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ASSESSMENT OF THE RECREATIONAL POTENTIAL OF LAKES IN THE ESIL RIVER BASIN (WITHIN THE NORTH KAZAKHSTAN REGION)

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Abstract: Lakes represent primary physiographic features that attract significant tourist flows. Their presence, distribution, hydrological regimes, hydrochemical profiles, and other characteristics serve as critical determinants for the development of the tourism industry. The lacustrine systems of the North Kazakhstan Region function as natural biomes for semiaquatic and aquatic nesting and migratory birds; furthermore, they contain concentrated stocks of ichthyofauna, therapeutic muds, sapropels, and brine (rapa). To date, a comprehensive assessment of the recreational potential of these lakes for integration into the tourism sector has not been previously conducted. This comprehensive evaluation encompasses four primary dimensions: functional, sanitary-hygienic, aesthetic, and technological. The assessment was based on an integrated analysis of ten criteria: morphometric, hydrological, hydrochemical, and hydrobiological indicators, as well as climatic factors, aesthetics, transport accessibility, current economic utilization, and the sanitary-ecological state. Each criterion comprised a specific set of variables. In total, 20 distinct parameters were examined, including: linear dimensions, surface area, water mass volume, mean depth, mineralization (salinity), average water and air temperatures, wind velocity, among others. Thirty-three key lakes within the Esil River basin were selected as focal points for this study. A specialized database was developed, and geoinformation mapping was performed using the ArcGIS 10.8 software suite. The evaluation employed a point-based scoring system. During the scoring process, the weight of each criterion was accounted for through the application of a significance coefficient. As a result of the study, the recreational potential of the region's lakes was determined, followed by their classification and physiographic regionalization based on suitability for the tourism sector. The obtained results allowed us to identify 5 levels of the recreational potential of the lakes of the studied region: low, below average, medium, increased/good high, very high. Specific types of tourist and recreational activities were proposed for designated lake clusters.

Keywords: lake, recreational potential, North Kazakhstan Region, assessment, Esil River basin

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INTRODUCTION

In the modern scientific paradigm, the study of natural and recreational potential acquires strategic significance, forming the methodological basis for the development of the tourism industry. The transformation of tourism into a significant sector of the national economy and an instrument of sustainable development determines the growing need for comprehensive research aimed at assessing recreational potential (Wendt, 2020; Dmitriyev et al., 2025; Sagatbayev et al., 2025).

Lakes as multifunctional natural-territorial complexes possess significant recreational potential, determining their strategic importance for tourism development and sustainable regional development (Agybetova et al., 2023; Mukayev et al., 2020; Rakhimzhanova & Mussina, 2025). The recreational value of lake ecosystems is formed under the influence of a complex of natural and anthropogenic factors, creating unique conditions for the organization of various types of recreation, fishing, and health tourism (Akhmedenov, 2020; Valeyev et al., 2024; Tokpanov et al., 2021; Sagatbayev et al., 2019).

The hydrological characteristics of lakes, including temperature regime, duration of ice cover and swimming season, chemical composition of water and features of the coastline, act as key determinants of their recreational attractiveness (Sabri et al., 2025; Nazarova et al., 2019; Fomin et al., 2020). A review of international scientific publications led to the general conclusion about the need for a balanced approach combining the development of tourist infrastructure with the preservation of the natural environment and the introduction of sustainable methods of recreational stress management. The common denominator of all the work is the search for a balance between the economic development of lake territories and the ecological sustainability of their ecosystems (Gündüz, 2025; Rajkovic et al., 2025; Tessar, 2025). The natural and

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recreational potential favorable to tourism development in the North Kazakhstan region is determined by the high concentration of lakes, and the region ranks first in Kazakhstan in terms of the number of lakes. According to the state register, the number of lakes with an area of more than 10 hectares is 2,328 water bodies (Dmitriyev et al., 2018).

