water inventory data, Table 2. In addition to these measurements, we analyzed and used measurements carried out by other organizations in the region [9, 10].

Table 2 – Calculation of Ile-Dobyn river water distribution of 50% capacity

Exponents	Months												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
River discharge in 2015, m^3/s	243	306	380	315	506	651	465	776	465	338	244	237	411
Distribution of the river flow, %	4,9	6,2	7,7	6,3	10,2	13,1	9,4	16,3	9,4	6,8	4,9	4,8	100,0
The flow of the 50%capacity, m^3/cs	594	751	933	764	1236	1588	1136	1976	1139	824	594	582	1010,8

The future demand for water industries both in China and in the Republic of Kazakhstan will increase. The following initial scenario for industries development are assumed: 1. Moderate development of industries. 2. Intensive development of industries.

For a moderate development of industries in China, the inflow to the territory of Kazakhstan ranges from 11.0 in 2015 to 10.40 km^3 in 2040, the intensive development of economic sectors, respectively, from 11.0 to 9.40 km^3, table 3. A similar situation for water areas (WEA) is observed in Kazakhstan.

If the flow of water in the border target (Figure 6), as a result of the PRC industries development will be reduced, then Kazakhstan will experience the same situation. Thus, the flows of the Ile River to different targets (Figure 7) will vary with the development of industries. If under a moderate development of the industries the inflow to target 2-2 in 2040 will be 10.10 km^3, under intense development it will make 10.04 km^3. The inflows of target 5-5 in the corresponding periods are assumed as 13.90 and 12.71 km^3 of water per year. The inflow of water to the various Ile River targets and reduction of water volume allocated to the sectors of economy, is illustrated in Figure 10. Hence, you can see that already in 2020, the volumes for different industries will be reduced to zero.

Table 3 – Calculation of the inflow to the Kapshagai reservoir target in the years of 50% supply under different levels of industry development in China and Kazakhstan

Target , hydroeconomic area	Exponents	PRC							
		To date	In future						
		2015	Moderate development			Intense development			
			2020	2030	2040	2015	2020	2030	2040
1	2	3	4	5	6	7	8	9	10
PRC	Water consumption	3,40	3,60	3,80	4,00	3,4	4,0	4,5	5,0
RK border (target 1-1)	Inflow to RK	11,4*	10,80	10,60	10,40	11,0	10,4	9,9	9,4
Rivers of the southern slope of the Dzhungar Alatau	River runoff								
	Water consumption								
	Excess								
Target 2-2	Ile River runoff								
Rivers of the northern slope of the Ketmen ridge	River runoff								
	Water consumption								
	Excess								
Target 3-3	Ile River runoff								
The Sharyn river	River runoff								
	Water consumption								
	Excess								
Target 4-4	Ile River runoff								
Area of the Big Almaty Channel	River runoff								
	Water consumption								
	Excess								
Target 5-5	Ile River runoff								
RK above the Kapshagai reservoir	Discharge								
	Consumption								

* Is an average inflow to the territory of the Republic of Kazakhstan - 11,40 km^3. In fact, it is probably even less. If it is 10.40, then all the calculations need to be adjusted (recalculated).

Continuation of table 3

Target , hydroeconomic area	Exponents	Republic of Kazakhstan							
		To date	In future						
		2015	Moderate development				Intense development		
			2020	2030	2040	2015	2020	2030	2040
1	2	11	12	13	14	15	16	17	18
PRC	Water consumption								
RK border (target 1-1)	Inflow to RK								
Rivers of the southern slope of the Dzhungar Alatau	River runoff	1,08	1,08	1,08	1,08	1,08	1,08	1,08	1,08
	Water consumption	0,38	0,39	0,39	0,38	0,38	0,40	0,42	0,44
	Excess	0,70	0,69	0,69	0,70	0,70	0,68	0,66	0,64
Target 2-2	Ile River runoff	11,70	11,49	10,29	10,10	11,70	11,08	10,56	10,04
Rivers of the northern slope of the Ketmen ridge	River runoff	0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36
	Water consumption	0,05	0,05	0,04	0,04	0,05	0,06	0,07	0,08
	Excess	0,31	0,31	0,32	0,32	0,31	0,30	0,29	0,28
Target 3-3	Ile River runoff	12,01	11,80	11,61	11,42	12,01	11,38	10,85	10,32
The Sharyn river	River runoff	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
	Water consumption	0,15	0,16	0,16	0,15	0,15	0,16	0,17	0,18
	Excess	1,00	0,99	0,99	1,00	1,00	0,99	0,98	0,97
Target 4-4	Ile River runoff	13,01	12,79	12,60	12,42	13,01	12,37	11,83	11,29
Area of the Big Almaty Channel	River runoff	2,44	2,44	2,44	2,44	2,44	2,44	2,44	2,44
	Water consumption	0,96	0,97	0,97	0,96	0,96	0,98	1,00	1,02
	Excess	1,48	1,47	1,47	1,48	1,48	1,46	1,44	1,42
Target 5-5	Ile River runoff	14,49	14,26	14,07	13,90	14,49	13,83	13,27	12,71
RK above the Kapshagai reservoir	Discharge	5,03	5,03	5,03	5,03	5,03	5,03	5,03	5,03
	Consumption	1,51	1,54	1,53	1,50	1,51	1,57	1,62	1,68

