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Original Research

Evaluation of Recreational Impact on Tourist Territories of East-Kazakhstan

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Abstract

The study aims to assess the impact of recreational activities and tourism on the tourist territories of Lake Alakol and the Shulba reservoir of East Kazakhstan. The article examines the influence of recreational activities on the pollution of coastal soils and coastal surface waters of tourist areas with chemical elements, biogenic and organic substances of Lake Alakol and the Shulba reservoir. Data on the gross content of chemical aspects and biogenic and organic substances in soils and waters were obtained. The hydro chemical composition of coastal surface waters has been studied. A comparative characteristic of the content of pollutants was carried out.

Keywords: sustainable tourism, soils, landscape, recreational impact, pollution

Introduction

The increasing population demand for outdoor recreation leads to increased recreational loads in tourist areas. The objects experiencing a negative impact on vacationers on the territory of East Kazakhstan include Lake Alakol and the Shulba reservoir.

Research related to the environmental impact of tourism received a significant boost in the 1970s thanks to the efforts of scientists such as Budowski [1] and Cohen [2]. Research on the negative impact of tourism continued throughout the 1980s, and since then concerns about the environmental impact of tourism have increased. Many researchers have paid particular attention to assessing the impact of tourism on the environment, among which scientist Pearce D. G. offered a basis for studying the effects of tourism on the environment in 1985. In the works of scientists of various scientific fields (presented in modern scientific works of Huddart [3], Sumanapala [4], Baloch Q. B. [5], Paramati S.R. [6], Mikhaylyuk I. [7], Ahmad F. [8], Agarwal R. [9], Szara M. [10], Tytła M. [11], Mariusz S. [12] and others), a complex of issues of formation, development, the transformation of the ecological state of territories that are associated with the influence of recreational activities on the environment.

The issues of the ecological state of the coast of Lake Alakol were dealt with by Yerdavletov S.R. and others.

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The study of the ecological state of the Irtysh River, where the Shulba reservoir was formed, was carried out by Beisembayeva M.A. [13] and others.

The development of recreational activities, accompanied by the concentration of vacationers and vehicles in small areas, leads to an increase in anthropogenic load on all components of the recreational landscape [14]. In the coastal zone of Lake Alakol and the Shulba reservoir, the greatest damage to the natural environment is caused by unorganized vacationers, when tents are set up on the shore, bonfires are lit, and food is prepared. Vacationers usually congregate in the most convenient places, where the recreational load increases many times. There are changes in the soil-plant complex: compaction and abrasion of the upper soil horizon, trampling, and destruction of grass cover. This leads to a decrease in the infiltration capacity of the soil, increased slope runoff, soil flushing, and removal of biogenic and pollutants into the reservoir. These and other negative consequences of human recreational activity lead to a decrease in the aesthetic, health, and environmental qualities of recreational landscapes.

One of the negative factors that violate the natural state of soils is motor transport. Transport and tourism in picturesque places can lead to the accumulation of heavy metals in the soil, affecting the soil ecosystem around picturesque places [15]. In the summer, many vacationers come by private vehicles. The flat terrain of the study area allows you to move by car without roads in different directions. The absence of coastal protective strips leads to the accumulation of vehicles directly along the coast, contributing to the removal of pollutants into the reservoir.

The coast and water areas of Lake Alakol and the Shulba Reservoir are used for a wide variety of recreational activities. This is swimming, beach holidays, boating, catamarans, scooters, and speedboats. A small motor fleet with intensive use is also a source of pollution of the lake with petroleum products. Therefore, it is relevant to study the concentration of fuel combustion products and petroleum products in the coastal surface waters of Lake Alakol, Shulba reservoir, used for recreational purposes.

Along with the aesthetic, health, and climatic qualities of the attractiveness of tourist areas, important indicators are knowledge of the current ecological state and the definition of recreational impact. The intake of certain pollutants should not exceed the approved maximum permissible concentrations and sanitary and hygienic standards.

