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## Ecoanalytical Assessment of the Condition of Lake Balkhash

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### ABSTRACT

**Background:** The pool of Lake Balkhash covers one of most densely occupied regions of Kazakhstan. Considerable development of economic activity entailed substantial negative ecological effects and led to that efficiency of Lake Balkhash for the last decreased years almost by 10 times. Not the last role was played here by pollution of habitat of hydro-bents by various classes of heavy metals and toxic substances. **Task:** In this regard the major task now is identification of areas of receipt of pollutant in Lake Balkhash. As negative impact on an ecosystem of the lake is made by a set of connections, at the solution of a similar task the assessment of its state according to integrated characteristics of impurity of water and ground deposits by a complex of the toxic substances as a whole defining its quality is expedient. Otherwise definition of places of the increased ecological danger in view of a polypro ability of a solved problem becomes almost impossible. **Results:** Methodological approach according to the forecast and an assessment of a condition of an ecosystem of Lake Balkhash on the basis of complex (integrated) characteristics of impurity of the water ecosystems considering the content of toxic substances and heavy metals in water and ground deposits is developed. Approaches of establishment of ecologically adverse areas, normalization of the content of toxic substances and heavy metals in a ground precipitation of various types, allowing localizing areas of their receipt in a water ecosystem are formulated and proved. **Conclusions:** The reasons and features of dynamics of the content of toxic substances and heavy metals in the main components of an ecosystem of Lake Balkhash at the present stage are established. The integrated approach of an assessment of degree of impurity of an ecosystem of the lake which can be used when determining regions of the raised anthropogenic loading is developed. The received complex sizes of impurity of water and ground deposits can be used for an assessment of consequences of versatile economic activity in the studied area.

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## INTRODUCTION

Ili– the Balkhash pool is one of the largest lake ecosystems of a planet and represents a unique natural complex, on the area exceeding the sizes of many states (Romanov, 2008).

The ecological situation near the Ili-Balkhash pool is characterized as unstable, with progressing vulnerability of Lake Balkhash. It is caused by irrational water use, an imperfect control system of resources, interstate problems of water division and other factors (Romanov, Kazangapova, 2003). Lack of software

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solution of a question can lead to the ecological disaster conducting to loss of national natural property, an iridizations of climate, social tension and ecological population shift (Studenikina *et al.*, 2006).

In this regard the major task now is identification of areas of receipt of pollutants to Lake Balkhash. As negative impact on an ecosystem of the lake is made by a set of connections, at the solution of a similar task the assessment of its state according to integrated characteristics of impurity of water and ground deposits by a complex of the toxic substances as a whole defining its quality is expedient.

Otherwise definition of places of the increased ecological danger in view of a poly alternativeness of a solved problem becomes almost impossible. In recent years the volume of researches on monitoring of structure, distribution and dynamics of polluting substances in Lake Balkhash considerably was reduced. In this regard the value of data on a condition of the ecosystem, obtained repeatedly increases during complex system monitoring as in this case, taking into account the available volume of these supervision in previous years, it is obviously possible to reveal regularities of formation of impurity of diverse sites of a reservoir and to reveal places of the raised environmental risk.

The purpose of work consisted in development of methodological approach to an assessment of an ecological situation, impurity of various sites of Lake Balkhash, identification on this basis of regions of the raised anthropogenic loading and the mechanism of their emergence. For achievement of this purpose the following tasks were set and solved:

- Establishment of the main sources of receipt of toxic substances to the water area of Lake Balkhash and an assessment of their contribution;
- studying of long-term dynamics of impurity of water and ground deposits of the lake by priority toxicant (oil products, poly aromatic hydrocarbons, the pesticides, the polychlorinated biphenyls, heavy metals);
- Development of a complex indicator of an assessment of a water component of an ecosystem – complex impurity of water;
- Typing of a ground precipitation of Lake Balkhash and development on this basis of criterion of an assessment of level of pollution – an index of impurity of ground deposits;
- carrying out the generalizing complex analysis of impurity of Lake Balkhash and identification of ecologically unsuccessful areas.

