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NATURAL RESOURCE POTENTIAL OF THE LAKE GEOSYSTEM OF AKMOLA REGION

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Abstract. This article discusses complex studies of determining the natural resource potential of the lake geosystem of the Akmola region. Today, one of the most pressing issues is to increase the pace of economic development of the country, increase the use of natural resources, protection, and further improvement of lake geosystems in the region. In solving these problems, the natural resource potential of the lake geosystem in the territory under consideration was determined, comprehensive geoecological assessments were carried out, and lake geosystem indices were calculated. The studies used conventional hydrological, geographical, ecological and new methods of GIS technologies for lake geosystems. Lakes provide a special environment for the life of organisms called hydrobionts, which actively contribute to the functioning and evolutionary development of hydroecosystems.

As a result of the study, maps of the lake geosystem were compiled. Mapping was carried out using GIS technology data, where the role of lakes is becoming increasingly important, since they remain necessary for preserving freshwater resources, despite ongoing anthropogenic pressure. The integrity of the lake basin is considered as the main part of the lake geosystem, uniting natural water and territorial systems, interconnected by economic and management activities, which are aimed at geoecological assessment of the potential of natural resources.

Key words: Lake geosystem, natural resource potential, surface water resources, hydrological assessment, economic significance

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АҚМОЛА ОБЛЫСЫ КӨЛДЕР ГЕОЖҮЙЕСІНІҢ ТАБИҒИ-РЕСУРСТЫҚ ӘЛЕУЕТІ

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Аннотация. Бұл мақалада Ақмола облысының көл геожүйесінің табиғи ресурстық әлеуетін анықтау бойынша кешенді зерттеулер қарастырылған. Бұған дейін Ақмола облысындағы көлдер геожүйесінің табиғи ресурстық әлеуеті толық ғылыми тұрғыдан зерттелмеген. Геожүйелер ғылыми сала ретінде табиғи ресурстардың әлеуетін анықтауда маңызды жұмыстарды атқарады. Географиялық кеңістіктік зерттеулерде геожүйелік тәсілге ұмтылу география ғылымының тарихында ертеде пайда болды. Қазіргі уақытта геожүйелер география ғылымындағы маңызды бағыт ретінде өзін танытты.

Дегенмен, геожүйелік тәсілді дамыту аясында ғылым енді ғана қарқын алып келеді. Бүгінгі таңда еліміздің экономикалық даму қарқынын арттыру, табиғи ресурстарды пайдалануды арттыру, қорғау, өңірдегі көлдердің геожүйесін одан әрі жетілдіру өзекті мәселелердің бірі болып табылады. Осы міндеттерді шешуде қарастырылып отырған аумақтағы көл геожүйесінің табиғи ресурстық әлеуеті анықталып, кешенді геоэкологиялық бағалаулар жүргізіліп, көл геожүйесінің индекстері есептелді. Зерттеулерде көл геожүйелері үшін жалпы қабылданған гидрологиялық, географиялық, экологиялық және ГАЖ технологияларының жаңа әдістері қолданылды, өйткені тұщы су объектілері, әсіресе көлдер мен өзендер ауыз судың негізгі көзі ретінде әрекет ететін адам өмірі үшін маңызды факторлардың бірі болып табылады. Көлдер гидроэкожүйелердің жұмыс істеуіне және эволюциялық дамуына белсенді түрде ықпал ететін су организмдері деп аталатын организмдердің тіршілігі үшін ерекше ортаны қамтамасыз етеді. Зерттеу нәтижесінде көл геожүйесінің карталары құрастырылды. Карталау ГАЖ технологиясының деректерін пайдалана отырып жүргізілді, мұнда көлдердің рөлі тұрақты антропогендік қысымға қарамастан тұщы су ресурстарын сақтау үшін маңызды болып қала береді. Көл бассейнінің тұтастығы табиғи ресурстардың әлеуетін геоэкологиялық бағалауға бағытталған шаруашылық және шаруашылық қызметімен өзара байланысты табиғи су және аумақтық жүйелерді біріктіретін көл геожүйесінің негізгі бөлігі ретінде қарастырылады.

