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ASSESSMENT OF NORMS OF ADMISSIBLE IMPACT ON WATER OBJECTS OF TRANS-BALKHASH AREA

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ABSTRACT

Calculations of norms of admissible impact on water objects help to establish levels of pollutants in surface water. The norms of acceptable impact (NAI) on water objects are developed and approved according to hydrographic or water management zoning of a water body for the purpose of preservation and restoration of aquatic ecosystems; minimizing effects of anthropogenic impact that creates risk of irreversible negative changes in aquatic ecosystem; ensuring sustainable and safe water use in the course of social and economic development of the territory. Identification of NAI was carried out on the basis of Methodical instructions on development of the norms of admissible impact on water objects approved by the order of the Ministry of natural resources of Russia of 12.12.2007 No. 328, and by the analysis of social and economic situation, usage and diagnostics of quality of water resources.

At the studied territory calculations of norms of admissible impact were counted on two indicators : NAI_{chem} and NAI_{w}. To determine the current anthropogenic impact, comparison of the actual mass of pollutants export (diffusion drain from residential areas, industrial sites and agricultural grounds, etc.) with the values of $NAI_{chem.}$ obtained from design water-resources region (WRR), was carried out. Results of comparative analysis show that the anthropogenic contribution to water bodies of Trans-Balkhash area is insignificant (about 10%). Exceeding of the established standards for import of chemical and suspended mineral substances was recorded at no WRR.

Calculations of NAI for withdrawal of water resources from water bodies of Trans-Balkhash area, have shown that water objects of the considered region provide consumers with water resources completely. Deficit of drain was noted at neither of considered section line.

Key words: Norms of admissible impact on water objects, Hydrophysical, Hydrochemical water indices, Background indices of natural water bodies, Complex research, Levels of surface water' impurity.

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INTRODUCTION

Norms of admissible impact on water objects (NAI) are intended for establishment of safe levels of pollutants, and other indices characterizing impact on water objects and taking into account climatic features of water bodies and the natural and technogenic situation, which has developed as a result of economic activity.

Norms of admissible impact on water objects for regulation of types of impact on water bodies are defined based on the destination of water body. The destination of water object or its site is defined by the current legislation. When developing norms of admissible impact on water objects, the water-resources region is accepted as the main calculated territorial unit.

Norms of admissible impact on water objects are developed and approved for water object or its site according to hydrographic and water-resources zoning for the purpose of ensuring sustainable functioning of the natural or developed ecosystems, preservation and restoration of aquatic ecosystem, minimizing effects of the anthropogenic influences creating risk of irreversible negative changes in aquatic ecosystem; ensuring sustainable and safe water use in the course of social and economic development of the territory.

Water bodies of Trans-Balkhash area are exposed to enormous anthropogenic impact today. The Balkhash industrial hub is located in the region, its activity is directly connected with Lake Balkhash. Main inflows to Lake Balkhash, the rivers Ili, Karatal, Aksy, Lepsy, Ayaguz also contribute to pollution.

EXPERIMENTAL

Trans-Balkhash area is the region located in South-East Kazakhstan and immediately adjacent to Lake Balkhash. The depression of L. Balkhash is of extremely elongated form: length – 600 km, average width – 30 Km. Such a shape causes the heterogeneity in the distribution of hydrometeorological and hydrochemical characterisitcs. Lake area under 314.5 m is 17330 Km^2, volume – 96.95 Km^3. The area of freshwater part of L. Balkhash is 10135 Km^2, volume – 38.1 Km^3.[1]

L. Balkhash is considered as semi-freshwater lake - the chemical composition of water depends on the hydrographic peculiarities of reservoir. The water of the western part of the lake is almost fresh (mineralization is 0.74 g\L) and more muddy (transparency – 1 m) and is used for drinking and industrial water supply. Eastern waters are more saline (from 3.5 to 6 g\L) and transparent (5.5 m). The total average mineralization of L. Balkhash is

2.94 g\L. Multiyear average salt sediment in L. Balkhash is 7.53 million ton, stock of dissolved salt in the lake is about 312 million ton. Water in western part has yellowish-grey color and to the eastern part is turned to blue and emerald-blue as may be seen on satellite' images[1].