Material and Methods

Lake Alakol (2,650 km^2) is located in the Eastern part of the Republic of Kazakhstan and occupies the lowest part of the Balkhash-Alakol basin, between the Zhetysu (Dzungarian) Alatau and the Tarbagatai ridge Fig. 1. Lake Alakol in recent years has become a favorite holiday destination for residents of Kazakhstan and neighboring countries. According to the Tourstat.kz database information system [16], in 2022, 582948 people visited Lake Alakol for tourism, almost 5 times more than in 2021 when the number of vacationers was 140872 thousand.

The Shulba reservoir (255 km^2) is also located in the Eastern part of the Republic of Kazakhstan, formed by the Shulba hydroelectric dam, and located on the Irtysh River 70 km from the city of Semey. A large number of people living in the city of Families come to rest on the shore of the Shulba Reservoir in the summer.

The studied tourist territories located on the shore of Lake Alakol and the Shulba reservoir are subject to anthropogenic impact in the process of recreational use. The purpose of this study is to study the content

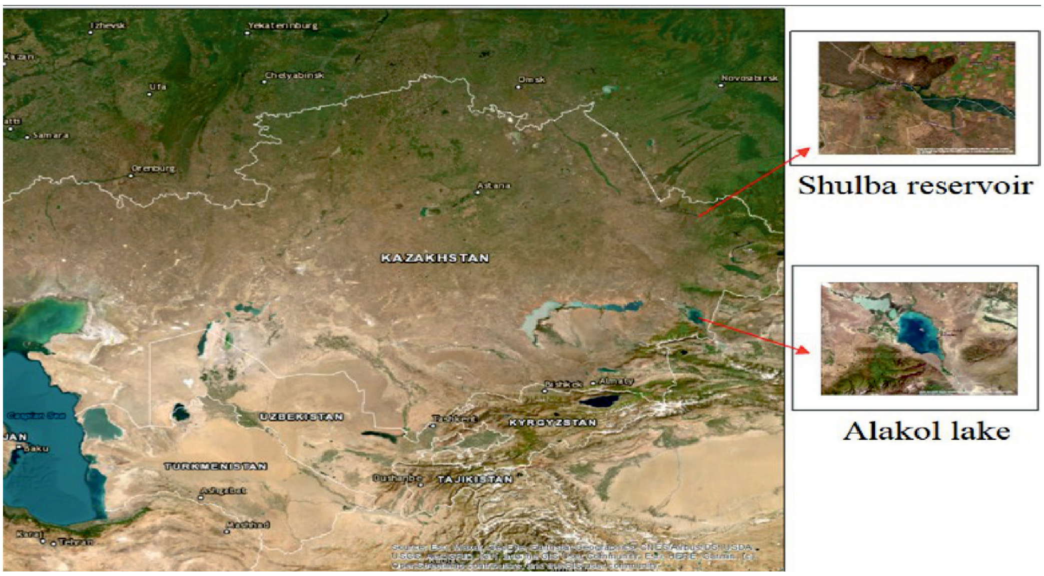

Fig. 1. Location of Lake Alakol and Shulba Reservoir.

Fig. 2. Lake Alakol.

Fig. 3. Shulba Reservoir.

of pollutants and chemical elements in soils and water bodies in the tourist territories of Lake Alakol and the Shulba reservoir.

The objects of the study were soil samples, and water samples were taken in the water area of Lake Alakol (Kabanbai village), Fig. 2. Shulba Reservoir Fig. 3 (Shulba village) in 2022. Samples were taken in July when the peak of the recreational season is observed. All analyses of soil and water samples were carried out according to generally accepted methods. The analysis for the content of chemical elements and major pollutants was carried out in the laboratory of the "National Center for Expertise and Certification" in Semey.

All the experimental material obtained was processed by methods of variational statistics using the MS EXCEL program.