## METHODS AND MATERIALS

For obtaining the average data on existential distribution of controlled toxicant on the water area of the lake the network of supervision consisting of 15 standard stations, eight regions of Lake Balkhash located on the water area was used.

The assessment of a state of pollution of the basin of Lake Balkhash was carried out on the basis of discussion literary yielded and results of expeditions of complex environmental monitoring which are carried out to various vegetative periods (spring, summer, fall) and include, in parallel with studying of quality of habitat, an assessment of hydrological, hydro chemical, hydro biological indicators. Assessment of level of pollution of water and ground deposits, extents of accumulation of toxicant, such as the weed aromatic hydrocarbons (WAH), pesticides, weed chlorinated 6th phenyls (PHB), heavy metals. The specified substances by criteria of ecological danger (toxicity, a gene of toxicity, cancer genic, prevalence, occurrence frequency) belong to priority polluting substances.

Analytical work was carried out in National scientific laboratory JSC The Center of Sciences about the Earth, Metallurgy and Enrichments and biology laboratory nitrogen of fixing microorganisms of RGP on PHV "Microbiology and Virology Institute" of KN of MES RK.

National scientific laboratory of collective is using in the priority direction "technologies for hydro carbonic also it is mountain – metallurgical sectors and the related service branches" JSC CNZME. Almaty, St. Shevchenko., Valikhanov St. corner, 29/133. The accreditation certificate no. KZ.I.02.1138 of April 08, 2011 For obtaining analyses of tests the nuclear and absorbing spectrometer of "Hitachi", model 180-50 (Japan) used; - ardent photometer of PFP7 (Great Britain); - optical issue spectrometer with the inductive and connected Optima 2000 DV plasma (USA). The autoclave electric in accordance with GOST 9586-61, a microscope biological in accordance with GOST 8284-78 Leica DMLS brands with a digital video camera of Leica DC 300F.

### **Results of research:**

For a complex assessment of level of impurity and identification of regions of the raised anthropogenic loading of the water area of Lake Balkhash the main sources of receipt of toxic substances in a reservoir were considered: the river drain, the dispersed drain, including sewage of the enterprises from coastal territorial of the lake, an atmospheric precipitation and Aeolian sediments (Konev, Yeletskii, 2005, Klenkin, Korpakova, 2008). Main suppliers of pollution of the Lake defined a river drain, an atmospheric precipitation. The analysis of data on the contents in the above objects of toxicant is carried out (Zhapparova, Sadykova, 2004).

Drain of the river. Three main rivers of the pool, Ili, Karatal and Lepsy, provide receipt to the lake more than 90% of a total drain. The drain of the river Ili is the main supplier to Lake Balkhash of calcium, magnesium, chrome, cadmium and organ chlorine pesticides, river Karatal – the most part of manganese, lead and zinc. Since 2010, carrying out with river waters of the majority of toxicant was significantly reduced. Intake of resistant organ chlorine pesticides of groups' dichlorophenyl three trichlormethyl methane (DDT) and hexachlorocyclohexane (HTsG) organ chlorine pesticides (HOP) decreased almost by 5 times. The maximum carrying out of heavy metals (to 59 tons per year) was noted in 2010-2011, and then it was reduced to 42, 6–46 tons per year.

It is atmospheric precipitation. After calculation of average quantity of the atmospheric precipitation which has dropped out over the water area of Lake Balkhash in 2010-2013 (8 cubic km a year), and the analysis of the obtained data on the contents in them oil hydrocarbons, HOP, PHB, PAU, heavy metals it is possible to draw a conclusion on an essential contribution of an atmospheric precipitation to the general pollution of an ecosystem of Lake Balkhash by priority toxicant.