Main rivers that flow into the lake are R. Ili, contributing up to 80%, and Lepsy, Karatal, Aksu, Ayaguz rivers.

Today, the unique lake is exposed to strong man-caused pollution by industrial enterprises. The northern part of Trans-Balkhash area is exposed to industrial pollution in greater extent. Main users here are Organization departments of «Kazakhmys» Corporation.

Maximal exposure is caused by following enterprises - «Kazakhmys Smelting», «Karagandacvetmet» (former «Balkhashcvetmet») and Balkhash heat-electric generating plant. Other enterprises as «Balkhash Su», «Ak kayyn», «AHCR of Priosersk city Akimat», «Balkhash balyk» and multiple recreation zones along the shore also contribute to pollution. Besides, native dwellers throwing out domestic wastes and forming unofficial dumps contribute to pollution too.

Negative effects are also caused by large sewage storage for cleaning rejects of copper mine of «Karagandacvetmet» and ashes of Balkhash heat-electric generating plant and «Kazakhmys» Corporation located on the shore of Torangalyk bay.

Today the discharge of sewage (heat) waters into the lake is carried out by «Balkhash HEGP» only and of those that are categorized as standard clear. In last five years the dynamics of sewage discharge volume looks as follows in Table 1.

Table 1: The volume of sewage discharge into the L. Balkhash[2]

Years	Sewage discharge (м^3)	Ton
2009	82 840 900	5.419
2010	94 465 700	3.71
2011	98 787 300	0.307
2012	90 411 000	42.699
2013	97 257 800	82.551

The ecological condition of modern delta of River Ili is considered critical. River channels and lakes are disappearing. Intense water consumption for agriculture purposes and building of Kapchagay reservoir lead to shrinkage of modern delta of River Ili. Lake and marsh biotopes, as well as reed-bed, are disappearing, biodiversity is declining, spawning areas are drying up and musquash trade is coming to an end.

Ancient (Bakanas) delta of River Ili in 50-60s of XX century was covered by saxaul “forests”. Cutting down of saxsaul forests activated desertification processes. Dry channels ("bakanas") of the ancient delta of river Ili are characteristic. Dumping of collector and drainage waters from the Akdalinsky array of irrigation into R. Ili increased the content of sulfates from 74-90 to 235 mg/L. Exceeding of irrigation norms by 3 times causes secondary salinization of soils.

Water of R. Ili contains wide range of the microelements exceeding maximum admissible concentration; areas of Eastern Balkhash become polluted both due to wind-induced phenomena when water overflows from the western into eastern part of the lake, and influx of toxicants from east rivers bearing in themselves the increased concentration of heavy metals.

Pollution of the main inflows, such as Ili and Karatal, makes essential contribution to the general pollution of the lake ecosystem.

There is a wide range of microelements in L. Balkhash, between them heavy metals are in lead due to geochemical properties of Trans-Balkhash area soils as well as influx of heavy metals with sewage and partial sedimentation of air emission on water surface. Heavy metals distribution in water of L. Balkhash is shown in (Fig. 1)[3].

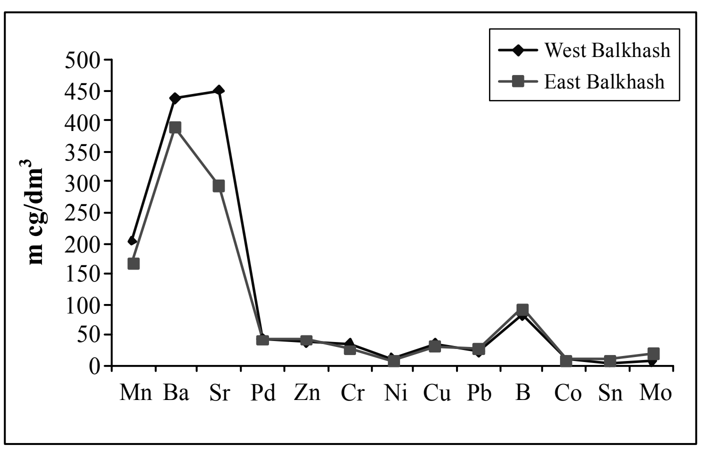

Fig. 1: Longstanding average of heavy metals in water of L. Balkhash

Considering type of elements distribution along lake area one should note its increasing concentration from west toward east: up to 3 times for lead, 2 times for nickel[3].