The numerous lakes of the region have limited economic application, mainly for fishing and in isolated cases for the use of therapeutic mud for balneological purposes (Kolomin, 2004; Dmitriyev et al., 2023).

To date, the level of use of lake systems does not meet the potential capabilities of water bodies and has not been fully studied. In this regard, the research and comprehensive assessment of the recreational potential of lakes in the North Kazakhstan region is an urgent task. The objective of the study was to conduct a comprehensive assessment of the recreational potential of the lakes within the North Kazakhstan Region situated in the Esil River basin.

Study Object

In the study, 33 lakes located in the Yesil River basin were selected. The schematic map of the location of the lakes under consideration is presented in Figure 1.

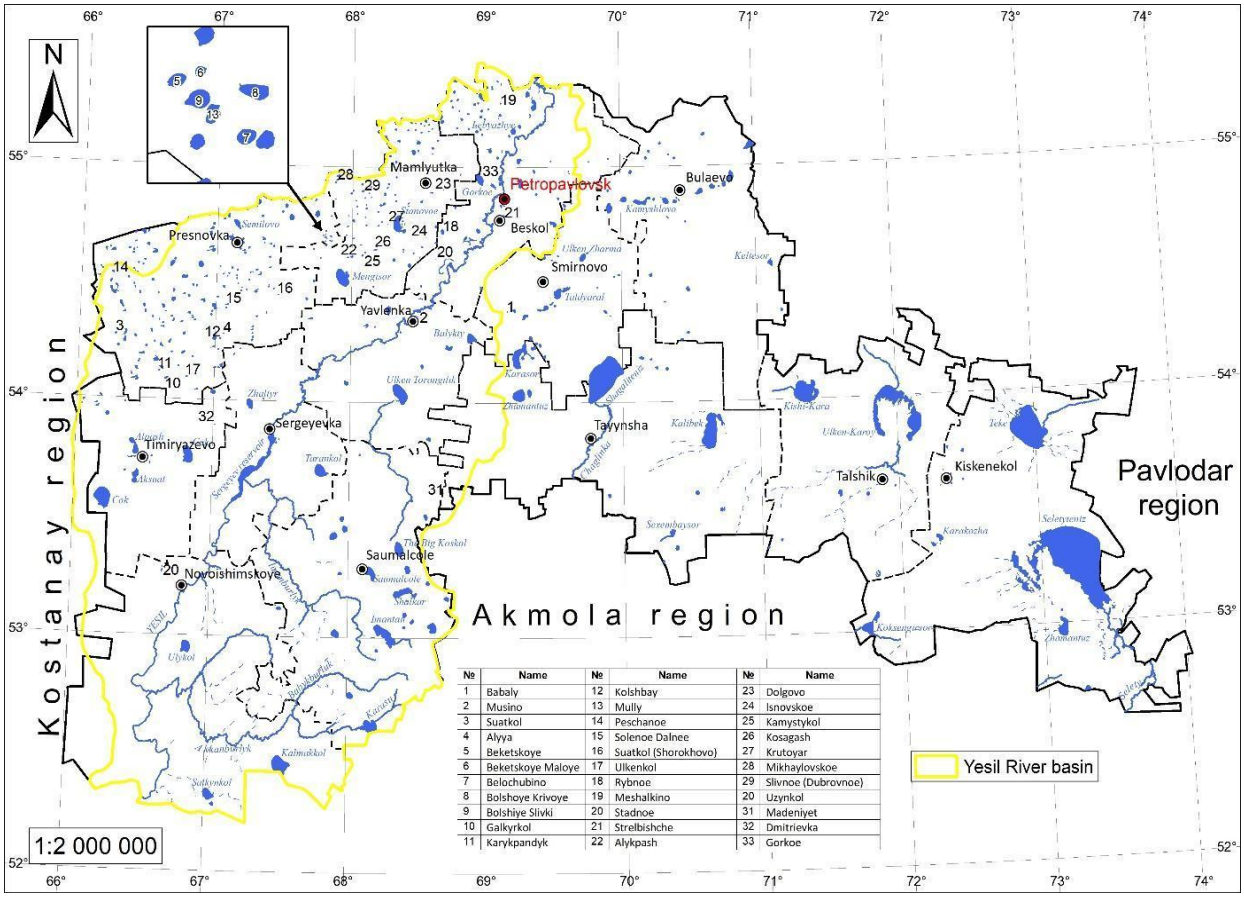

Figure 1. Schematic map of lakes locations (Source: developed by the authors)