Ground deposits are more informative object of researches, than water. It is first caused by that the chemical composition of ground deposits, unlike the water environment, bears information on the general condition of an ecosystem, on a natural and techno genic component of pollution during the long period of time. Secondly, owing to high coefficient of accumulation of toxicant (about 10 thousand) the range of components found in ground deposits is much wider, so informatively, than in water, and allows tracing dynamics of accumulation of bigger number of pollutant. At the same time, interpretation of structure and quality of ground deposits is complicated because dependence of extent of accumulation of toxicant on granola metric structure of a ground precipitation, and also a variety and heterogeneity of structure of ground deposits not only in different water objects, but also on separate sites of one reservoir or a waterway aren't studied. Also there are no approved standards of the content of controlled substances (similar maximum concentration limits for water) for ground deposits. For an assessment of quality of ground deposits results of long-term monitoring which allowed to offer the approach based on leveling of their types with use of the generalizing size – the average characteristic concentration (ACC) of priority polluting substances in various types of ground deposits of studied object were analyzed. The list includes oil products, 30 organ chlorine pesticides, the polychlorinated biphenyls, 14 heavy metals. Typing is carrying out of ground deposits of Lake Balkhash became the first step on a way of creation of a generalizing indicator. The saved up long-term experience of research allowed to allocate 6 types of the ground precipitation established on the basis of two approaches:

1. Typing of ground deposits on the external distinctive signs, including 3 steps:

- Preliminary systematization of ground deposits in a damp state (the prevailing component of soil – a shell rock, sand, silt or their mixes is thus estimated);
- Systematization of ground deposits after drying – thinner structure (against silt there are noticeable sandy or shelly components) is thus shown, or get characteristic for the corresponding type of soil coloring and density;
- Systematization of ground deposits on hardness.

2. Correlation dependence of the content of some heavy metals with stones types of ground deposits. Ground deposits of Lake Balkhash contain the shell rock mixed with silt and sand in a large number. For identification of various types of a ground precipitation sets the reference of the elements, characterizing various types of soil were used. Breakdown of ground deposits of the lake on 6 types according to concentration of the listed above elements, is presented in tab. 1.

The carried-out typing of a ground precipitation of Lake Balkhash allowed formulating the new integrated size – the average characteristic concentration (ACC) of priority polluting substances in various types of ground deposits. This relative size doesn't depend on sorption ability of a ground precipitation and allows carrying out comparison of impurity of various regions of Lake Balkhash.

For calculation of SHK of controlled toxicant results of the analysis more than 1000 tests of the ground deposits received during various seasons (spring, summer, fall) during the period 2010-2013gg were processed. As a result of processing of such data file values of average characteristic concentration of pesticides, polychloride biphenyls, heavy metals and oil products in ground deposits were received.

**Table 1:** The maintenance of elements in various types of ground deposits, mg/kg of dry weight.

Type of ground deposits	Strontium	Alluminium	Iron	Nickel	Vanadium
1	1100–1350	10000–30000	2000–9000	18–19	10–25
2	400–700	31000–49000	10000–19000	30–45	30–45
3	300–390	50000–59000	20000–29000	46–55	50–75
4	220–290	60000–69000	30000–39000	56–65	80–95
5	170–210	70000–75000	40000–49000	66–75	100–115
6	120–160	76000–82000	50000–53000	76–79	120–35

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Comparison of results of the analysis in absolute concentration with SHK gives dimensionless size – frequency rate of MCD: Multiplicity MCD= Ci/MCD, – absolute concentration of defined i-substance;