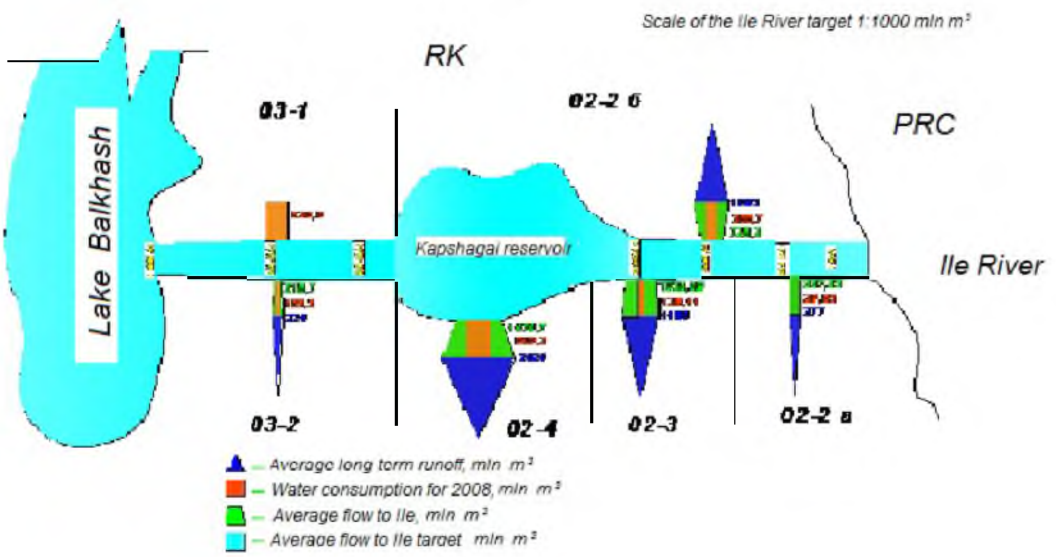

Figure 6 – Water resources, water use and the inflow in the Ile River on the balance sheet plots