Characteristics of pollution of water resources of L. Balkhash by hydrochemical zones is demonstrated in (Table 2).

Table 2: Pollution of water resources of L. Balkhash by hydrochemical zones according to KazRSIEC for 2014 year, mcg/dm^3

Elements	Zones							
	1	2	3	4	5	6	7	8
Lead	14	24	27	37	62	65	75	83
Copper	5.3	6.3	7.5	12.4	12.6	9	15	13.6
Zink	23	18	33	34	43	34	35	36
Cadmium	22	20	28	32	37	33	51	50

According to recent data, the most polluted sector is south-western including Torangalyk bay, Torangalyk chicken farm, and ex-pioneer camp «Blue wave (Golubaya volna)». It is due to predominantly north-eastern wind with reiteration 45% per year. Bertys bay and Small Sary-Shagan are less polluted. Moreover, pollutants are entering Torangalyk bay during dusting tailing dump BMCP, located only in 250-300 meters from the shore.

Recently, general increase of sulfates above MPC in fisheries reservoirs was recorded. Sulfates concentration exceeds MPC in L. Balkhash in 13.2-20.9, in Bertys bay in 7.7-9.5, at Balkhash city in – 7.7-8.1 times. The MPC exceeding was also observed in chlorides content: in Small Sary-Shagan in 1.3-1.5 times, in Bertys bay and At Balkhash city – in 1.3-1.6 times[4].

As to impurity of Lake Balkhash, the MPC excess was reached in 80.4% of cases for hydrochemical analysis, for sulfates and copper - in 100%, for zinc - in 25.3%, fluorides - in 98.0%, oil products - in 40%, phenols - in 33.3% of cases.

Pollution of lake Balkhash by residual quantities of DDT and HCCH is observed constantly. For example, the actual total concentration of HCCH isomers ranges from 0.0027 to 0.157 mcg/L with average value about 0.045 mcg/L, whereas the sum of DDT metabolites - from 0.0036 to 0.060 mcg/L, average value is 0.0261 mcg/L. It should be also noted that pesticides determination reveals alpha, beta, gamma isomers of HCCH and DDT, last is metabolized to DDE or dissolved compound DDD[5].

Identification of NAI was carried out on the basis of Methodical instructions on development of the norms of admissible impact on water objects approved by the order of the Ministry of natural resources of Russia of 12.12.2007 No. 328, and by the analysis of social and economic situation, usage and diagnostics of quality of water resources.

Main criteria determinative the list of chemicals for which NAI_{chem} is required are:

- Anthropogenic entry into water bodies with sewage or other way today or in the long term;
- Stable exceeding of MPC of a compound in water of water bodies within the last several years.

On the basis of the hydrochemical analysis and analysis of data of economic development of the territory the list of prior chemicals for which NAI_{chem} for all WRR is necessary calculation was defined.

For NAI definition, it is necessary to know background (natural) concentration of chemicals in water. Determination of background concentration has to be carried out according to Methodical indications of carrying out calculations of background concentration of substances in water of water currents (RD 52.24.622-2001)[7]. Background (natural) concentration of chemicals in surface water is defined in alignment of water body above, which anthropogenic influence is absent. In the territory of the considered region calculation of background concentration has been made in the 1980-th.

Because systemic observation over background water quality of water bodies in L. Balkhash basin are not available, pollutants MPC have been accepted instead.