Түйін сөздер: көлдік геожүйе, табиғи ресурстық әлеует, жер үсті су ресурстары, гидрологиялық бағалау, экономикалық маңыздылық

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ПРИРОДНО-РЕСУРСНЫЙ ПОТЕНЦИАЛ ОЗЕРНОЙ ГЕОСИСТЕМЫ АКМОЛИНСКОЙ ОБЛАСТИ

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Аннотация. В данной статье представлены комплексные исследования определения природно-ресурсного потенциала геосистемы озёр Акмолинской области. Ранее природно-ресурсный потенциал геосистемы озёр Акмолинской области научно не был полностью изучен. Геосистема, как научное направление, выполняет важную работу по определению потенциала природных ресурсов. Стремление к геосистемному подходу в географических пространственных исследованиях возникло в прошлом в истории географической науки. Геосистема в настоящее время зарекомендовала себя как важное направление в географической науке. Однако в рамках развития геосистемного подхода наука только набирает обороты. На сегодняшний день одним из наиболее актуальных вопросов является увеличение темпов экономического развития страны, расширение использования природных ресурсов, их охрана и дальнейшее совершенствование геосистем озёр на территории области. В решении этих задач были определены природно-ресурсный потенциал геосистемы озёр на рассматриваемой территории, проведены комплексные геоэкологические оценки, рассчитаны индексы геосистемы озёр. В исследованиях применялись общепринятые гидрологические, географические, экологические и новые методы ГИС-технологий для озёрных геосистем, так как пресноводные водоёмы, особенно озёра и реки, являются одним из важнейших факторов для жизни человека, выступая в качестве основных источников питьевой воды. Озёра обеспечивают особую среду для жизни организмов, называемых гидробионтами, которые активно способствуют функционированию и эволюционному развитию гидроэкосистем. В результате исследования составлены карты геосистемы озёр. Картирование осуществлялось с помощью данных ГИС-технологий, где роль озёр становится всё более важной, поскольку они остаются необходимыми для сохранения ресурсов пресной воды, несмотря на продолжающееся антропогенное давление. Целостность озёрной котловины рассматривается как основная часть озёрной геосистемы, объединяющая естественные водные и территориальные системы, взаимосвязанные хозяйственной и управленческой деятельностью, направленной на геоэкологическую оценку потенциала природных ресурсов.

Ключевые слова: озёрная геосистема, природно-ресурсный потенциал, поверхностные водные ресурсы, гидрологическая оценка, экономическая значимость.

Introduction. The study of lake geosystems is of great importance in the context of sustainable natural resource management, ecological stability, and regional economic development. In Kazakhstan, where surface water resources amount to 100.5 km³ annually - only 56.5 km³ of which is generated within the country - lakes serve as essential reservoirs that support biodiversity, freshwater supply, and various economic activities. Given the growing challenges posed by climate change and increasing human activity, the need for a comprehensive assessment of lake ecosystems has become more pressing than ever.

The Akmola region, home to approximately 954 lakes with a total drainage area of 327,768.63 km², presents a diverse and complex hydrological landscape. These lakes vary in origin, mineralization levels, and ecological significance, with major systems such as the Tengiz-Korgalzhyn geosystem playing a critical role in global bird migration patterns, while the Borovoe and Ereymentau lakes serve as vital freshwater reserves. Despite their importance, many of these lakes remain insufficiently studied, particularly in terms of their morphometric characteristics, resource potential, and role in regional development.

This research aims to analyze the natural resource potential of the lake geosystem in the Akmola region by assessing its physical and geographical features, structural characteristics, and hydrological dynamics. By applying the methodology developed by the Belarusian State University, as well as utilizing GIS technologies such as ArcGIS 10.8.1 for spatial analysis (Vlasov et al., 2012; Yakushko, 1981), this study seeks to provide a detailed classification of lakes based on their size, mineralization levels, and ecological functions.

The results will contribute to the scientific understanding of Kazakhstan's lake geosystems and serve as a foundation for future environmental management strategies, ensuring the effective use and conservation of these valuable natural resources.

Materials and methods of research. The concept of geosystems was introduced to science in 1963 by Academician V.B. Sochava (Sochava, 1963). In the early stages, this term was used exclusively to refer to natural territorial complexes, but nowadays it encompasses natural-social systems. According to V.B. Sochava's definition, a geosystem consists of natural geographical units that range from the general geographical shell to the smallest facies. Significant contributions to the development of the geosystem concept were made by researchers such (Solntsev, 1981; Sochava, 1978; Korytny, 1992; Rumney, 1970), whose works further expanded the concept. In Kazakhstan, the study of geosystems, particularly as a prominent scientific discipline, was shaped by Professor (Dzhanaleeva, 2008), who founded the local school of thought on this topic.