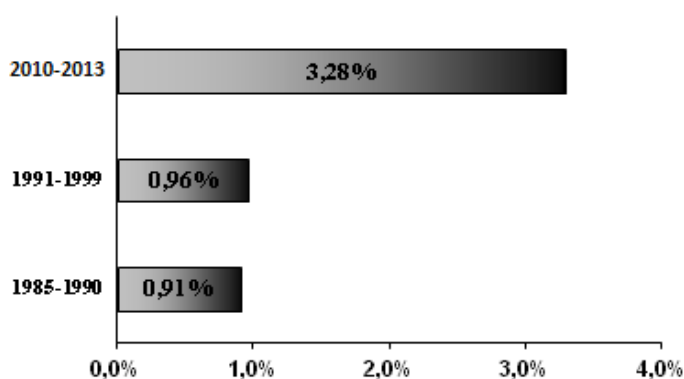
Frequency rate of MCD characterizes susceptibility of this area to anthropogenic ally influence during the studied period of time. In case frequency rate of  $MCD \leq 1$ , it is possible to consider that to this area of the lake, regardless of absolute values of impurity and type of analyzed soil, practically there was no fresh receipt of a defined toxicant. At frequency rate of  $MCD SHK \leq 11$  it is possible to consider that this area is the area of the increased anthropogenic ally influence during the concrete period of time and demands more detailed research for establishment of a source of pollution.

Use of frequency rate of MCD allowed looking in a new way at dynamics of impurity of Lake Balkhash during the modern period (2010-2013) and more adequately to define places of receipt of toxicant in the lake.

Values of frequency rate of MCD of oil products during various seasons of 2010-2013 changed ranging from 0, 20 to 6, 48. During the considered period on the average lower values of frequency rates are noted during the summer period – 1, 05. In the spring and in the fall average values of frequency rates were quite close and made respectively 1, 28 and 1, 24. Lower values of frequency rate of MCD during the summer period are connected with an intensification of processes of self-cleaning at temperature increase of water thickness and a lake precipitation.

#### **Pollution by poly aromatic hydrocarbons (PPH):**

During 2010-2013 average annual values of concentration of PPH in water of the sea changed from 100 to 220 ng/l respectively.



**Fig. 1:** Average share of biogenic UV in total amount of found UV during various periods of supervision.

The contents полиаренов in ground deposits lay in the range from 2,3 to 4,4 mg/kg of dry weight.

Since 2010 the increase in the content PPH which has reached a maximum in 2013 is noted. The most polluted is the central region of the lake (Figure 1).

As a part of water and a ground precipitation of Lake Balkhash in 2010-2013 the maintenance of 12 individual priorities PPH was analyzed. In water naphthalene prevailed, its share averaged 32% of total concentration individual place. In one of studied tests of water the contents oil (a) preens didn't reach the maximum permissible norm established for water of reservoirs – 5 ng/l.

As a part of PPH of a ground precipitation of the sea dominated is chrysene, naphthalene and fluorantenic to which share 20, 2, 16, 8 and 15, 7% fell, respectively. The contents oil (a) preens changed from trace quantities to 5, 1 mkg/kg, having averaged 0,6% of PPH sum.

As presence at water ecosystems of PPH can be caused by processes both natural and anthropogenic character, "the technogenic index", that is a ratio between hydrocarbons of anthropogenic and natural genesis was estimated. Due to the features of behavior of individual toxicant in objects of research it is offered at calculation of "a technogenic index" PPH found in water and ground deposits of Lake Balkhash, to use the relation of the sum of concentration of and fluorantenic (PPH of mainly anthropogenic origin) to the sum of concentration phenanthrene and chrysene (PPH of a natural origin).

"The technogenic index" in water of Lake Balkhash averaged the last two years 0, 96. In ground deposits "the tekhnogennic index" averaged 1, 3, that is "anthropogenic" PAU slightly prevailed. The share of cancer genic PPH in water of the lake averaged low size – 4, 9%. In ground deposits the share of cancer genic PPH was on the average much higher, than in water – 30, 4%.

#### **Pollution pesticides:**

For determination of duration of stay in the DDT water environment the so-called coefficient of DDT/DDE (a ratio of concentration of the substance and its isomer dichlorophenyl three trichlormethyl ethylene (DDE)) was used. If value of coefficient > 1, it testifies to rather recent pollution. From 2010 to 2013 pollution of the water area of Lake Balkhash by DDT is characterized, generally as "is fresher", and the coefficient of DDT/DDE reached values 18. In 2010 of DDT it was in most cases found in general without metabolites. In the

summer of 2012 of DDT it is recorded in water in 54% of cases and its concentration reached 24 µg/l (2,4 maximum concentration limits), in the fall – it met in water in 74% of cases and its maximum concentration exceeded maximum concentration limit by 4–9 times.