In general, calculation of NAI_{chem} for water-resources region for any period of time is carried out on the balance formula considering receipt part:

$$NAI_{chem} = C_{nr}\, W_{ych} - \text{sum}\,(C_{nr}W_{ect} + C_{nvkh}W_{vx} + C_{nobpr}W_{obpr}) \qquad \ldots(1)$$

where W_{ych} – the total amount of drain in water-resources region to the closing alignment for certain period, mln.m^3 determined by formula:

$$W_{ych} = W_{ect} + W_{supr} + W_{vx} + w_{obospr} = w_{bpr} + w_{ndif} + w_{supr} + w_{vx} + w_{obpr} \qquad \ldots(2)$$

where W_{ect} – The volume of local drain within area, mln.m^3:

$$W_{est} = W_{bpr} + W_{ndif} \quad \text{...(3)}$$

W_{bpr} – The volume of lateral influx from the sites not subjected to anthropogenic impact (minus the sites of the water-collecting square transformed by economic activity with the available diffused sources of pollution, managed, and uncontrollable), mln.m^3;

W_{ndif} – The volume of lateral influx on sites with uncontrollable diffused sources of pollution, mln.m^3;

W_{supr} – Water disposal volume, including the dot and potentially managed diffused sources of pollution, mln.m^3;

W_{vx} – The drain volume arriving from the above-located water-resources region, mLn.m^3;

W_{obpr} – The drain volume arriving with the inflows of the first order considering as independent calculated sites with one standards of water quality of water body, mLn.m^3;

C_{nr}, C_{nvkh}, C_{nobpr} – Standards of water quality for water object for the corresponding water-resources region, mg/L;

The volume of lateral influx W_{ndif} is defined as product of the drain module q (l/Km^2 x c) calculated security for the corresponding period of time T and area occupied with uncontrollable diffused sources of pollution F_{nd}, within zone of direct impact on water body (in the absence of data is accepted as product of contour length of adjunction of pollution source to water body and 5-10 multiple width of the respective water protection zone).

$$W_{ndif} = 0.001 \text{ x } q \text{ x } F_{nd} \text{ x } T \quad \text{...(4)}$$

The volume of lateral influx of W_{bpr} is defined as product of the drain module q of calculated supply for the corresponding period of time T and the water-collecting area minus areas occupied with managed by F_{ud} and uncontrollable F_{nd} diffused sources of pollution

$$W_{bpr} = 0.001 \text{ x } q \text{ x } (F - F_{nd} - F_{ud}) \text{ x } T \quad \text{...(5)}$$

During hydrological seasons when diffusion sources do not function (winter low-water), the lateral influx is defined from all private water-collecting area.

The volume of water disposal W_{supr} is determined by summing calculated volumes of disposal water by point sources of pollution (stataccounts 2TP-we) and volumes of potentially managed diffused sources of pollution.

Volumes of drain of W_{vx} and W_{obospr} are established: (1) according to the state water register; (2) on the basis of data monitoring; (3) according to hydrological and water management calculations for the corresponding limiting seasons and the periods of hydrological year taking into account water consumption volumes; (4) to water management balances.

The value of NAI_{chem} determined by the above-stated formulas is the most admissible mass of dumping pollutants at site at observance by the most part of time standards of water quality on the main water area, i.e. NAI_{chem} (max.).

As observance of the standard of water quality for all indices during all annual cycle is ideal option, for practical use NAI_{chem} (max.) is adjusted by control recalculation on the actual average concentration defining the current loading (NAI_{chem}*)

For the upper and isolated sites calculation NAI_{chem}* is conducted on formula:

$$NAI_{chem}^{*} = C_{nr}\, W_{uch} - C_{fakt}\, (W_{est} + W_{supr}) \qquad \ldots(6)$$

For the general case the formula is:

$$NAI_{chem} = C_{nr} W_{uch} - \text{summa}\, (C_{faktr} W_{est} + Cf_{aktvkh}\, W_{vkh} + C_{faktobpr}\, W_{obpr}) \qquad \ldots(7)$$

The values of average concentration C_{faktr} characterizing condition of water object or its site are defined as –

$$C_{faktr} = \text{Sum}\, (CbiLi)/L \qquad \ldots(8)$$

where Cbi – Value of concentration of pollutant in intermediate control alignment (site of monitoring), mg/L;

Li – The length of waterway site tending to this intermediate control alignment (length between the middle of waterway segnments with two adjacent sites of monitoring), km.

L – Total length of hydrographic network on calculated site, Km.

$C_{faktvkh}$, $C_{faktobpr}$ – The actual concentration of pollutants for entrance alignment and the isolated inflows, mg/L.