The unique characteristics of a geosystem include its integrity, self-management capacity, stability over time, and its genesis and dynamics. Among these components, the most distinguishing feature is integrity. The components of a geosystem are interconnected by the circulation of energy and matter. Energy transfer occurs through transformations from one element to another. The structure of a geosystem

can be understood in both horizontal and vertical orientations. The horizontal structure follows a specific spatial organization, while the vertical structure is defined by its stratified nature. Geosystems, like landscapes, consist of five natural components: the earth's crust, atmospheric air, water, plant life, and animal life. These components interact and create entirely new forms, such as natural territorial complexes, which possess unique properties such as the emergence of living organisms and the formation of soil. All natural components are closely tied to the flows of matter and energy. Natural territorial complexes are categorized into two broad groups based on their properties and size: physical-geographical regions and landscapes.

From the perspective of limnology, the study of lakes is characterized by complex hydrological and hydroecological ecosystems. Therefore, the full range of hydrological research methods is applied to their study. The term "limnology" derives from the Greek words lake and study, referring to the science of lakes, rivers, freshwater bodies, and the physical, chemical, and biological aspects of water composition. Freshwater bodies, particularly lakes and rivers, are one of the most critical factors for human life, serving as primary sources of drinking water.

Geographically, lakes play a central role in the regulation of water flows. The integrated impact of lakes on runoff is particularly significant, as they act as natural regulators of the flow. In rare cases, evaporation from the surface of a lake can lead to a reduction in annual runoff. Lakes also regulate chemical flows, retain a portion of the runoff, and positively influence the microclimate of the surrounding areas. Thus, lakes represent substantial recreational resources. Furthermore, lakes receive large amounts of both autochthonous and allochthonous materials, which transform into specialized formations known as "lower sediments" through the process of sedimentogenesis. Lakes provide a specific environment for the life of organisms called hydrobionts, which actively contribute to the functioning and evolutionary development of hydroecosystems. The role of lakes has become increasingly important, as they remain essential for the preservation of freshwater resources despite the ongoing anthropogenic pressures. Lakes are often the core of specially protected natural areas, including national parks, nature reserves, and various levels of conservation areas.

Results

Natural resource potential is the total of natural resources that are available for use in current economic activities, in accordance with the principles of maintaining ecological sustainability and efficient use of the environment (Kabdrakhmanova, et al., 2019; Salikhov, et al., 2025). The integrity of the lake basin is considered as the main part of the lake geosystem, which unites natural water and territorial systems interconnected through economic and management activities. The natural resource potential of these geosystems consists of the natural resources of the developed lakes and the surrounding areas in the long term. For geoecological assessment of the natural resource potential of lake geosystems, it is recommended to use administrative-territorial units. To assess the value of each resource indicator, an

index value of the resource is calculated relative to the average value for the region (it is suggested to consider administrative areas, physiogeographical and landscape provinces, and large river basins).

The geoecological assessment of the natural-resource potential of the lake geosystem of Akmola region is based on the use of lake resources in the region's economic activities and the determination of the relationship between the resources of the lakes and the surrounding areas. For the assessment, the main types of resources that fully characterize the natural-resource potential of the lake geosystem are selected (Annual Bulletin..., 2023; National Atlas of Kazakhstan, 2004; State Climate Cadastre, 2025). The proposed structure of the indicators is shown in Table 1.

Territorial resources describe the size and structure of the lake geosystem. The area of lakes, as well as the land area near the lake, are considered as components of this resource.

Table 1. Indicators of Geoecological Assessment of Natural Resources of the Lake Ecosystem

Resources	Index
Territorial Resources	Lakes area (ha)
	Land area (ha)
Water Resources	Water volume in lakes (million m³)
	Groundwater
	River discharge volume (million liters)
Mineral Resources	Gold balance reserve (thousand tons)
	Iron-manganese balance reserve (thousand tons)
	Diamond balance reserve (thousand tons)
Biological Resources	Seasonal biomass of phytoplankton (mg/dm³)
	Seasonal biomass of zooplankton (mg/dm³)
	Fish productivity (kg/ha)

The area of lakes defines the water collection potential of lake ecosystems and outlines the possibilities for water management, biodiversity conservation, and recreational purposes. The land area, in turn, defines the ecological condition of the lands around the lake, as well as the interaction between natural and economic entities in these areas.

The index (I_i) of the i-resource of the lake geosystem within the administrative district boundaries is calculated using the following formula (1.1):

$$I_i = \frac{x_i}{x_n} \quad (1.1)$$

I_i – esource type index,

x_i – indicator representing the volume of the i-resource in the region,

x_n – average volume of the i-resource in the region.

The average volume of the i-resource (x_n) in the region can be calculated using the formula (1.2):

$$x_n = \frac{\sum_{i=1}^{n} x_i}{n} \quad (1.2)$$

x_n – average volume of the i-resource in the region,
x_i – indicator representing the volume of the i-resource in the region,
n – number of districts within the geosystem.