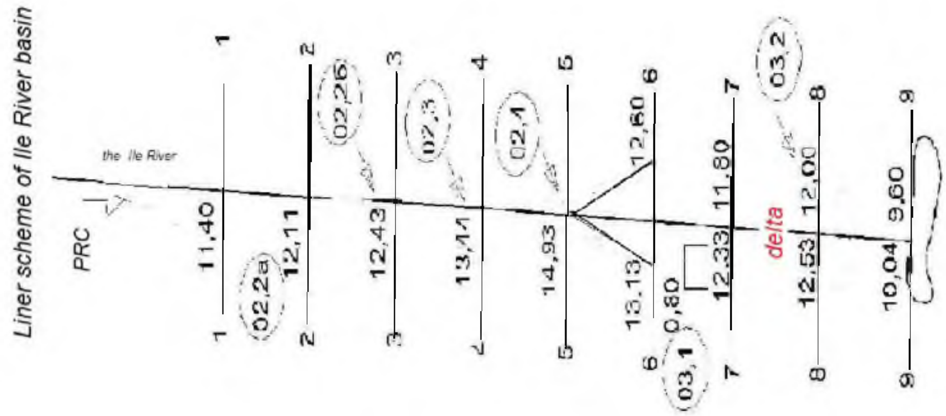

Figure 7 – WEB and a linear scheme of Ile River basin water resources use

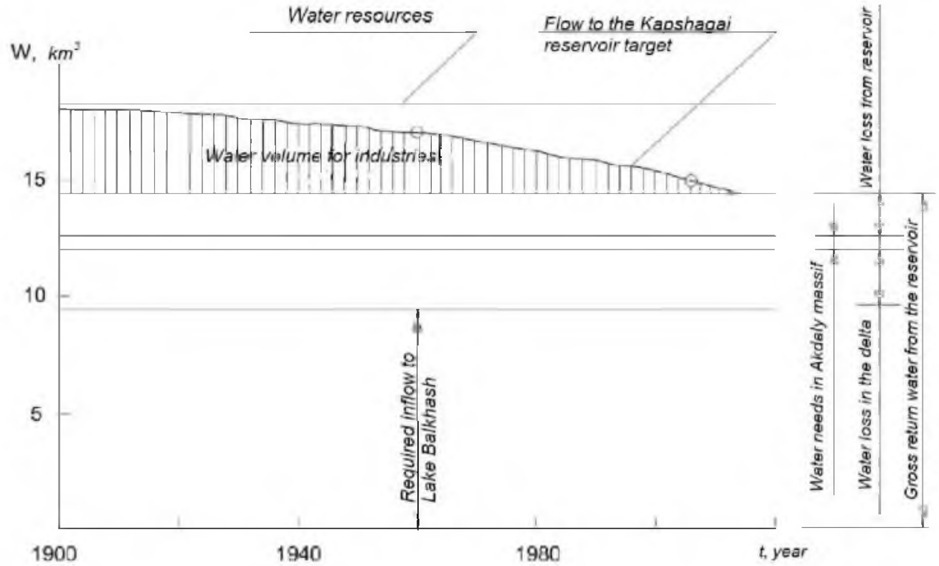

Figure 8 – Water resources, the inflow to Kapshagai reservoir target and gross return water from the reservoir (Ile River basin) to the present level of economic sectors

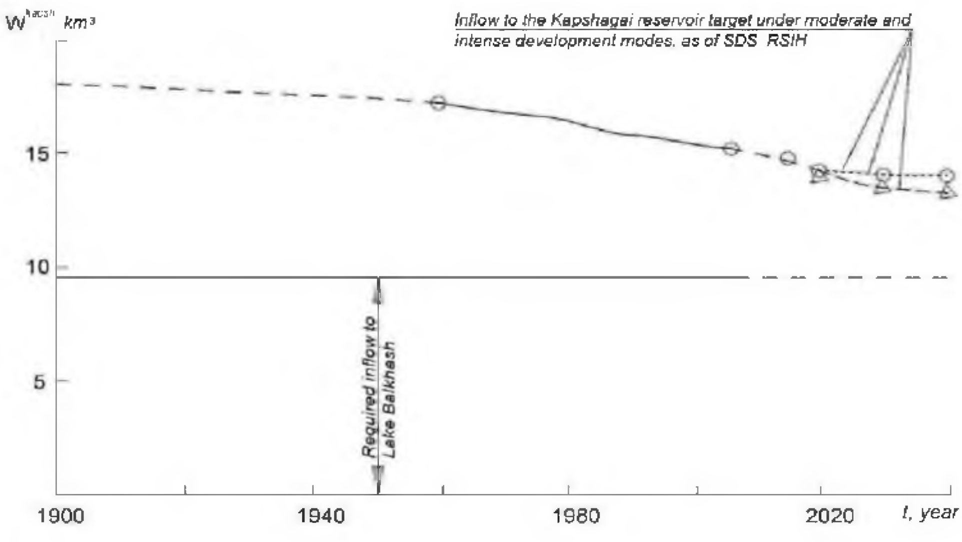

Figure 9 – the influx to Kapshagai reservoir target given the planned (moderate and intense) economic branches development in PRC according to the scenarios by SDS RSIH

4. The proposed principle of identifying the reservoir parameters. ***4.1. Calculations to identify the flow of water in the Ile River by hydroeconomic areas (HEA) in the Republic of Kazakhstan for the average water river.*** The value of 50% supply river flow is added to the difference of water discharge and consumption at each hydroeconomic area, table 3. These calculations are made from the target 1-1 to target 5-5, figure 7. (For example: "The rivers of the southern slope of the Zhungar Alatau", target 2-2. Firstly, the calculations are carried out in the context of a multi-year period, according to the flow regime of the river, provided that there is some background information, and in those cases where there is no data, the calculations are made according to regional schemes, and thus the calculated flow is found. Excess or deficit in the observed flow calculation intervals are calculated basing on water use and water consumption mode. If the result of calculations is a deficit, then this month there would be no water inflow to the Ile River. The Ile River runoff is calculated as the flow of the Ile River at the border alignment (Dobyn point), plus the difference between the flow and consumption in hydroeconomic area). Thus, the calculation is made in the context of each alignment.

4.2. Calculations to determine the impact of water from Kapshagai for average water river. The calculations in the downstream reservoir are made from Lake Balkhash (target 9-9), to the Kapshagai reservoir alignment (target 5-5). Thus, the calculation is made from the lower to the upper area under the following restrictions. Water level in Lake Balkhash should be at least 341.0 m. The Ile tributary is 80% of the total inflow to Lake Balkhash equal to 12.0 km^3. That is, Lake Balkhash should receive 9.6 km^3 of water per year from the Ile River.