Results and Discussion

During the summer field research in 2022, as part of the research work, soils were selected in the coastal zone of Lake Alakol, soils were selected in areas of congestion of vehicles.

In the selected samples, the reaction of the soil solution in the upper horizons is highly alkaline, (the pH is aqueous in the range of 8.6-9.0). The average content of ammonium nitrogen is 1.4 mg/kg, and the content of nitrates varies from 174-291 mg/kg. The average content of carbonates in humus horizons is 600 mg/kg, and the content of hydro carbonates was 2136 mg/kg. The content of petroleum products in the soils of the studied territory was not detected. The content of sulfates in humus horizons ranges from 8.9-61.5 mg/kg, with an average of 35.2 mg/kg. The chloride content in humus horizons ranges from 28360-131874 mg/kg, averaging 80117 mg/kg.

The results of the study of soils in the coastal zone of Lake Alakol showed (Table 1) that the gross copper content in soils in the humus-accumulative horizon ranges from 0.33-0.43 mg/kg, averaging 0.38 mg/kg, with a coefficient of variation of 13.3 %. The average copper content in the soils of the lake. Alakol does not

Table 1. Variational and statistical indicators in the soils of Lake Alakol, mg/kg.

Parameters	X±Sx	lim	σ	CV%
pH	8.8±0.2	8.6-9.0	0.2	2.4
NH_4^+	1.35±0.00	1.4-1.4	0.0	0.0
NO_3^-	233±42	174-291	59	25
H_2CO_3	600±0.00	600-600	0.00	0.00
HCO_3^-	2136±109	1983-2288	152.55	7.14
H_2SO_4	35±19	8.93-61	26.27	74.62
HCl	80117±36969.3	28360-131874	51757	65
Cu	0.38±0.04	0.33-0.43	0.05	13
Zn	0.61±0.02	0.582-0.63	0.02	4
Pb	0.65±0,04	0.60-0,70	0.05	7.94

Note: $\bar{X} \pm S\bar{x}$- average±error of average, σ - standard deviation, lim - scope of limits, ρ - limit difference, CV% - coefficient of variation.

exceed the values of MPC, (33 mg/kg), [17]. The total zinc content in the humus-accumulative horizon of the soils of the region varies from 0.58-0.63 mg/kg, the average content is 0.61 mg/kg, and the coefficient of variation is 3.78%. The average zinc content does not exceed the maximum permissible concentrations, which are 100 mg/kg [17]. The total lead content in the humus-accumulative horizon of soils ranges from 0.60-0.70 mg/kg, averaging 0.65 mg/kg. The average lead content in the soils of the lake. Alakol does not exceed MPC values (32 mg/kg) [17]. No cadmium content was found in the soils of Lake Alakol.

The results of the hydrochemical composition of the coastal surface waters of Lake Alakol, the results are presented in (Table 2).

The pH value is an important indicator of the ecological and geochemical state of waters, on which, in particular, the development and vital activity of aquatic organisms, the stability of forms of migration of chemical elements and compounds and the degree of disequilibrium of waters relative to underlying rocks and river sediments depend. The chemical analysis made it possible to establish that the coastal waters of Lake Alakol used for recreational purposes are alkaline in terms of pH. The average pH value was 8.5.

According to the classification of O.A. Alekin, the water in the waters of Lake Alakol to the predominant anion belongs to the class of chloride-sulfate, and according to the predominant cation – to the group of sodium waters.

The value of the total hardness (from 31.5 to 37.5 mg/dm^3) characterizes the waters of Lake Alakol as very hard (29%). The average value of the total stiffness was 34.5±2.14 mg/dm^3 with a coefficient of variation of 8.7%.

The average total mineralization (dry residue) is 9059.5 mg/dm^3. The water is brackish or bitterly salty, very hard (31.5-37.5 mg-eq/L).