The index (I_v) describing the resource volume of the i-resource in the lake geosystem is calculated using the following formula (1.3):

$$\overline{I_v = \sum_{i=1}^{n} I_i} \quad (1.3)$$

I_v – index of the resource type volume,
$\overline{I_i}$ – index of the i-resource volume,
n – number of resource indicators.

For example, the index of the lakes area (ha) resource of the lake geosystem in the Akmola region can be calculated as follows:

$$x_n = \frac{327768{,}63}{20} = 16388{,}43$$

Thus, the indexes of each resource type are calculated for all districts. The results of calculating the index for the lakes area (ha) resource of the lake geosystem in the Akmola region are shown in the table and figures below (Table 2, Figures 1).

Table 2. Resource Index of Lakes Area (ha) in the Akmola Region Lake Geosystem

№	Name of the district	Lake area in the district, ha, $\underline{x_{lakearea}}$	Lake Area Resource Index, ha, $\underline{I_{lakearea}}$
1	Kosshe	0.00	0.00
2	Esil	8,20	0,001
3	Zhaksy	7,20	0,001
4	Zharkaiyn	76,50	0,005
5	Zerendi	160,40	0,01
6	Egindykol	174,80	0,011
7	Ereymentau	261,20	0,016
8	Kokshetau	1486,90	0,091
9	Sandyktau	1544,70	0,094
10	Stepnogorsk	2425,83	0,148
11	Bulandy	4299,40	0,262
12	Shortandy	4562,50	0,278
13	Atbasar	8106,70	0,495
14	Astrakhan	9310,60	0,568
15	Arshaly	15677,9	0,957

16	Burabay	17837,10	1,088
17	Akkol	17870,30	1,09
18	Tselinograd	20660,70	1,261
19	Birjan Sal	22292,60	1,36
20	Korgalzhyn	201005,10	12,265
Total area of all lakes in the Lake Ecosystem of the Akmola Region		327768,63	
Average regional size of lake resource reserves, x_n		16388,43	
Index reflecting the total lake area resource reserve (ha), $I_{lakearea}$		20,00	

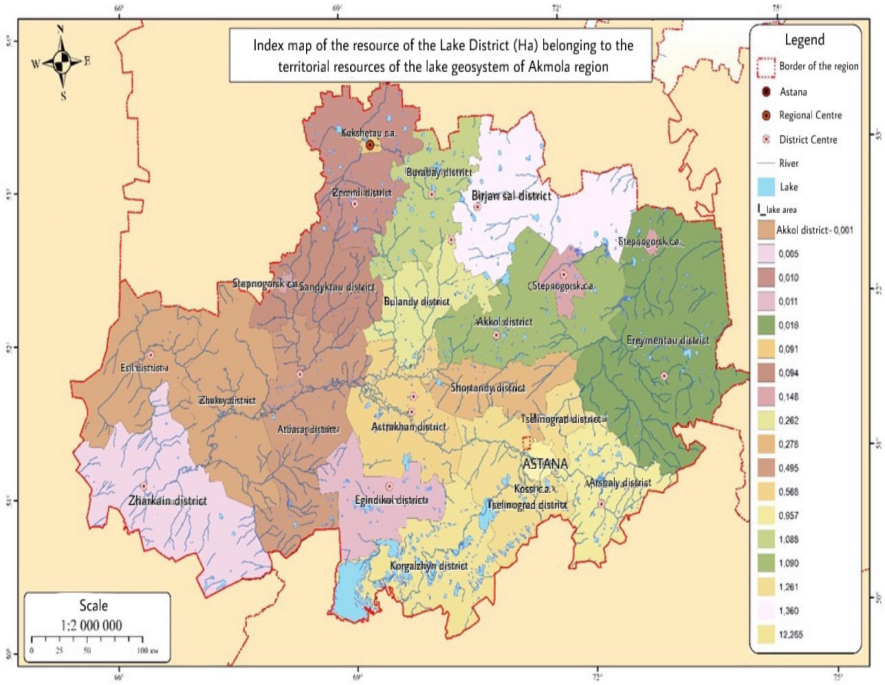

Figure 1. Map of the resource index of the lake district area (ha) related to the territorial resources of the Lake Ecosystem of the Akmola Region

The calculation of the land area resource index (ha), related to the territorial resources of the lake ecosystem of the Akmola region, is carried out as follows:

$$I_{\text{A.}land} = \frac{x_{\text{A.}land}}{x_n} = \frac{931473,89}{729965,59} = 1,276$$

The results of the calculation of the land area resource index (ha), related to the territorial resources of the lake ecosystem of the Akmola region, are presented in the map (Figures 2).