To do this, the amount of water loss in the delta is calculated which at this stage is 2.4 km^3, figure 5. Then in target 8-8, an inflow to the Delta should be equal to 12.0 km^3. The inflow to the same alignment of the 7-7 (front intake in Akdalinsky irrigation array) should be equal to 12.8 km^3. Demand for Akdalinsky water irrigation array (permanently) is 0.8 km^3 of water per year.

Water releases from the Kapshagai reservoir (target 6-6) should reach 12.6 km^3 of water per year, since 0.2 km^3 of water per year will be delivered by the Kurty river (excess water flow in the Kurty river basin).

4.3. Long-term regulation reservoir parameters calculation. The above calculations show that the net return of water from the reservoir (water releases from the Kapshagai reservoirs - target 6.6 should make up to 12.6 km^3 per year): $A_{w.releas}$ = 12.6 km^3. Loss of water from the reservoir, for average conditions: W = 1,9 km^3. Then gross return water: $A_{gr}^{kapsh.resv} = A_{w.releas} + W_{inf}^{kapsh\,resv} = 12{,}6 + 1{,}9 = 14{,}5$ km^3. Table 4 shows the calculations to determine the inflow to the Kapshagai reservoir target.

Table 4 – Summary of the Kapshagai reservoir calculation parameters for retrospective and prospective period (2040) under different scenarios of expected development of industries in the PRC and in Kazakhstan

№	Exponents	Till 1970	2015	Perspective (2040)		
				Under moderate development	Under intense development	According to the SDS RSIH scenario
1	Inflow to the reservoir target,km^3	17,0	14,93	13,90	12,71	14,38
2	Gross water release (average for a multi-year period) given the Balkhash level at 341,0 m, km^3	14,5	14,5	14,5	14,5	14,5
3	Reservoir parameters: Total volume, km^3, including:	28,0	18,6			
	- dead volume	12,8	12,8	12,8	12,8	12,8
	- usable capacity	15,2	5,8			
	Retaining marks, m: - DLM (dead level marks)	474,5	474,5	474,5	474,5	474,5
	- NWL (normal water level)	485	479			

4.4. Task solution.

4.4.1 Flow parameters for 2040 (enlarged):

- average multi-year value of inflow to the reservoir target, $W_{inf}^{kapsh.resv}$ = 13,0 km^3;

- coefficient of variation $C_V = 0,30$;
- coefficient of asymmetry $C_s = 2\ C_V$.

4.4.2 Gross water release from the reservoir: $A_{gr}^{kapsh.resv} = 14,5$ km^3.

4.4.3 Regulation of the flow rate is determined according to [11, 12]:

$$\acute{\alpha}_{gr} = \frac{A_{gr}}{W_{\inf}^{kapsh.resv}}. \qquad (1)$$

where $\acute{\alpha}_{gr}$ – is coefficient of regulation; A_{gr} – gross water release from the reservoir; $W_{\inf}^{kapsh.resv}$ average value of water inflow to the reservoir alignment.
Then $\acute{\alpha}_{gr} = 14,5 / 13,0 = 1,12$.

4.4.4 Autocorrelation coefficient between the drain adjacent years. The most probable value r = 0,3 [13, 14].

4.4.5 The long-term component of long-term regulation reservoir capacity (β_{longt}) [15-17]:

$$\beta_{longt} = (\acute{\alpha}, C_V, C_s, r, p). \qquad (2)$$

where r – is autocorrelation coefficient between the drain adjacent years; p – water consumers satisfaction; β_{longt} – long-term regulation.

4.4.6 Water consumers satisfaction is found as [18,19]:

$$P_{HEC} = \frac{\sum_{i=1}^{n} p_i \cdot \Pi_i}{\sum_{i=1}^{n} \Pi_i}, \qquad (3)$$

where Π_i – is water consumption volume of an industry; P_{HEC} – hydroeconomic complex (HEC) satisfaction with water consumption; P_i – HEC - participant's satisfaction with water consumption; n – total number of HEC participants.

The following economy branches are located below the Kapshagai reservoir:

- Lake Balkhash - natural system of national importance: $\Pi_i = 9,6$ km^3 and $P_{com} = 95\%$;
- irrigated agriculture. Water need of the Akdalnsky irrigated array: $\Pi_{irg(irrigation)} = 0,8$ km^3 (consumptive water use) and $p_{irg} = 85\%$.