The lakes are located within the boundaries of 9 administrative-territorial units of the North Kazakhstan Region (NKR): Akkaiynsky, G. Musrepov, Yesilsky, Zhambylsky, Kyzylzharsky, Mamlyutsky, Tayynshinsky, Timiryazevsky districts.

According to the genetic classification of lake basins, the lakes under consideration belong to the floodplain terraces of the Yesil River valley, floodplain, hollow-hilly-ridge types (Beletskaya et al., 2022). The source of nutrition for most lakes is the water mass coming from the catchment area during spring snowmelt. Underground waters play a small role in the hydrological regime of individual water bodies. The sizes of the lakes vary within significant limits from 3.1 ha Lake Madeniet (Tayynshinsky district) to 1,282 ha Lake Gorkoe (Kyzylzharsky district). For the most part, the lakes are small. By size, lakes can be grouped into small with an area not exceeding 10.0 ha; small, whose sizes vary within 10-50 ha (14 lakes - 43%); medium - 50-100 ha (12 lakes - 36%); large - 100-150 ha (4 lakes - 12%) and large - with an area exceeding 150 ha (3 lakes - 9%). The shape of the lakes is mainly oval. The bottom is flat with a gradual depression, usually covered with silty sediments. In some lakes, the bed is covered with organomineral accumulations (sapropel) (Kirillov et al., 2011; Dmitriyev et al., 2023). The slopes are low and gentle. The shores are slightly indented, accumulative.

Lakes are characterized by insignificant depth. Their maximum depth reaches 3 m - Lake Peschanoye (Zhambylsky district) and Lake Madeniet (Shunkyrkol) (Tayynshinsky district). The smallest depth indicator is noted on Lake Solenoe Dalnee (Zhambylsky district) - 0.55 m. The predominant part of lakes (15 or 45.5%) have depths from 1.0 to 2.0 m. Among the lakes under consideration, 15 (45.5%) have a depth from 2.1 to 3.0 m. The depth of 3 (9%) lakes does not exceed 1.0 m.

Due to the significant difference in the size and depth of lakes, the volume of their water mass varies from 0.095 million m³ Lake Madeniet (Shunkyrkol) (Tayynshinsky district) to 31.18 million m³ Lake Gorkoe (Kyzylzharsky district). According to this parameter, lakes are conditionally united into several groups: small, whose water mass volume does not exceed 1 million m³ (15 lakes - 45.5%); small - the volume of water mass is 1.1-2.1 million m³ (8 lakes - 24.2%); medium - the volume of water mass is equal to 2.1-4.0 million m³ (6 lakes - 18.3%), above average - 4.1-6.0 million m³ (3 lakes - 9%) and high-water - more than 6 million m³ (1 lake - 3%) (Dmitriyev et al., 2018). Most lakes are endorheic, and as a result, become final receivers of salts brought by surface runoff, groundwater and wind. The chemical composition of lake waters is characterized by great diversity and inconstancy of total mineralization and salt composition. Wide seasonal and multi-year fluctuations in salt concentration and their composition are associated with the extreme instability of the water regime of water bodies. The salinity of lakes sharply decreases during spring floods and increases by autumn, and in shallow lakes it also increases in winter due to ice formation. The mineralization of lake waters ranges from 141 mg/dm³ Lake Mully to 261,377 mg/dm³ Lake Solenoe Dalnee (Zhambylsky district). According to the degree of water salinity, the lakes under consideration can be divided into three groups: fresh - with mineralization up to 1 g/dm³, 20 lakes (61%) are assigned to this group; brackish - with mineralization from 1 to 25 g/dm³ - 12 lakes (36%), and hypersaline with mineralization more than 40 g/dm³ - 1 lake (3%). The indicator of water hardness of lakes differs significantly - from 2 meq./dm³ Alykpash (Mamlyutsky district) to 132.5 meq./dm³ Lake Solenoe Dalnee (Zhambylsky district). According to the degree of water hardness, lakes can be divided into 4 groups: with soft water - up to 4 meq/dm³, 9 lakes (27.3%) are assigned to this group; with water of medium hardness - from 4 to 8 meq/dm³ - 7 lakes (21.2%); with hard water - from 8 to 12 meq/dm³ - 9 lakes (27.3%); with very hard water - over 12 meq/dm³ - 8 lakes (24.2%). The value of oxidizability varies from 0.51 mg/dm³ Lake Belochubino to 35.6 mg/dm³ Lake Solenoe Dalnee (Zhambylsky district). For plain lakes, the values of permanganate oxidizability should not exceed 5-12 mg/dm³. For recreation, 15-30 mg/dm³ is allowed. In 13 (39%) lakes, this indicator exceeds the established norm, which indicates a high content of organic substances in the water.