Water resources are one of the main components of the lake geosystem and

consist of the volume of water, groundwater volume, and river runoff. The volume of water in lakes determines the water supply level in the region, the ecological state of water bodies, and their potential for use in economic activities.

The level of groundwater affects the water balance in lakes, allowing local residents to access clean water. The volume of river runoff helps maintain a stable water level in lakes and supports the management of water resources.

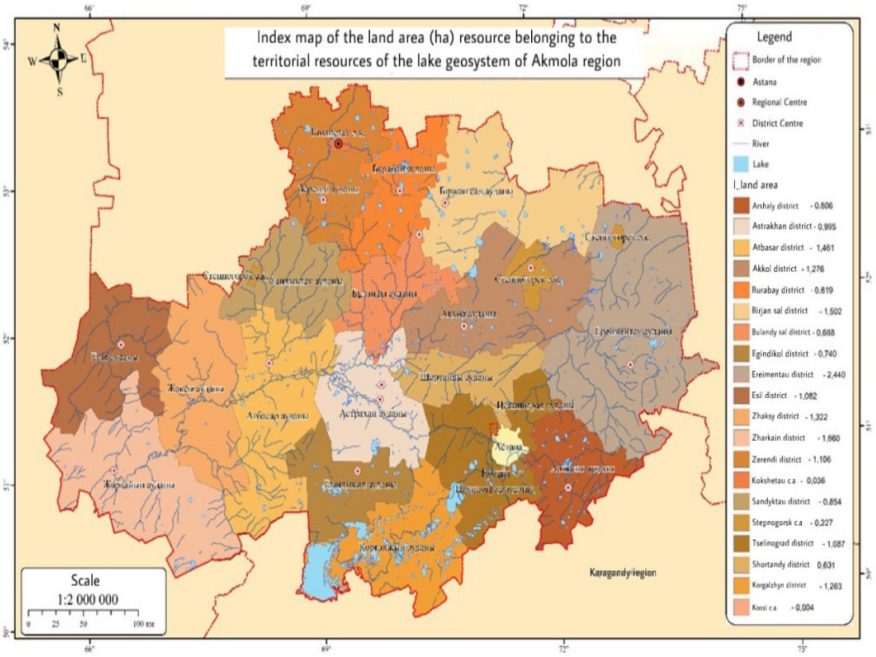

Figure 2. Map of the resource index of the land area (ha) belonging to the territorial resources of the lake geosystem of Akmola region

The calculation of the resource index for the volume of water in lakes (million m^3), related to the water resources of the lake geosystem of Akmola region, is as follows (1.4):

$$I_{C_V.} = \frac{x_{C_V.}}{x_n} \tag{1.4}$$

The results of the calculation of the water resources index (million m^3) in lakes belonging to the water resources of the lake geosystem of Akmola region are shown in the picture below (Figure 3).

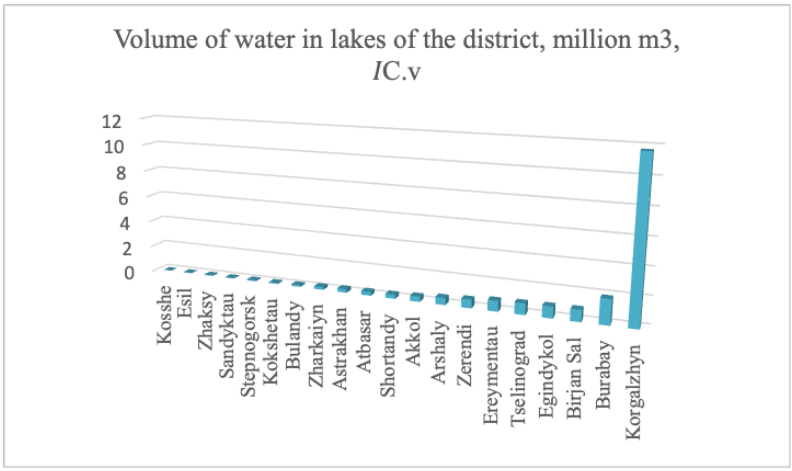

Figure 3. Water Volume Resource Index in Lakes Relating to the Water Resources of the Lake Ecosystem of the Akmola Region (million m³)

Balance reserves of groundwater related to the water resources of the lake ecosystems of the Akmola region (thousand m³/day), the resource index calculation will look like this (1.5):

$$I_{Cgroundwater} = \frac{\left(\frac{x_{AKM.reg.}}{\frac{x_{KZ}}{a}}\right)}{n} \quad (1.5)$$

$I_{Cgroundwater}$ - Balance reserves of groundwater related to the resources of the lake ecosystem (thousand m³/day),

$x_{AKM.reg.}$ - Size of groundwater balance reserves in the Akmola region,

x_{KZ} - Volume of groundwater balance reserves in Kazakhstan,

a - Number of regions in the republic,

n - Total number of districts in the Akmola region.