Then $P_{HEC} = 0,94$. We can conclude with more confidence that $P_{HEC} \approx 95$ %.

It is not possible to find a long-term component of long-term regulation reservoir capacity (β_{longt}) by the nomograms, since, in this case, the level of regulation of the flow is $\acute{\alpha}_{gr} \geq 1,0$. In the nomograms data are provided only for $\acute{\alpha}_{gr} \leq 0,9$ [13, 15], where it turns out that it is not possible to meet the water needs of water users.

Therefore, in the long term, from 2014-2015, it is necessary to take drastic measures to reduce water needs of all water users. And, until 2015, yet there may be some increase, but in the next five years and decades there should be significant reductions in water consumption, table 5.

Table 5 – Assumed water consumption levels for economic branches in 2015-2060
as of the development scenario by SDS SGI [20]

№	Future periods (years)	Water use by the industries in shares from 2015					Notes
		domestic water supply	industrial water supply	agricultural water supply	regular and estuary irrigation	other branches	
1	2015	0,95	0,95	0,95	0,95	0,95	
2	2020	0,90	0,90	0,90	0,90	0,90	
3	2030	0,80	0,80	0,80	0,80	0,80	
4	2040	0,70	0,70	0,70	0,70	0,70	
5	2050	0,60	0,60	0,60	0,60	0,60	
6	2060	0,50	0,50	0,50	0,50	0,50	

Water consumption by economic branches in accordance with the environmental protection requirements (maintaining the level of Balkhash lake at 341,0 m), table 6, figures 9, 10.

Analysis of Table 6 shows that efforts to reduce water needs of water users in the basin of the Ile River in Kazakhstan are insufficient to compensate for the increase in demand for water by the PRC industries. For example, if by 2040 the demand for water increase under moderate development of industries in China is 1.0 km^3, the water needs reduction of water users in the basin of the Ile River in Kazakhstan is – 0,42 km^3.

The issue of the inner reservoir – Lake Balkhash - preservation would be solved only provided that an international agreement would be signed with the PRC.

So, it is necessary to cut down the needs of water consumers throughout the Balkhash-Alakol water economy region (adoption of drastic measures on water saving) in order to compensate for the increase of rising needs in water of Chinese industries.

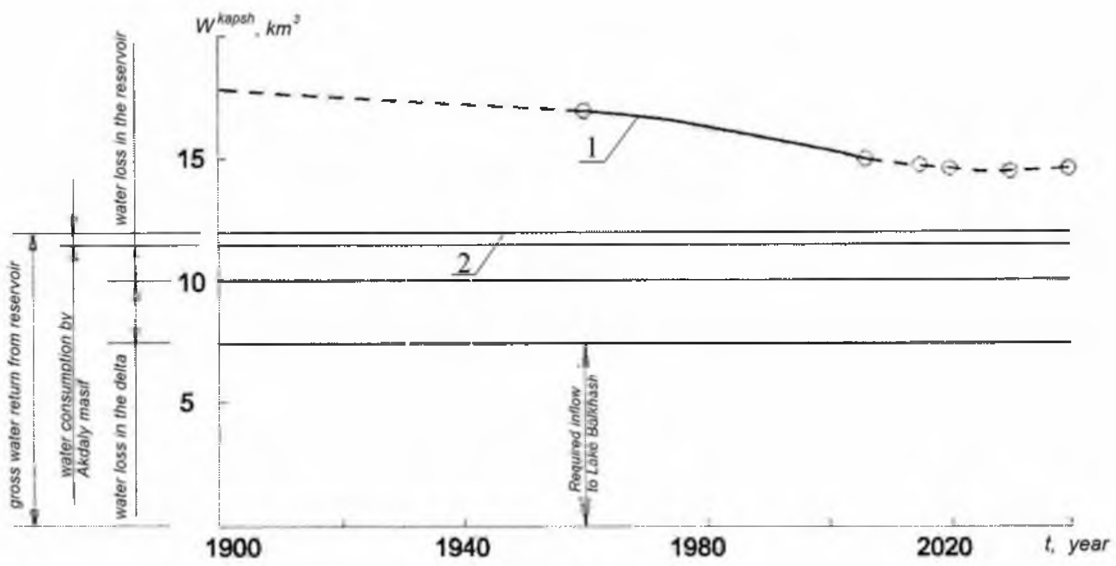

Figure 10 – Inflow to the target and impact of gross water return from the Kapshagai reservoir in the Ile basin during drastic measures to reduce the industries demand for water: 1 – inflow to the target; 2 – gross water return from the reservoir