The size of admissible influence on influx of chemicals depends on the hydrological and hydrochemical mode of water bodies, and also the mode of functioning of pollution sources, composition and characteristics of which considerably vary within a year. In this regard calculation of NAI_{chem} is recommended to be different for main hydrological seasons. Such seasons are winter and summer-autumnal low-waters, spring or spring and summer flood.

In the presence of the developed and approved hydrograph of ecological drain calculation is conducted on the corresponding volumes; in the absence of it - on the most adverse conditions within each characteristic season.

The following could be considered as the most adverse conditions:

- Summer-autumnal and winter low-water of year of 95% of security and drain volumes corresponding to them;
- Spring or spring and summer flood of year of 50% of security and drain volumes corresponding to them (acceptance of this security is caused by the most adverse ratio between the mass of the arriving pollutants from dot and diffusion pollution sources and the diluting potency of water object for this season).

Drain volumes for seasons are determined by data of water management balance of site or standard hydrological calculations.

The most adverse conditions for formation of qualitative characteristics of separate seasons do not match within specific calendar or hydrological year therefore the standard of admissible influence in annual section $NAI_{chemann}$ is determined for conditional year with emergency conditions of quality formation as the sum of the seasonal values calculated on the above-stated formulas:

$$NAI_{chemann} = NAI_{chemw}\,95\% + NAI_{chemsa}\,95\% + NAI_{chem}\,vp50\% \quad \ldots(9)$$

Values of $NAI_{chemann}$ measurement data for conditional year are considered as theoretical value. Management of water resources uses various annual data, usually in the supply range from 50% to 95%. Seasonal transitional coefficients from basic value NAI_{chem} on seasons are applied to transition from conditional year to calculated security:

$$\text{Kzr of \%} = \text{Wzr \%/\% Wz95} \quad \ldots(10)$$

$$\text{Klo of \%} = \text{WlOr \%/\% Wlo95} \quad \ldots(11)$$

$$Kvpr\ of\ \% = Wvpr\ \%/Wvp50\ of\ \% \quad \ldots(12)$$

For example, the standard NAI_{chem} for the year of 95% supply, which is in most cases calculated under the terms of anthropogenic impact are defined as follows:

$$NAI_{chemann}\ 95\% = 1 \text{ x } NAI_{chemw} 95\% + 1 \text{ x } NAI_{chemsa} 95\% + (Wvp\ 95\%/\%\ Wvp\ 50) \text{ x } NAI_{chem}\ vp\ 50\% \quad \ldots(13)$$

RESULTS AND DISCUSSION

Various groups of indices, between them principal abiotic (physical, chemical, radiological) and biotic (macro- and microbiological), are used for assessing the ecological state of aquatic objects[8].

Diagnostics of water quality and aquatic environment had included the general analysis of aquatic objects, as well as individual measurements of water pollution using hydrophysical, hydrobiological and hygiene and sanitary indices.

Analyzing the hydrophysical indices of water of all design zones the following summaries were made: water transparency comes to 8-10 cm by standard type(print), annual water turbidity makes less than 15 g/м3, chroma of river (fluvial) water ranges widely (from 10 to 180^o); water reaction mainly neutral (pH ranges 6.80-8.40 in the course of year); water temperature among R. Ili valley changes insignificantly (average at warm period 8-9^{o}C); radiation environment in the river basin is favorable.

Surface water quality in WML water bodies was assessed by comparing hydrochemical measurements de facto with standard data – MPC (for fish industry, recreation, irrigation and watering).

Have assessed the quality of surface water of water bodies we concluded:

(1) The quality of water of all designed water-resources regions by several compounds (iron, copper, zinc, manganese, aluminium, facile oxidative organic compounds well oxidized organic compounds (by BOD_5)) does not meet standards for fish industry.

(2) Increased concentration of iron, copper, zinc compounds, BOD5 и CODbichr is determined generally by natural background due to intra-reservoir process and decaying organic humic compounds;

(3) The excessive concentration of sulfates was recorded in the water of L. Balkhash, as well as carbonates and calcium ions. This is due to underlying sedimentary rock represented by limestone.

(4) At the middle stream of R. Ili concentrations of manganese and copper are increasing.