The values of groundwater balance reserves related to the water resources of the lake ecosystems of the Akmola region are presented in Table 3.

Table 3. Balance reserves of groundwater related to the water resources of the lake ecosystems of the Akmola region (thousand m³/day)

Indicator	Mark	Value
Groundwater balance reserves in Akmola region	$x_{AKM.reg.}$	349,88
Groundwater balance reserves in Kazakhstan	x_{KZ}	43383,5
Number of regions in Kazakhstan	a	20.00
Total number of districts in Akmola region	n	20.00

$$I_{Cgroundwater} = \frac{\left(\frac{349,88}{\frac{43383,5}{20}}\right)}{20} = 0,008$$

- Note: This value is the same average index for all regions.

Balance reserves of groundwater related to the water resources of the lake ecosystems of the Akmola region (m³/day), the index reflecting the overall resource reserve ($I_{v_{groundwater}}$) is equal to 0.008.

$$I_{v_{groundwater}} = 0,008$$

Calculation of the resource index for the river runoff volume (million liters) related to the water resources of the lake ecosystems of the Akmola region:

$$I_{Cr.r.v.} = \frac{x_{Cr.r.v.}}{x_n} = \left(\frac{2200}{\frac{156164}{20}}\right) \Big/ 20 = \left(\frac{2200}{7808,2}\right) /20 = \frac{0,28}{20} = 0,014$$

- Note: This value is the same average index for all districts in the lake ecosystem.

The volume of river runoff related to the water resources of the lake ecosystems of the Akmola region (million liters), the index reflecting the overall resource reserve ($I_{v_{r.r.v.}}$) is equal to 0.28.

$$I_{v_{r.r.v.}} = 0,014$$

Mineral resources are an important part of the economic potential of the region. These resources include gold, iron-manganese reserves, and diamonds. The results of the calculation of the resource index of the balance fund (thousand tons) of gold related to the mineral resources of the lake ecosystems of the Akmola region are presented in the table below (Table 4).

Calculation of the resource index for the balance reserves of iron and manganese (thousand tons) related to the mineral resources of the lake ecosystems of the Akmola region:

$$I_{Fe,Mn} = \frac{x_{Fe,Mn}}{x_n} = \frac{37,2}{36,561} = 1,017$$

The results of the calculation of the resource index for the balance reserves of iron and manganese (thousand tons), related to the mineral resources of the Tengiz-Korgalzhyn Lake Ecosystem, are presented in the table below (Table 4).

Biological resources characterize the ecological and biological potential of the lake ecosystems. These include the biomass of phytoplankton and zooplankton, as well as fish productivity.

Seasonal biomass of phytoplankton reflects the main biological characteristics of the lake and influences the ecological state of the ecosystem.

Zooplankton, in turn, serves as food for fish, helping to maintain the biological productivity of the lake.

Fish productivity characterizes the economic value of the lake ecosystem, allows for the development of fisheries, and provides food for the local population.

Calculation of the resource index for the seasonal biomass (mg/dm³) of phytoplankton in the plant world, related to the biological resources of the lake ecosystems of the Akmola region:

$$I_{phytoplankton} = \frac{x_{phytoplankton}}{x_n} = \frac{3,1}{1151,7} = 0,003$$

Table 4. Resource index of the balance reserves of iron-manganese (thousand tons) related to the mineral resources of the lake ecosystems of the Akmola region

№	Name of the district	Balance Reserves of Iron-Manganese (thousand tons), $x_{Fe,Mn}$	Resource Index of Iron-Manganese Reserves, $I_{Fe,Mn}$
1	Esil, Tasoba	7,82	0,214
2	Zerenda, Kumdykol	10,2	0,279
3	Birjan Sal, Athanasor	37,2	1,017
4	Zhaksy, Aybas	676	18,49
Total balance reserves of iron and manganese in all districts of the Lake Ecosystem of the Akmola region		731,22	
Average regional size of iron-manganese reserves.., x_n		36,561	
The index reflecting the overall reserve of iron-manganese resource reserves (thousand tons) related to the mineral resources of the Lake Ecosystem of the Akmola region: I_(Fe, Mn), $I_{Fe,Mn}$		20,01	

The results of the calculation of the resource index for the seasonal biomass (mg/dm³) of phytoplankton in the plant world, related to the biological resources of the lake ecosystems of the Akmola region, are presented in the table below (Table 5).