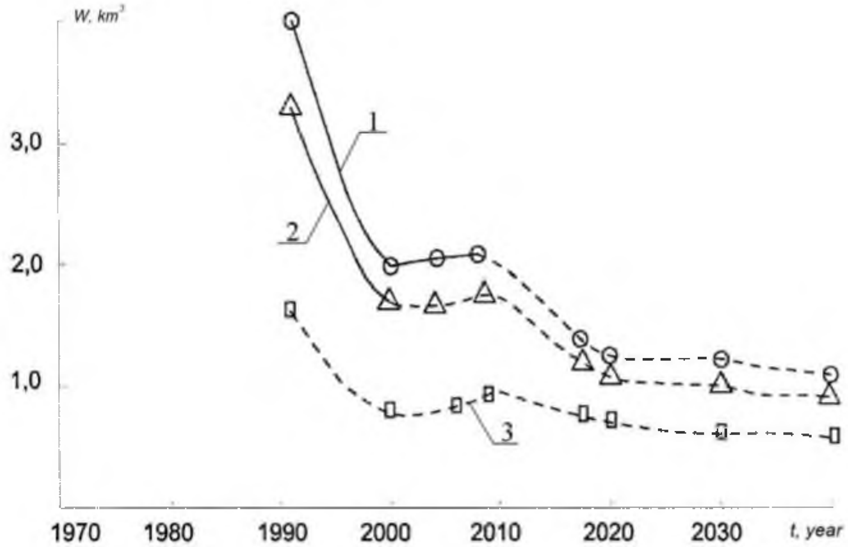

Figure 11 – Actual and assumed volumes of water consumption by industries in accordance with crucial measures to reduce the demand in water: 1 – the Ile River basin above the Kapshagai reservoir; 2 – the basin of the Big Almaty Channel (BAC) without the Ile basin; 3 – Akdalynsky irrigation array

Table 6 – Calculation of water flow to the Kapshagai reservoir target in the years of 50% capacity under the moderate economy development in PRC, according to the development scenario by the SDS SHI in Kazakhstan and provided that the natural complex of especial importance for the state is being preserved (Lake Balkhash, not lower than 341,0 m) km^3

Target, water economy plot	Exponents	PRC				Republic of Kazakhstan					Notes
		today	Moderate development			today	Development as of SDS SHI				
		2015	2020	2030	2040	2008 (2006)	2015	2020	2030	2040	
PRC	Water consumption	3,40	3,60	3,80	4,00						
RK border **(target 1-1)**	Flow to RK	11,40*	10,80	10,60	10,40						
Rivers of the southern slope of Zhungar Alatau	Rivers runoff					1,08	1,08	1,08	1,08	1,08	
	Water consumption					0,37	0,35	0,33	0,30	0, 26	
	Excess					0,71	0,73	0,75	0,78	0,82	
Target 2-2	The Ile River runoff					**12,11**	**11,73**	**11,55**	**11,38**	**11,22**	
	Water consumption					0,04	0,04	0,04	0,03	0,03	
	Excess					0,32	0,32	0,32	0,33	0,33	
Target 3-3	The Ile River runoff					**12,43**	**12,05**	**11,87**	**11,71**	**11,55**	
The Sharyn River	Rivers runoff					**1,15**	1,15	1,15	1,15	1,15	
	Water consumption					0,14	0,13	0,13	0,11	0,10	
	Excess					1,01	1,02	1,02	1,04	1,05	
Target 4-4	The Ile River runoff					**13,44**	**13,07**	**12,89**	**12,75**	**12,60**	
The BAC area	Rivers runoff					**2,44**	2,44	2,44	2,44	2,44	
	Water consumption					0,95	0,90	0,86	0,76	0,66	
	Excess					1,49	1,54	1,58	1,68	1,78	
Target 5-5	The Ile River runoff					**14,93**	**14,61**	**14,47**	**14,43**	**14,38**	
RK: above the Kapshagai reservoir	Runoff					**5,03**	**5,03**	**5,03**	**5,03**	**5,03**	
	Water consumption					**1,47**	**1,42**	**1,36**	**1,20**	**1,05**	
Rivers of the northern slope of Ketmen Ridge	Rivers runoff					**0,36**	0,36	0,36	0,36	0,36	

5. Water economy activities for the reduction of water consumers' needs in water. Accepted starting point. Identification of parameters for the Kapshagai – long-term regulation reservoir was made on the assumption that the needs of water consumers throughout the Balkhash-Alakol water economy region (BAWER) have been reduced (as a result of drastic water saving measures). Then, water flow to Lake Balkhash by the Ile River could be lessened due to water resources saved throughout the BAWER. This would result in annual 20% water economy, which makes 1,9 km^3. Then only 7,7 km^3 a year instead of 9,6 km^3 of water should flow to Lake Balkhash.