(5) At the middle and low stream of R. Ili discrepancy in economic and drinking standards regarding COD bichr, manganese and iron, on R. Karatal and R. Lepsy regarding lygnosulfonates were observed;

(6) At the middle stream of R. Ili discrepancy in standards for watering places regarding oil products was observed;

(7) In all aquatic objects of R. Ili basin breach of recreational standards regarding hardly oxidizing organic compounds (COD bichr) was observed;

(8) In general, the quality of water of aquatic objects allows usage for irrigation and watering.

For the complex investigation of water quality level of surface water the hydrochemical specific combinatory water quality index (SCWQI) was used. For the considered period of 2010-2014 the quality of water of Lake Balkhash and its inflows fluctuated both towards-deterioration. And improvement (from category "clear" 2nd class to category "extremely dirty (7th class). River Aksu has the greatest stability, with water of 4 classes 3 and 4 (moderately polluted and polluted). Quality of water of the main rivers Ili and Karatal - is polluted (4 C.) and dirty (5 C.), water of lake Balkhash is characterized by 7 C. - extremely dirty and 6 C. - very dirty (Table 13). In general, typical pollutants of water bodies of the basin of L. Balkhash and its inflows were iron, copper, zinc, COD bichr, BOD_5.

The WQI dynamics for surface water of Lake Balkhash and its main inflows (Fig. 2, Table 3), shows that the class of water quality of Lake Balkhash refers to 7 C - extremely dirty, the WQI r fluctuates from 7.87 to 14.08 and the average of WQI makes 10.6. Water quality of river Ili refers to 3 C - moderately contaminated, WQI of water fluctuates from 1.31 to 2.74 and the average of WQI makes 1.97. Water qualities of river of Lepsy refers to 4 C - contaminated, WQI of water fluctuates from 1.02 to 5.31 and the average of WQI makes 2.3. Qualities of water of river Karatal consists 4 C - contaminated, WQI of water fluctuates from 1.44 to 4.25 and the average of WQI makes 2.27. Qualities of water of river of Aksu consists 3 C - moderately contaminated, WQI of water fluctuates from 0.96 to 3.86 and the average of WQI makes 1.88.

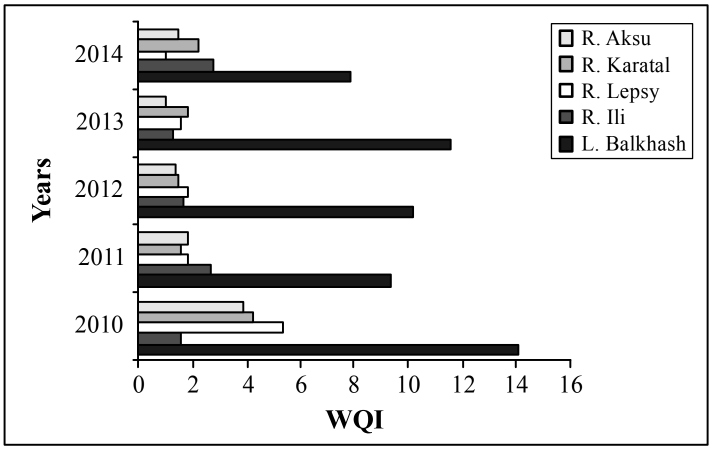

Fig. 2: The dynamics of water quality index of surface water of Ili-Balkhash basin

Table 3: Water quality index of L. Balkhash and its main confluents[9]

Years	L. Balkhash	R. Ili	R. Karatal	R. Lepsy	R. Aksu
2010	14.08 (7 C.) extremely dirty	1.53 (3 C.) moderately polluted	4.25 (5 C.) dirty	5.31 (5 C.) dirty	3.86 (4 C.) polluted
2011	9.36 (6 C.) very dirty	2.65 (4 C.) polluted	1.53 (3C.) moderately polluted	1.87 (3C.) moderately polluted	1.78 (3C.) moderately polluted
2012	10.16 (7 C.) extremely dirty	1.62 (3 C.) moderately polluted	1.46 (3 C.) moderately polluted	1.82 (3 C.) moderately polluted	1.34 (3 C.) moderately polluted
2013	11.53 (7 C.) extremely dirty	1.31 (3 C.) moderately polluted	1.87 (3 C.) moderately polluted	1.52 (3 C.) moderately polluted	0.96 (2 C.) clear
2014	7.87 (6 C.) very dirty	2.74 (4 C.) polluted	2.25 (3 C.) moderately polluted	1.02 (3 C.) moderately polluted	1.46 (3 C.) moderately polluted
Avearge	10.6 (7 C.) extremely dirty	1.97 (3 C.) moderately polluted	2.27 (4 C.) polluted	2.3 (4 C.) polluted	1.88 (3 C.) moderately polluted