The content of dissolved oxygen varies from 5.39 mg/dm³ Lake Stadnoe to 8.24 mg/dm³ Lake Gorkoe (Kyzylzharsky district). In general, the content of oxygen dissolved in water in lakes is favorable for most species of fish and invertebrates. The area of lake overgrowth differs significantly. The lowest rate of overgrowth is noted on Lake Gorkoe (Kyzylzharsky) - 3.2%, the highest on Lake Rybnoe (Zhambylsky district) - 98% (Dmitriyev et al., 2018; Kolomin, 2004).

Emergent and submerged plants play the main role in the overgrowth of water bodies. Among emergent plants, the leading place in the overgrowth of water bodies (in terms of area occupied and production of organic matter) belongs to common reed (*Phragmites australis*). In addition to reed, narrow-leaved cattail (*Typha angustifolia*) and lake rush (*Schoenoplectus lacustris*), flowering rush (*Butomus umbellatus*), common water-plantain (*Alisma plantago-aquatica*) and various species of sedge (*Carex* spp.) are of great importance in overgrowth.The degree of overgrowth of water bodies with aquatic vegetation is largely determined by the depth of the water body; the higher the depth, the lower the degree of overgrowth. This is explained by the biological characteristics of one or another species of aquatic vegetation. Thus, the most common type of rigid emergent vegetation - lake reed occupies areas with depths, as a rule, not exceeding 2.5 m. Among submerged plants, the leading place in lake overgrowth belongs to fennel pondweed (*Stuckenia pectinata*), shining pondweed (*Potamogeton lucens*), perfoliate pondweed (*Potamogeton perfoliatus*) and water milfoil (*Myriophyllum aquaticum*). The degree of overgrowth of water bodies with submerged vegetation changes not only by seasons of the year (its value reaches a maximum in July-August), but can differ greatly by years.

The hydrological regime of water bodies is generally favorable for the habitation of certain species of fish. The hydrochemical parameters of lakes are favorable for the habitation of certain species of fish, with the exception of Lake Solenoe Dalnee. The ichthyofauna is represented by 5 species from 2 families. Four species from the carp family (*Cyprinidae*) live in the lakes: silver crucian carp (*Carassius gibelio*), goldfish (*Carassius carassius*), roach (*Rutilus rutilus*) and tench (*Tinca tinca*), one species - Chinese sleeper (*Perccottus glenii*) from the sleeper family (*Odontobutidae*). The latter is non-commercial, acclimatized. The most widespread species is silver crucian carp. This species is native and has commercial significance. The wide distribution of this species in the lakes of the region is determined by the low requirement for the content of oxygen dissolved in water. There are no fish listed in the Red Book of Kazakhstan and the IUCN. Fish stocks in lakes vary within significant limits. The largest reserves (75.19 t) are noted in Lake Gorkoe (Kyzylzharsky district). The smallest volume of fish reserves among the lakes under consideration (0.531 t) was revealed in Lake Beketskoye (Zhambylsky district). In 4 lakes: Lake Stadnoe (Kyzylzharsky district), Lake Solenoe Dalnee (Zhambylsky district), Lake Kosagash (Mamlyutsky district), Lake Dmitrievka (Timiryazevsky district), not a single representative of ichthyofauna was caught, which indicates its absence in these water bodies.