Annually, till 2013, cases when the coefficient of DDT/DDE exceeded 1 that testifies to receipt to the lake forbidden pesticides were noted.

Besides resistant pesticides of DDT and GHTsG groups pesticides of other classes were found in water of the lake. The found concentration of many connections the limit admissible concentration (LAC) exceeding size for fishery reservoirs. During various seasons of 2010–2013 absolute values of concentration of HOP in ground deposits of the lake lay within 0, 1–43, 3 mg/kg of dry weight. Values of frequency rate of SHK of the sum of HOP during various seasons changed ranging from 0, 05 to 17,6. Annually the concentrations of HOP exceeding SHK from 2 to 5 times meet. The greatest content of pesticides is noted in the ground precipitation adjoining on areas of intensive agriculture where they earlier decades were applied uncontrolledly. Most of all them it is revealed in ground deposits of the area Tasaral, and in actually.

The component composition of pesticides in ground deposits of the lake is more changeable, than in water thickness. Frequency of detection of GHTsG isomers during the first studied period made 76%, DDT – 81%. By 2010 the number of tests of ground deposits which were characterized by "fresh" pollution of DDT, reached 32%. DDT/DDE coefficient during this period equaled 2–3. Since 2013 in pollution of ground deposits of Lake Balkhash DDT metabolites began to prevail. It is possible to find DDT only incidentally.

In the ground sedimentations of Lake Balkhash except proof HOP the DDT bands and GHTsG other pesticides are systematic determined, however their list less than, than list of the pesticides determined in a water layer.

#### **Contamination of polychlorinated biphenyls:**

When analyzing the dynamics of PCBs ecosystem of Lake Balkhash in the period of 1990–1996. it was found that the concentration of these toxicants in the lake water were within 110–620 ng / l. In sediments, these compounds were found more often than in water, and the concentrations varied within 1,0–29,8 mg / kg, averaging 7.5 mg / kg dry weight. In the years of economic stagnation (1998–2003) PCB concentrations in the water of Lake Balkhash decreased. Their range was 5,0–123 ng / L for water and 1,0–15,3 mg / kg dry weight for sediment. From 2010 to 2013, these compounds are found everywhere. The range of detectable concentrations also increased: up 5,0–426 ng / l in water and 1,0–73 mg / kg dry weight in the sediments. The highest long-term concentrations of these substances are found in the southwestern part of the lake (up to 2 MAC). The frequency of PCBs in the sediments of Lake Balkhash for 2010–2013 reached 60%. The most intense of PCBs observed at the border of the eastern and south-western area of the lake where the sediments found in concentrations above 1.2 times the SCC.

#### **Pollution with heavy metal:**

Analyzing the dynamics of the lake surface contamination by heavy metals in the period 2010–2013 determined by the contents of water and sediments 13 elements - Ca, Mg, Cr, Cu, Pb, Cr, Ni, V, Na, Sr, As, Hg and Zn. In 2010–2013 the company in the water of Lake Balkhash cases exceeding the MPC of lead, cadmium and chromium were recorded. Maximum permissible concentration of copper and mercury was nearly ubiquitous and averaged 2.6 and 4.6 times respectively.