The obtained data on the macro-component composition of water showed that the average content of bicarbonate ions in the coastal waters of Lake Alakol was 802±2 mg/dm^3. The range of variation of this ion ranges from 799 to 805 mg/dm^3, and the coefficient of variation was 0.4%.

Table 2. Statistical indicators of the content of chemical elements in the coastal surface waters of Lake Alakol, mg/dm^3.

Parameters	X±Sx	lim	σ	CV%
pH	8.6± 0.03	8.5-8.6	0.05	0.5
Dry residue	9060± 1417	7076-11043	1984	21.9
Overall stiffness	34.5± 2.1	31.5-37.5	3	8.7
BOD	3±0.07	2.9-3.1	0.1	3.3
Dissolved oxygen	9.6± 0.07	9.5-9.7	0.1	1.04
Suspended substances	57.0±7.9	46-68	11	19.3
Alkalinity	19.5±0.2	19.2-19.7	0.3	1.3
Pb	0.001±0	0.001-0.001	0	0
Zn	0.17± 0.02	0.17-0.22	0.03	12.8
Cu	0.093± 0.003	0.09-0.10	0.0035	3.8
NO_3^-	41.6± 0.7	40.6-42.6	1	2.4
HNO_2	0.052±0	0.052-0.052	0	0
H_2SO_4	3816± 874	2592-5040	1224	32.1
HCl	1523± 25	1488-1558	35.0	2.3
Fluorides	1.3±0.13	1.2-1.5	0.18	13.1
NH_4+	1.5±0.03	1.47-1.55	0.04	2.7
Na^+	2379± 506	1670-3088	709	29.8
Ca^{2+}	68±37	16-120	52	76.5
Mg^{2+}	373± 48	306-440	67	18
H_2CO_3	802±2.18	799-805	3.05	0.38
HCO_3^-	189± 6.4	180-198	9	4.8

Note: $\bar{X} \pm S\bar{x}$- average±error of average, σ - standard deviation, lim - scope of limits, ρ - limit difference, CV% - coefficient of variation.

The average concentration of sulfate ions in the studied waters was 3816±874 mg/dm^3 with a coefficient of variation of 32% and a range of limits of 2592-5040 mg/dm^3. The average concentration of nitrate ions in the coastal waters of Lake Alakol was 41.6±0.7 mg/dm^3. The coefficient of variation of nitrates is 2.4 mg/dm^3. The average concentration of calcium ions in the studied waters was 68±37 mg/dm^3 with a coefficient of variation of 76% and a range of limits of 16-120 mg/dm^3. The average magnesium content in the coastal waters of Lake Alakol was 373±47 mg/dm^3. The coefficient of variation was 18%, and the range of variation was 306-440 mg/dm^3.

Phosphates, surfactants, petroleum products, phenols, organic and inorganic substances, and cadmium were not found in the waters of Lake Alakol.

As our studies have shown, the average concentration of lead in the surface waters of Lake Alakol is 0.0001 mg/dm^3. The zinc content in the water of Lake Alakol varies from 0.17 to 0.22 mg /dm^3, averaging 0.2 mg/dm^3, the coefficient of variation is 13%. The average copper content in the waters of Lake Alakol was 0.093 mg/dm^3 with a coefficient of variation of 4%, and the range of variation was 0.089-0.096. Analysis of the obtained data on the concentration of chemical elements in the coastal waters of Lake Alakol showed that, for lead, zinc, and copper, no excess of the maximum permissible concentrations was detected. The average bitrate content is 41.6, the nitrite content is 0.052 mg/dm^3.

In the coastal water of Lake Alakol, there was no excess of indicators for most of the studied elements. The lack of indicators of the maximum permissible concentrations of the studied elements is probably facilitated by the processes of self-purification of the lake. Sampling on Lake Alakol was preceded by a strong storm.