Thus, the net water discharge from the reservoir (annual water releases from the Kapshagai reservoir – target 6-6 - should make 10,3 km^3 of water, i.e. net water discharge from the reservoir: $A_{gr}^{kapsh.resv}$ = 10,3 km^3. Water loss from the reservoir: $W_{cons}^{kapsh.resv}$ = 1,7 km^3. Then gross water discharge:

$A_{gr}^{kapsh.resv} = A_{w.releas} + W_{cons}^{kapsh.resv} = (10,3 + 1,7)\cdot 10^9 = 12,0\ km^3$.

Water inflow to the Kapshagai reservoir target under the drastic measures is between 14,6-14,4 km^3, table 6. The summarized data on the water inflow to the Kapshagai reservoir target are given in table 7.

Table 7 – The summarized data for calculating the Kapshagai reservoir parameters for the past and future periods (2040) as of the development scenario by SDS RSIH in Kazakhstan given the preserved natural complex of special state importance (Lake Balkhash level not below the mark of 341,0 м) km^3

№	Indexes	Till 1970	2015	2040
1	Water inflow to the reservoir target, km^3	17,0	14,93	14,38
2	Gross water return (average for many years) provided the level of L.Balkhash 341,0 m, km^3	14,5	14,5	12,0
3	Reservoir parameters:full volume, km^3, including:	28,0	18,6	
	- dead volume	12,8	12,8	12,8
	- usable capacity	15,2	5,8	7,0
	Water marks, m:			
	- DLM (dead level marks)	474,5	474,5	474,5
	- NWL (normal water level)	485	479	480,0

Conclusion.

1. The initial premise taken into account for adjusting the Kapshagai parameters was the future development of industries both in PRC (China) and in Kazakhstan assumed in accordance with the following scenarios:

- Moderate development;
- Intensive development.

2. Given the moderate development of industries in China, the inflow to the border of Kazakhstan target in 2040 will amount to 10.40 km^3, instead of 11.0 km^3 in 2015, while under the intensive development of economic sectors 9.4 km^3 of water will come instead of 11 km^3 in 2015.

3. For a moderate development of industries in Kazakhstan, the influx of Kapshagai target in 2040 will amount to 13.90 km^3, instead 14.49 km^3 in 2015 and, respectively, for the intensive development of economic sectors 12.31 km^3 of water will come in 2040, instead of 14, 49 km^3 in 2015.

4. To maintain the level of water in the lake. Balkhash at elevations below 341.0 m, water saving work is recommending, thus the development of industries in the Republic of Kazakhstan in accordance with the SDS RSIH scenario. Water management activities on water conservation in the economy in the Ile River basin, in accordance with the recommendations of the SDS RSIH reduce water consumption for 2040 by only 0.42 km^3, which is not enough to compensate for the increased demand for water in China by 1.0 km^3. Therefore, water management activities on water conservation are being carried throughout the Ile-Balkash water management district.

5. Water conservation activities in the Ile-Balkash water management district allow to save about 1,90 km^3 by 2040, and in this case the influx to the Kapshagai target will be between 14,6-14,4 km^3 a year. Consequently, then 7,7 km^3 will come along the Ile River to Lake Balkash annually, instead of 9,6 km^3. Net water release will make 10,3 km^3, water loss from the reservoir - 1,7 km^3, annual gross water release from the Kapshagai reservoir will be 12,0 km^3 water.

6. P_{HEC} DLM NWL. The Kapshagai reservoir parameters were adjusted for an average water content year in accordance with the proposed methodology for ensuring that the water needs of water complex Pwec = 95%, the mark of the dead volume EMA = 474 m (12.8 km^3) and normal propped level NPU = 480 m (19, 8 km^3).

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АҒЫНСЫЗ ӨЗЕНДЕРДІҢ АЛАПТАРЫНДАҒЫ СУ ҚОЙМАЛАРДЫҢ ПАРАМЕТРЛЕРІН ТҮЗЕТУДЕГІ НЕГІЗГІ ҒЫЛЫМИ-ТЕХНИКАЛЫҚ ЖӘНЕ ӘДІСТЕМЕЛІК ЖЕТІЛДІРУЛЕР (ІЛЕ ӨЗЕНІ АЛАБЫНЫҢ МЫСАЛЫНДА)