Economic use and anthropogenic impact. The lakes under consideration are not included in the list of fishery water bodies and are not currently used for fishing and aquaculture purposes. A number of lakes are used for cattle watering (Lake Uzynkol, Musino, Isnovskoye, Mikhailovskoye, etc.). Many water bodies near settlements are used for water intake by filling special tanks (barrels) (Lake Mikhailovskoye, Isnovskoye, etc.) for watering gardens and household needs. Lake Gorkoe (Kyzylzharsky district) is part of the water supply facilities of Petropavlovsk city. It is a second-order storage pond for sewage treatment facilities of Limited Liability Partnership (LLP) (Kyzylzhar su LLP, 2025).

MATERIALS AND METHODS

Within the framework of the study, the recreational potential of lakes is considered as a set of natural, engineering-technical, ecological conditions and resources that are necessary to ensure the possibility of developing various types of recreational and tourist activities. Lakes as objects of recreation can be used for various types of recreation (beach-swimming,

fishing, walks, etc.). In this regard, the task of the study was not only to assess the recreational potential, but also to determine the most suitable type of recreation that can be recommended for the organization for the lakes under consideration.

To assess the recreational potential of North Kazakhstan Region lakes, a complex of criteria was determined, including morphometric, hydrological, hydrochemical, hydrobiological, sanitary-hygienic, aesthetic indicators and parameters.

A total of 20 evaluated parameters were selected: lake area, km²; average depth, m; volume of water mass, million m³; water mineralization, mg/dm³; water hardness, meq./dm³; oxidizability (permanganate), mg/dm³; dissolved oxygen in water, mg/dm³; overgrowth with emergent vegetation, %; fish resource reserves, t; diversity of ichthyofauna (species composition); character of the shore; character of the shallows (beach); approach to water; air temperature in summer during daytime, °C; air temperature in winter during daytime, °C; water temperature, °C; wind speed in summer and winter period, m/s; landscape diversity; transport accessibility, km; anthropogenic load. The assessment of the recreational potential of the region's lakes was carried out in 4 aspects: functional, sanitary-hygienic, aesthetic and technological. Lakes were evaluated from the standpoint of favorable conditions for the organization of recreational activities (presented in Figure 2).