A slight excess of the maximum permissible concentrations of ammonium nitrogen creates prerequisites for further monitoring studies. The excess of ammonium nitrogen is probably due to flushing from the body of vacationers, which is present in the final products of the human body's metabolism. Vacationers mainly concentrate in the coastal zone Fig. 2.

Studies on the hydrochemical composition of the coastal surface waters of Lake Alakol used for recreational purposes, conducted by us in 2014, showed that the concentration of copper in the coastal surface waters of Lake Alakol varied from 0.0025-0.0040 mg/dm^3, averaged 0.0032±0.0003 mg/dm^3; the coefficient of variation was 21%. The average zinc concentration was 0.0125±0.0079 mg/dm^3, the coefficient of variation was 126.15%, and the range of variation was 0.0040-0.0360. Analysis of the obtained data on the concentration of heavy metals in the water area of Lake Alakol showed that the excess of MPC was detected for copper – 3.2 MPC, zinc – 1.25 MPC [18].

According to the toxicological analysis conducted in the Alakol-Sasykkol Lake system within the framework of the GEF/UNDP project/The Government of the Republic of Kazakhstan Globally significant wetlands of Kazakhstan (Alakol-Sasykkol Lake system), the excess of MPC was detected for copper - up to 10 MPC in a sample taken in the water area of Lake Alakol.

The research of S.R. Yerdavletov revealed that, under existing loads, especially on weekends of the summer period, when 1000-1300 people are resting on the beaches at the same time, about 5.1-6.6 kg of nitrogen, 1.6-2 kg of phosphorus per day from swimmers enters the lake and is respectively about 160-200 kg and 60-80 kg for the recreational season. According to the industry standard, in reservoirs with a water volume of 1 million m^3 (the volume of Lake Alakol is 58.6 million m^3) eutrophication of the reservoir begins with a room of 1000 people on a day, and at 400-500 – the ability to self-purify is preserved. This indicator is also confirmed by our calculations – the optimal load on the lake is 450 people/ day.

The results of the study in the soils of the Shulba reservoir showed that (Table 4) the reaction of the soil solution in the upper horizons varies from slightly acidic to neutral (pH water in the range of 5.73-6.92). The average content of ammonium nitrogen was 1.10 mg/kg, and the content of nitrate nitrogen was 28.2 mg/kg. The content of bicarbonates ranges from 152.6-366.1 mg/kg. No petroleum products were found in the soils of the territory. The content of sulfates in humus horizons ranges from 38-49 mg/kg, with an average of 43 mg/kg. The chloride content in humus horizons ranges from 124.1-478.6 mg/kg, averaging 287.6 mg/kg, which does not exceed the maximum permissible concentrations.

The average copper content in the humus-accumulative horizon is 0.20 mg/kg, ranging from 0.14-0.25 mg/kg, with a coefficient of variation of 19.4%. The average copper content in the soils of the Shulba reservoir does not exceed the MPC values (33 mg/kg) [17]. The total zinc content in the humus-accumulative horizon of the soils of the region varies from 0.31-0.37 mg/kg, the average content is 0.34 mg/kg, and the coefficient of variation is 5.9%. The average zinc content in the soils of the Shulba reservoir does not exceed the MPC values (100.0 mg/kg) [17]. The gross lead content in the humus-accumulative horizon of soils varies from 0.16-0.17 mg/kg, averaging 0.17 mg/kg. The average lead content in the soils of the Shulba reservoir does not exceed the MPC (32 mg/kg) [17]. The cadmium content in the soils of the Shulba reservoir was not detected.

According to the data of field studies in 2022, we obtained the results of the hydrochemical composition of the coastal surface waters of the Shulba reservoir for the content of chemical elements and pollutants in them are presented in (Table 5).

The hydrochemical analysis made it possible to establish that the coastal waters of the Shulba reservoir used for recreational purposes are slightly alkaline in terms of pH. The average pH value was 7.2.

Table 3. Variational and statistical indicators of chemical elements in the soils of the Shulba reservoir, mg/kg.