**Table 2:** Average ionic composition of the therapeutic mud of Lake Balkhash deposit.

№	Name of defined characteristics, units	Norm on LP	Actual values of the test results
1	Mass fraction of magnesium, %	276,0	GOST 26428-85
2	Mass fraction of calcium, g / t	281	GOST 26428-85
3	Mass fraction of barium, g / t	0,019	GOST 5382-91
4	Mass fraction of lead, %	0,001	ST RK ISO 11047-2008, method A
5	Mass fraction of zinc, %	No find	ST RK ISO 11047-2008, method A
6	Mass fraction of copper, %	0,0013	ST RK ISO 11047-2008, method A
7	Mass fraction of potassium%	0,66	ST RK ISO 11047-2008, method A
8	Mass fraction of chromium%	0,97	GOST 26425-85
9	Mass fraction of nickel, %	0,04	GOST 26424-85
10	Mass fraction of vanadium, %	1,06	GOST 26427-85
11	Mass fraction of sodium, %	0,071	GOST 26427-85
12	Mass fraction of strontium, %	0,09	GOST 26426-85
13	Mass fraction of Arsenic %	469	GOST 26425-85
14	Mass fraction of mercury %	0,07	GOST 26424-85
15	Mass fraction of chloride ion, %	0,1	GOST 26427-85
16	Mass fraction of the carbonate ion, %	0,01	GOST 26427-85
17	Mass fraction of sulfate ion,%	54,7	GOST 26426-85
18	pH	7,3	MEM ST 26449.1-85

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In the observation period 2010-2013 greatest contribution to the pollution brought iron and mercury. Thus excess mercury MPC again bore virtually ubiquitous and averaged 2.7 times. Cases exceeding the MPC of lead, zinc, chromium and cadmium were reported. According to the annual average for 2010-2013 the average concentration of manganese, zinc, lead, cadmium and chromium in the water of Lake Balkhash not exceed the MPC. Maximum permissible concentration was observed for iron, copper and mercury often (Table 2).

A full analysis of the spatial distribution of heavy metals at the bottom of Lake Balkhash and identify the most contaminated areas is almost impossible, because each element has studied the distribution of its own dynamics, which differs from year to year does not coincide with other elements. Comparison of polluted sediments of Lake Balkhash showed that all fluctuations in the growth or reduction of pre-season and annual average concentrations of the metal are not essential and can talk about almost constant their presence in the sediments of Lake Balkhash. Spatial distribution of heavy metals on the area of the lake bottom in relative units (multiplicity SCC) has allowed establishing the arrival of these areas toxicants. These include Karashigan bay, islands and Algazy Maykamys, Bay Area Ortaderisin, Tasaral, Maykamys and Borlytobinsky.

Assessment of pollution of the water column of Lake Balkhash in the period 2010-2013 MAGNITUDE complex water pollution (CWP).

The status of aquatic ecosystems can affect not only the individual substances, but also the different classes of compounds present in the water at the same time. Therefore, there is an objective need to develop the integral indicator of water pollution, which can be described as comprehensive water pollution CWP). To solve the problem of integral evaluation of the content of various toxicants in water offered the same method that was used for heavy metals include results of determination of individual substances to their maximum permissible concentration and then summing the obtained data. Multiplicity MPC has the same physical meaning for each toxicant, which allows its use for integrated features - integrated water pollution (SGC), which is calculated by the formula:

$$K3B = \frac{C_{\text{HII}} / \text{ПДК}_{\text{HII}} + C_{\text{ПХБ}} / \text{ПДК}_{\text{ПХБ}} + \sum C_{\text{ХОП}} / \text{ПДК}_{\text{ХОП}} + \sum C_{\text{Me}}^i / \text{ПДК}_{\text{Me}}^i}{4}$$

where SORT / PDKNP - multiple absolute concentration of oil in water in relation to the MPC for NP; SPHB / PDKPHB - the multiplicity of the absolute concentration of PCBs in the water in relation to the MRL for PCBs;  $\Sigma$  SKHOP/PDKHOP- multiplicity absolute concentration of OCPs in water with respect to the MPC for CVD;  $\Sigma$  SiMe / PDKiMe - sum of the multiplicities of the absolute concentrations of metals in relation to their Macs, divided by the number of detected metal (Andasbayev, Dzhetimov, 2012). Resulting from the settlement of the above formula indicators characterize the degree of water pollution complex study area and can be used to determine water quality by 5 classes (Table 3).