Аннотация. Негізгі шарт. 1992 жылғы Рио-де-Жайнеродағы негізгі принципті қадағалау. Балқаш көлі деңгейінің 341 м-ге төмендеуінен сақтау. Қазақстандағы Іле алабының экологиялық тұрақтылығын сақтау және экономикалық салалардың тұрақтылығын қамтамасыз ету. Мақалада, Қапшағай су қоймасының параметрлерін түзетудің зерттеулері мен нәтижелері және ғылыми-техникалық негіздер мен әдістемелер келесі жүйелілікте жасалынған:

- Қазақстан Республикасы территориясындағы өзен алабының қазіргі жағдайдағы жер-су ресурстарын пайдалануды талдау;
- Қазақстан Республикасындағы Иле алабының су шаруашылық жерлеріндегі су ресурстарын және экономикалық салалардың су тұтынушыларын қарастыру;
- Қытай Халықаралық Мемлекетінің территориясындағы және Қазақстан Республикасы территориясындағы, Іле өзені алабының әр түрлі бекеттеріне ағып келетін ағынды, экономикалық салалардың дамуындағы сценарийлерді ескере отырып, әдістемелік және ғылыми-әдістемелік негізінде анықтау;
- Ұсынылатын су шаруашылық шаралар Ресей мемлекеттік гидрологиялық институтының тұрақты дамудың сценарийлерін ескере отырып, қабылданады;
- Қапшағай су қоймасының параметрлерін гидрологиялық және су шаруашылық есептеулерімен анықтау.

Су қоймалардың параметрлерін түзетудегі экологиялық және экономикалық тиімділік шаралар мен әлеуметтік негізін дәлелдеудегі қабылданған әдістемелік және ғылыми-әдістемелік негіздер 3 кезеңнен тұрады:

- әр түрлі келешектегі кезеңдердегі ағынның режимі мен көлемі ҚР территориясындағы су қоймасының тұстамасында анықталады;
- су қоймасының тұстамасындағы ағын салыстырылады;
- әлеуметтік-экологиялық-экономикалық жағдайлардың негізінде су шаруашылық кешеннің параметрлерінің тиімді нұсқасы негізделеді.

Түйін сөздер: ағып келетін ағынның режимі мен көлемі, су қойманың бекетіне келіп құятын ағын, су қойманың кепілдемелігі, су қойманың параметрлері, су шаруашылық кешен, су шаруашылық тепе-теңдік, экологиялық акваториялар.

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УСОВЕРШЕНСТВОВАНИЕ МЕТОДОЛОГИИ И НАУЧНО-ТЕХНИЧЕСКИХ ОСНОВ КОРРЕКТИРОВКИ ПАРАМЕТРОВ ВОДОХРАНИЛИЩ В БАССЕЙНАХ БЕССТОЧНЫХ РЕК (НА ПРИМЕРЕ БАССЕЙНА РЕКИ ИЛЕ)

Аннотация. Исходная предпосылка. Соблюдение основного принципа Декларации Рио-де Жанейро 1992 г. [1]. Сохранения уровня воды в оз. Балкаш не ниже отметки 341,0 м. Обеспечение устойчивого развития отраслей экономики и сохранение экологической устойчивости в Казахстанской части бассейна реки Иле.

Приведены методология и научно-технические основы, и результаты исследования по корректировке параметров Капчагайского водохранилища, которые осуществляются в следующей последовательности:

- анализ современного уровня использования водно-земельных ресурсов бассейна реки на территории Республики Казахстан (РК);
- водные ресурсы и водопотребление отраслями экономики по водохозяйственным участкам в пределах бассейна реки Иле на территории РК;
- методология и научно-методические основы по определению притока воды к различным створам в бассейне реки Иле с учетом различных сценариев развития отраслей экономики как на территории РК, так и на территории Китайской Народной Республики (КНР);
- рекомендуемые водохозяйственные мероприятия принимаются в соответствии с учетом «Сценарии устойчивого развития Российского государственного гидрологического института» (СУР ГГИ) [2];
- производство гидрологических и водохозяйственных расчетов по определению параметров Капчагайского водохранилища.

Принятая методология и научно-технические основы обоснования социальной, экологической и экономической эффективности мероприятий по корректировке параметров функционирующих водохранилищ осуществляется в три этапа:

- на первом этапе на основе анализа объемов и режимов приточной воды на территории РК устанавливается приток к створу водохранилища за различные перспективные периоды;
- на втором этапе осуществлялось сопоставлением притока воды в створ водохранилища;
- на третьем этапе производится социально-эколого-экономическое обоснование оптимального варианта параметров водохозяйственного комплекса.

Ключевые слова: объемы и режимы приточной воды, приток воды в створ водохранилища, отдачи воды из водохранилища, параметры водохранилища, водохозяйственный комплекс, водохозяйственный баланс, экология акватории.