Om data RSE «Kazhydromet»

Background (C_b), regional (C_r) и normative (C_n) indices of water quality of Trans-Balkhash region in Table 4.

Table 4: Background (C_b), regional (C_r) и normative (C_n) indices of water quality of Trans-Balkhash region

Water body, alignment	Index	Quality indices (g/m^3)								
		Suspended matter	Nitrogen sum	Phos-phates	Iron sum	COD	Oil products	Copper	Zinc	Fluorine
L. Balkhash	C_b	22.13	1.099	0.116	0.117	12.67	0.025	0.002	0.006	0.706
	C_r					43.0		0.0017	0.021	
	C_n	20.25	0.02	0.01	0.16	43.6	0.05	0.0017	0.021	0.05
R. Ili	C_b	26.45	0.377	0.023	0.119	20.93	0.041	0.00	0.005	0.479
	C_r					43.6		0.0017	0.021	
	C_n	20.25	0.02	0.01	0.16	43.6	0.05	0.0017	0.021	0.05
R. Karatal	C_b	23.65	0.425	0.029	0.079	17.67	0.052	0.00	0.003	0.53
	C_r					43.0			0.021	
	C_n	20.25	0.02	0.01	0.16	43.6	0.05	0.0017	0.021	0.05
R. Lepsy	C_b	16.88	0.42	0.026	0.069	18,41	0.031	0.00	0.00	0.48
	C_r					43.0				
	C_n	20.25	0.02	0.01	0.16	43.6	0.05	0.0017	0.021	0.05
R. Aksu	C_b	25.69	0.37	0.023	0.11	20.93	0.041	0.00	0.005	0.479
	C_r					43.6		0.0017	0.02	
	C_n	20.25	0,02	0.01	0.16	43.6	0.05	0.0017	0.021	0.05

Calculations of NAI for the allocated types of influence were carried out according to the examples given in Methodical instructions by calculation of the norms of admissible impact on water objects approved by the Order MPR of Russia of 12.12.2007, No. 328.

Results of calculation of NAI on import of chemicals (NAI_{chem}) in water bodies of Trans-Balkhash area are given in Table 5.

Table 5: Norms of admissible impact on import of chemical compounds (NAI_{chem}) in aquatic objects of Trans-Balkhash region of 95 % supply, t

Aquatic object, section line	Season	Quality indices ($g/м^3$)							
		Suspended compds.	Nitrogen, gen	Phos-phates	Iron, gen	COD	Oil products	copper	zinc
L. Balkhash	SP	576.0	789.72	450.60	159.47	23465.8	61.46	0.683	9.11
	SAL	182.74	237.98	135.76	48.27	7103.5	18.54	0.207	2.76
	WL	216.70	288.91	164.83	58.48	8605.5	22.50	0.250	3.34
	Annual	975.44	1316.61	751.18	266.23	39174.7	102.50	1.140	15.21
R. Ili	SP	567.85	826.87	439.34	202.90	22543.5	81.11	0.902	9.02
	SAL	240.74	340.28	180.79	83.68	3239.3	33.39	0.372	3.72
	WL	86.67	116.47	61.88	28.75	3194.2	11.43	0.128	1.28
	Annual	895.26	1283.62	682.01	315.33	35035.1	125.93	1.401	14.02
R. Karatal	SP	272.68	395.21	212.72	75.64	10805.3	48.59	0.324	4.32
	SAL	70.66	95.94	51.64	18.45	2608.7	11.80	0.079	1.05
	WL	17.67	17.65	9.49	3.48	492.2	2.17	0.015	0.20
	Annual	361.01	508.61	273.85	97.57	13906.2	62.56	0.418	5.58
R. Lepsy	SP	146.31	221.59	115.50	29.17	5892.5	29.17	0.233	2.92
	SAL	110.11	156.97	86.09	21.75	4394.0	21.74	0.174	2.18
	WL	36.73	51.88	28.46	7.19	1452.9	7.19	0.058	0.72
	Annual	293.15	419.44	230.05	58.11	11739.4	58.09	0.465	5.81
R. Aksu	SP	145.73	210.15	115.26	29.11	5880.3	29.11	0.233	2.91
	SAL	86.13	123.70	67.85	17.14	3462.6	17.13	0.137	1.71
	WL	46.40	66.47	36.46	9.21	1861.0	9.21	0.074	0.92
	Annual	278.27	400.33	219.57	55.46	11203.9	55.45	0.444	5.55