Parameters	X±Sx	lim	σ	CV%
pH	6.5±0.3	5.7-6.9	0.5	7.6
NH_4+	1.1±0.1	0.8-1.48	0.2	19.7
NO_3^-	28.3±15.4	5.4-68.2	26.6	94.3
HCO_3^-	274.6±47.0	152.6-366.1	81.7	29.6
H_2SO_4	42.9±2.3	37.5-49.0	4.1	9.5
HCl	287.1±73.8	124.1-478.6	127.6	44.4
Cu	0.20±0.02	0.14-0.25	0.04	19.4
Zn	0.34±0.01	0.31-0.37	0.02	5.9
Pb	0.2±0.0	0.16-0.17	0.01	3.7

Note: $\bar{X} \pm S\bar{x}$- average±error of average, σ - standard deviation, lim - scope of limits, ρ - limit difference, CV% - coefficient of variation.

Table 4. Statistical indicators of the content of chemical elements in the coastal surface waters of the Shulba reservoir, mg/dm^3.

Parameters	X±Sx	lim	σ	CV%
pH	7.2±0.4	6.2-8.0	0.7	9
Dry residue	150.7±11.3	135-180	19.6	13
Overall stiffness	1.8±0.1	1.6-2.0	0.1	8
Pb	0.001±0.0	0.001-0.001	0	0
Zn	0.06±0.0	0.06-0.07	0.0	5
Cu	0.04±0.0	0.04-0.04	0.0	4
NO_3–	1.9±0.3	1.5-2.7	0.5	25
HNO_2	0.05±0.02	0.01-0.11	0.04	80
H_2SO_4	22.8±1.8	18.7-27.4	3.09	14
HCl	14.00±1.35	10.5-17.5	2.3	17
Fluorides	0.59±0.08	0.39-0.72	0.1	23
NH_4+	0.08±0.01	0.06-0.11	0.02	23
Na^+	23.6±2.5	17.1-29.8	4.4	18
Ca^{2+}	25.7±0.9	24-28	1.6	6
Mg^{2+}	5.8± 0.6	4.2-7.2	1.07	18
H_2CO_3	103.7±11.8	85.4-134.2	20.3	20
HCO_3^-	6±0.0	6-6	0	0
BOD	1.4±0.1	1.2-1.7	0.2	14
Dissolved oxygen	6.2±0.4	5.2-7.0	0.6	11
Suspended substances	82.7±5.7	68-96	9.8	12
Alkalinity	1.8±0.2	1.4-2.2	0.3	16

Note: $\bar{X} \pm S\bar{x}$- average±error of average, σ - standard deviation, lim - scope of limits, ρ - limit difference, CV% - coefficient of variation.

The average content of total mineralization (dry residue) was 150.7 mg/dm^3. Soft, fresh water (1.6-2 mg-eq/L).

According to the classification of O.A. Alekin, the water in the water area of the Shulba reservoir belongs to the class of bicarbonate to the predominant anion, and the group of sodium-calcium waters according to the predominant cation.

The average ammonium content in the waters of the Shulba reservoir was 0.08 mg/dm3. The average sodium content ranges from 17.1 to 29.8 mg/dm^3, calcium from 24.0 to 28.0 mg/dm^3, and magnesium from 4.2 to 7.2 mg/dm^3. The average content of hydrocarbonates is 103.7 mg/dm^3 and carbonates 6 mg/dm^3. The obtained data on the macro-component composition of water do not exceed the maximum permissible concentrations.

The average nitrate content is 1.94 mg/dm^3, and the nitrite content is 0.05 mg/dm^3. The content of sulfates varies from 18.7 to 27.4, chlorides 10.5 to 17.5, fluorides 0.39-0.72 mg/dm^3.

Organic substances, formaldehyde, chemical oxygen consumption, surfactants, petroleum products, phenolic index, and inorganic substances, phosphates, and cadmium were not found in the waters of the Shulba Reservoir.