Table 5. Resource index of the seasonal biomass (mg/dm³) of phytoplankton in the plant world, related to the biological resources of the lake ecosystems of the Akmola region

№	Name of the district	Area of Lakes in District (ha), x_{phyto}	Resource Index of Lakes (ha), I_{phyto}
	Korgalzhyn	3,1	5,1

	Zerendi	9,663	16,105
Total seasonal biomass of phytoplankton in all districts of the Lake Ecosystem of the Akmola region		12,763	
Average regional seasonal biomass of phytoplankton.., x_n		0,6	
The index reflecting the overall reserve of the seasonal biomass resource (mg/dm³) of phytoplankton, related to the biological resources of the lake ecosystems of the Akmola region, $I_{phytoplankton}$		21,205	

Calculation of the resource index for the seasonal biomass of zooplankton (mg/dm³) in the animal world, related to the biological resources of the lake ecosystems of the Akmola region:

$$I_{zooplankton} = \frac{x_{zooplankton}}{x_n}$$

The results of calculating the resource index of the seasonal biomass of zooplankton (mg/dm³) as part of the animal world belonging to the biological resources of the Akmola region's lake geosystem are shown in the table below (Table 6).

Table 6. Resource index of the seasonal biomass of zooplankton (mg/dm³) in the animal world, related to the biological resources of the lake ecosystems of the Akmola region

№	Name of the district	Area of Lakes in District (ha), x_{phyto}	Resource Index of Lakes (ha), I_{phyto}
	Korgalzhyn	0,04	6,25
	Zerendi	0,089	13,90
The seasonal biomass of zooplankton in all districts of the Akmola Lake Ecosystem		0,129	
The average regional seasonal biomass of zooplankton. x_n		0,006	
The index reflecting the overall reserve of the seasonal biomass (mg/dm³) of zooplankton, related to the biological resources of the Akmola Lake Ecosystem, I_{300}		20,15	

The calculation of the productivity index (kg/ha) of fish resources in the animal world, related to the biological resources of the lake ecosystems of the Akmola region, will look as follows:

$$I_{fish.} = \frac{x_{fish.}}{x_n}$$

Integral Index of the Natural Resource Potential of the Lake Ecosystem (I_p) is calculated using the formula (1.6):

$$I_p = \sum_{i=1}^{n} I_v \quad (1.6)$$

I_p – the integral index of the natural resource potential of the lake ecosystem,

I_r – the resource size index,

n – the number of resource indicators.

The integral index of the natural resource potential of the Akmola Lake Ecosystem (I_p) is 90.4.

$$I_p = 20{,}0 + 20{,}01 + 20{,}01 + 20{,}0 + 20{,}26 + 20{,}01 + 21{,}20 + \\ + 20{,}15 + 18{,}82 = 180{,}46$$

Integral Index of the Natural Resource Potential of the District in the Lake Ecosystem (I_r) is calculated using the formula (1.7) (13):

$$I_r = \sum_{i=1}^{n} \quad I_i \tag{1.7}$$

I_r – the integral index of the natural resource potential of the district,

I_i – the resource type index,

n – the number of resource indicators.

The results of the calculations for the integral index of the natural resource potential of all districts (I_r) in the Akmola Lake Ecosystem are presented in the table below (Table 7).

Table 7. Integral Index of the Natural Resource Potential of All Districts in the Akmola Lake Ecosystem, (I_r)

Name of the district	Lake area (ha)	Land area (ha)	Water volume in lakes (million m³)	Groundwater balance reserves (thousand m³/day)	River flow volume (million liters)	Gold balance reserves (thousand tons) resource index	Iron-manganese balance reserves (thousand tons)	Diamond balance reserves (thousand tons)	Phytoplankton seasonal biomass (mg/dm³)	Zooplankton seasonal biomass (mg/dm³)	Fish productivity (kg/ha) resource	Integral index of the natural-resource potential of all areas in the lake geosystem
	$I_{lakearea}$	$I_{A.land}$	$I_{C_V.}$	$I_{Cgroundwater.}$	$I_{Cr.r.v.}$	I_{Au}	$I_{Fe,Mn}$	I_a	I_{phyto}	I_{zoo}	$I_{fish.}$	I_r
Kosshe	0.0	0,004	0.0	0,008	0,014	-	-	-	-	-	0.0	0,026
Kokshetau	0,091	0,036	0,087	0,008	0,014	-	-	-	-	-	0,009	0,245
Zhaksy	0,001	1,322	0,04	0,008	0,014	-	-	-	-	-	0,223	1,608
Sandyktau	0,094	0,854	0,049	0,008	0,014	-	-	-	-	-	0,844	1,863
Stepnogorsk	0,148	0,227	0,078	0,008	0,014	1,77	-	-	-	-	0,005	2,25