Note: SP – spring tide; SAL – summer-autumn low-water season; WL – winter low-water season

To determine current anthropogenic impact the actual mass pollutants ejection (nitrogen, phosphates, iron, zinc copper, COD, oil products) was compared with the obtained values of NAI_{chem} on WRR. Results of comparative analysis are provided in Table 6. The anthropogenic contribution to water bodies of Trans-Balkhash area was insignificant (about 10%). The exceeding of the established norms for import of the chemical and suspended mineral substances has been recorded for no WRR.

Table 6: The comparison of actual mass of pollutants ejection (AM) for dot and diffuse source of pollution (2014) with NAI_{chem} for water bodies, t/yer

Aquatic object, section line	Index	Quality indices, g/м^3							
		Suspended compds	Nitrogen, gen	Phos-phates	Iron, gen	COD	Oil products	Copper	Zinc
L. Balkhash	AM	47.5	0.052	0.042	0.089	0	0.004	5.32	2.56
	NAI_{chem}	975.44	1316.61	751.18	266.23	39174.7	102.50	1.140	15.21
	NAI_{chem}– AM	927.94	1316.55	751.13	266.14	39174.7	102.50	4.18	12.65
R. Ili	AM	20	0.023	0.014	0.087	0	0.006	5.3	1.56
	NAI_{chem}	895.26	1283.62	682.01	315.33	35035.1	125.93	1.401	14.02
	NAI_{chem}– AM	875.26	1283.59	682.0	315.24	35035.1	125.93	-3.89	12.46
	AM	15	0.023	0.018	0.065	0	0.0052	7.32	2.69
R. Karatal	NAI_{chem}	361.01	508.61	273.85	97.57	13906.2	62.56	0.418	5.58
	NAI_{chem}– AM	346.01	508.58	273.84	97.51	13906.2	62.56	-6.90	-2.89
	AM	13.42	0.068	0.006	0.020	0	0.063	10.47	14.26
R. Lepsy	NAI_{chem}	293.15	419.44	230.05	58.11	11739.4	58.09	0.465	5.81
	NAI_{chem}– AM	279.73	419.37	230.05	58.09	11739.4	58.02	-10.0	-8.45
R. Aksu	AM	45.5	0.022	0.016	0.098	0	0.007	6.31	1.79
	NAI_{chem}	278.27	400.33	219.57	55.46	11203.9	55.45	0.444	5.55
	NAI_{chem}– AM	232.77	400.31	219.56	55.36	11203.9	55.45	-5.86	3.76

CONCLUSION

The analysis of comparison of standards NAI_{chem} with the actual import of pollutants across Lake Balkhash and its main inflows shows that the anthropogenic contribution to water bodies of Trans-Balkhash area was insignificant (about 10%). Generally these are nitrite nitrogen, nitrogen ammonium, phosphorus of phosphates. At the same time in downstream sites there is large supply of admissible import for the majority of ingredients. It is caused by relatively large volumes of drain from the territories, which are in state close to natural, and thus averaging of qualitative structure. Therefore, despite favorable condition of water object, for preservation ecological system it is required to adhere to norms at all water area of water body that means carrying out actions for minimization of pollutants import receipt from the managed or potentially managed diffused sources.

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