As our studies have shown, the average concentration of lead in the surface waters of the Shulba reservoir is 0.0001 mg/dm^3. The zinc content in the waters of the Shulba reservoir varies from 0.06 to 0.07 mg /dm^3, averaging 0.06 mg /dm^3, the coefficient of variation is 5%. The average copper content in the waters of the Shulba reservoir was 0.04 mg/dm^3 with a coefficient of variation of 4%. Analysis of the obtained data on the concentration of chemical elements in the coastal waters of the Shulba reservoir showed that, for lead, zinc, and copper, no excess of MPC was detected.

The absence of pollution and excess of MPC in the reservoirs studied by us is probably due to the ability of self-purification. In the Shuba reservoir due to the fairly rapid flow of the Irtysh River. Most of the suspended contaminants are deposited, these are suspended mineral and organic particles, helminth eggs, and microorganisms, thanks to this, the water is clarified and becomes transparent. Reducing the concentration of inorganic substances polluting water bodies occurs by neutralizing acids and alkalis due to the natural buffering of natural waters, the formation of insoluble compounds, hydrolysis, sorption, and precipitation. The concentration of organic substances and their toxicity are reduced due to chemical and biochemical oxidation.

According to the results of toxicological studies conducted by N.A. Tirskaya in 2013, it was revealed that in the Shulba reservoir, of all the toxicants, the concentration of zinc did not exceed the limits of fisheries MPC. For copper in 2006-2009, exceedances were recorded mainly in the middle part, this is because water enters the Shulba reservoir after passing through the section of the Irtysh River receiving water from the most polluted tributaries – the Krasnoyarsk and Glubochanka rivers.

Concerning the content of petroleum products, a certain feature was also revealed – the lower part, unlike the other two parts, was characterized from year to year by an acceptable content of petroleum products, which favored the vital activity of the hydro-fauna. In the upper and middle parts, there were cases of exceeding the MPC [19].

As our research has shown, currently recreational activities are not noticeably reflected in the reservoirs and coastal tourist territories of Lake Alakol and the Shulba Reservoir. Additional monitoring studies are needed to obtain more reliable data on the concentration of pollutants in coastal soils and surface waters used for recreational purposes.

An uncontrolled approach to tourism and recreation poses a potential threat to the natural environment and biodiversity. An important task is to prevent a negative impact on landscapes, which will preserve the stable functioning of the circulation of matter and energy both in water bodies and in landscapes.

Conclusions

1. The content of Zn, Pb, Cu and other elements in soil samples taken along the coastal strip of Lake Alakol and the Shulba reservoir do not exceed the maximum permissible concentrations. At the moment, motor transport does not affect the pollution of the soil cover of the coastal recreational areas of Lake Alakol and the Shulba reservoir.

2. The coastal water of Lake Alakol is acceptable for recreational use by most indicators. A slight excess of the maximum permissible nitrogen concentration creates prerequisites for further monitoring studies of nitrogen and phosphorus entering the lake.

3. Hydrochemical analysis of the coastal waters of Lake Alakol showed that lead, zinc and copper, and other elements did not exceed the maximum permissible concentrations, probably this is due to the high self-cleaning potential of the lake. Earlier toxicological studies have shown excess concentrations of copper and zinc.

4. Hydrochemical analysis of the obtained data on the concentration of chemical elements in the coastal waters of the Shulba reservoir showed that, for lead, zinc, and copper, no excess of the maximum permissible concentrations was detected. However, earlier studies showed an excess of copper and petroleum products.

5. Studies conducted in 2022 have shown that recreational activities do not have a significant impact on soil and water pollution in the coastal tourist areas of Lake Alakol and the Shulba Reservoir. Further monitoring studies are needed to obtain more reliable data on the concentration of pollutants in coastal soils and surface waters used for recreational purposes.

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Conflict of Interest

The authors declare no conflict of interest.

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