Shortandy	0,278	0,631	0,31	0,008	0,014	-	-	-	-	-	1,082	2,323
Astrakhan	0,568	0,995	0,271	0,008	0,014	-	-	-	-	-	0,605	2,461
Bulandy	0,262	0,688	0,132	0,008	0,014	-	-	-	-	-	1,36	2,464
Jar-qaiyn	0,005	1,66	0,217	0,008	0,014	-	-	0,279	-	-	0,527	2,71
Agindy-Kul	0,011	0,74	0,863	0,008	0,014	-	-	-	-	-	1,324	2,96
Atbasar	0,495	1,461	0,294	0,008	0,014	-	-	-	-	-	0,79	3,062
Arshaly	0,957	0,806	0,53	0,008	0,014	-	-	-	-	-	1,917	4,232
Ereymen Mountain	0,016	2,44	0,793	0,008	0,014	-	-	0,214	-	-	1,503	4,988
Borovoye	1,088	0,819	1,86	0,008	0,014	-	-	-	-	-	1,748	5,537
Birzhan-sal	1,36	1,502	0,874	0,008	0,014	-	-	1,017	-	-	1,137	5,912
Tselino grad	1,261	1,087	0,843	0,008	0,014	3,8	-	-	-	-	1,917	8,93
Akkol	1,09	1,276	0,395	0,008	0,014	5,06	-	-	-	-	1,183	9,026
Esil	0,001	1,082	0,026	0,008	0,014	-	-	18,49	-	-	0,267	19,888
Korgal-zhyn	12,265	1,263	11,698	0,008	0,014	-	-	-	5,1	6,25	1,917	38,515
Zerendi	0,01	1,106	0,641	0,008	0,014	9,37	20,26	-	16,105	13,9	1,642	63,056

The analysis shows that the Korgalzhyn and Zerenda districts are the richest in natural and biological resources. They are distinguished by large areas of land, water reserves, phytoplankton and zooplankton biomass, and fish productivity. Although other districts have fewer natural resources and water, each district has its unique characteristics.

Discussion. According to our research, the structural features of geosystems are determined by their origin, mineralization level, area and volume of water space, depth and ecological significance. The structural features of lakes, first of all, depend on their location and water balance. The Tengiz-Korgalzhyn geosystem, as the largest, is distinguished by highly mineralized salt lakes and is a habitat for birds of global importance. On the other hand, the Burabay and Ereimentau lakes are the most ecologically stable and have important hydrological significance as fresh water reserves. The geosystems of the northern plain, the central region and the Ishim depression are represented by plain water bodies, most of which are distinguished by an average level of mineralization and biological diversity.

In limnology, the focus is on studying natural processes in terrestrial water bodies. The spatial characteristics of lake geosystems are described by lakes and their surrounding areas (watershed, administrative districts). Lake geosystems within the boundaries of administrative districts were studied by scientists (Vlasov et al., 2012; Grishchenkova, 2012). In this regard, the area of lake geosystems is traditionally defined by the "lake-catchment" system, and this approach is adopted for studying the lakes of the Akmola region (Filonets, et al., 1974).

Conclusions

Based on the research conducted in this work, the following conclusions were drawn:

- The physical-geographical characteristics of the lake geosystem of Akmola region were identified and analyzed. This made it possible to determine the reserves of natural resource types within the districts, the laws of their territorial

differentiation, and the share of lake resources in the structure of natural resource potential.

- The morphometric features of the lake geosystem of Akmola region were identified and analyzed. Lakes were classified using a ranking method based on several parameters. The genesis of lake basins in the Akmola region was studied, and their origin was investigated. According to statistical analysis, the area of lakes in the region ranges from 0.002 km² to 1198 km². Most lakes (approximately 55.41%) have an area of less than 1 km², while lakes between 1.0 km² and 10.0 km² account for 38.04% of the total lake area. Lakes with an area of 10.1 to 60.0 km² constitute 6.39%.

- The natural resource potential of the lake geosystem was analyzed using the methodology for determining the natural resource potential of lake geosystems proposed by B.P. Vlasov, head of the Faculty of Geography at Belarusian State University.

- Using ArcGIS 10.8.1 software, physical, administrative, and geological maps of Akmola region at a scale of 1:2,000,000 were created, and maps for each index were developed to determine the natural resource potential of the lake geosystem.

The conclusions obtained from the research results can serve as the basis for developing programs for nature management and the effective use of the region's natural resources.

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