Average values of the SGC for the entire lake in the period 2010-2013y showed that in 2010, the quality of water in an average year can be classified as "moderately polluted". In subsequent years 2011-2013 water pollution decreased to 1st class quality and is classified as "clean". In the last 3 years of observations SGC values are quite similar and the average for the year amount to a single value - 0.71.

**Table 3:** Classification of integrated assessment of water pollution of Lake Balkhash.

CCW	Quality class	Classification
0 - <1,0	1	clean
1,0 - <1,3	2	Moderately polluted
1,3 - <1,7	3	Contaminated
1,7 - <2,0	4	Dirty
2,0 - >2,0	5	Very dirty

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The relative contributions of organ chlorine compounds and heavy metals in the CCW was on average almost the same and was respectively 22 and 23%.

### Discussion:

Visualizing the dynamics of average annual change in the integrated pollution confirms surprising, then, that for 2010-2013., Despite the increase in production, continued reduction of toxicants in Lake Balkhash, which began in the 90s (Tungyshbekov, 2000). The higher the degree of contamination of the aquatic ecosystem of Lake Balkhash complex on priority toxicants observed in the spring, when melt water from coastal areas in the lake washed away all the dirt accumulated over the winter. At the same time almost all the dirty Karashigan Bay, the northern part of the lake in the bays and Tasaral Maykamys and partly Western Lake District. Reducing the level of pollutants observed during summer periods. Apparently, this is not due to a decrease in revenues of toxicants, and with the intensification of the processes of degradation at higher temperatures. In the summer of

contaminated remains a central part of the bay Karashigan, north of the lake, the Bay Area Ortaderisin. Autumn area is districts with a high degree of contamination of the complex increases. These areas are located in the eastern part of the lake, and the most contaminated territory becomes Borlytobinsky bay.

Use to assess water pollution dimensionless quantities, multiple MACs relevant toxicants possible to solve another problem - the highlight areas of greatest environmental risk. These are the places where the water from one year to get the various toxic substances. It turned out that it is virtually the entire coast of Lake Balkhash. Also, contaminated areas are marked not only in the narrow coastal strip, but also extend far into the lake. In the bay comes Ortaderisin entire spectrum of pollutants. North and west of the lake is polluted with oil products, heavy metals and polychlorinated biphenyls. In the bays and Tasaral Maykamys besides oil and heavy metals, PCBs and pesticides are found. Zone Incoming pesticides extends further to the east of the lake. Thus, using long-term data on the integrated water pollution, can obtain a fairly complete picture of the receipt of toxicants in Lake Balkhash.

But we must not forget that water content is still very labile structure of the aquatic ecosystem. To confirm and extend the range of discovered patterns, it is necessary to analyze the status and dynamics of the other part of the pollution of the sea ecosystem - bottom sediments.

### **Conclusions:**

Based on the analysis results expeditionary observations and literature data were assessed for the ecosystem of Lake Balkhash, the tendencies of its transformation under the influence of anthropogenic factors in the complex over the last two decades, taking into account changes in the economic and environmental situation in the country. In this period from 2010 to 2013 y. was changed in the oil concentration in the water ranged from 0.05 to 0.54 mg / l, and in sediment - from 0.35 to 1.22 g / kg; PAH - in water 100-220 ng / l in sediments 2,3-4,4 mg / kg; HOP - water 2,7-66,4 ng / l in sediments 0,1-43,3 mg / kg; PCBs - in water 5-620 ng / l in sediments 1-29,8 mg / kg dry weight.

Distribution of heavy metals determined 13 wore an individual character, but in general their content in the lake during the study period for all fluctuations in the average was about the same level.

The worst, in terms of contamination by toxic, period falls on the active economic activity, 1990-1996. In the modern period (2010-2013 years), despite the increase in economic activity and reduce the input intensity of river water, increasing the content of most of toxicants in the lake ecosystem has been noted.

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