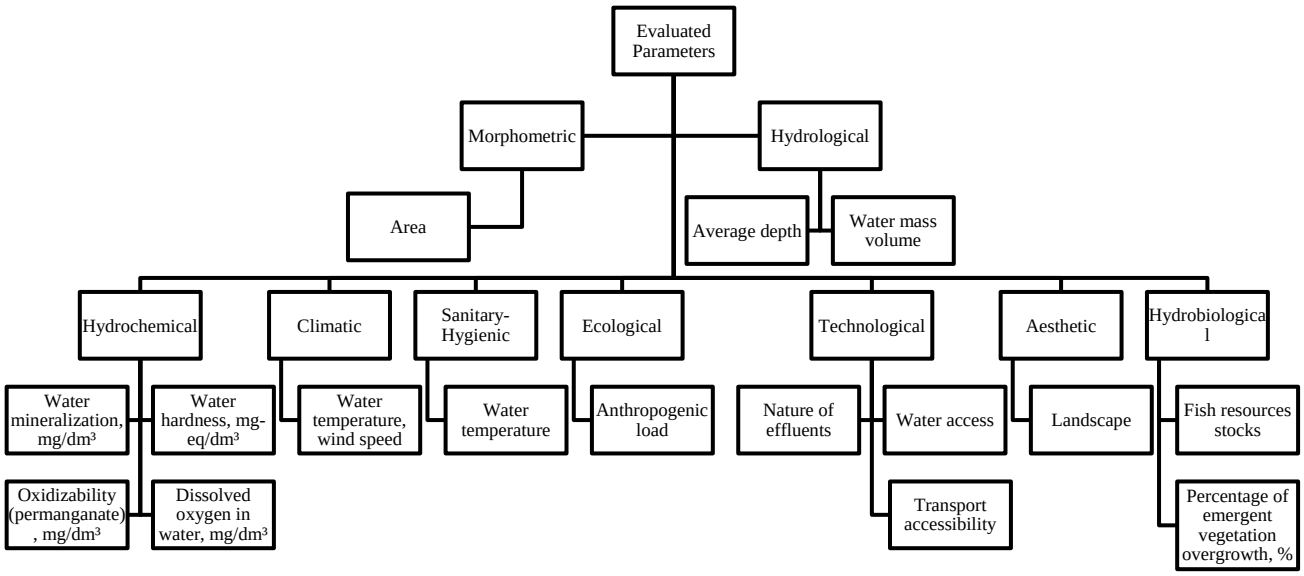

Figure 2. System of Evaluation Parameters and Indicators (Source: developed by the authors)

The necessary data for the assessment were obtained based on the analysis of available literary, cartographic materials, information provided by specialized institutions, as well as measurements and calculations carried out from satellite images, field research (2023-2025). The sources of initial data on morphometric, hydrological, hydrochemical, hydrobiological parameters of lakes were water body passports, hydrographic bulletins of the Branch of the Republican State Enterprise (RSE) "Kazhydromet" for the NKR, reports on the biological justification of lakes of the Communal State Institution (KSU) "Department of Natural Resources and Regulation of Nature Management of the Akimat of the NKR", Republican State Institution (RSU) "Yesil Basin Inspectorate for the Regulation of Use and Protection of Water Resources of the Committee on Water Resources of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan". The necessary climatic parameters were obtained based on the analysis of data from meteorological and climatic bulletins of the Branch of the RSE "Kazhydromet" for the North Kazakhstan Region for the period 2000-2024. Based on observations from meteorological stations and agricultural posts closest to the lakes, interpolation was used to calculate indicators of air temperature, wind speed for the warm and cold periods of the year (July, January) near the coastline and coastal zone of water bodies. Remote sensing data processing. To determine the surface temperature of water bodies, satellite images from the Landsat 8 satellite in the far infrared spectrum (Band 10) with wavelengths of 10.30-11.30 μm were used. Image processing consisted of the following stages:

1. The calculation of the spectral radiance of the upper atmospheric layers (Lλ) was performed in accordance with the official Landsat 8 radiometric calibration methodology published on the U.S. Geological Survey website (USGS, 2025):

$$L_\lambda = M_L \times Q_{cal} + A_L$$

where: L_λ - spectral radiance in channel 10, W/(m²·sr·μm); M_L - multiplicative coefficient (Radiance_Mult_Band_10); Q_{cal} - digital pixel value (DN) from Band 10 raster; A_L - additive coefficient (Radiance_Add_Band_10).

2. Calculation of brightness temperature of the upper atmosphere layers (USGS, 2025):

$$TB = K_2 / \ln(K_1/L_\lambda + 1)$$

where: TB - brightness temperature of the upper atmosphere layers, K; K_1, K_2 - thermal calibration constants; ln - natural logarithm; L_λ - spectral radiance in channel 10.

The implementation of this calculation was carried out in the Raster Calculator module of the ArcGIS software environment or similar spatial analysis tools. This formula allows converting digital pixel values from the raster (DN)

obtained from satellite images into a physically measurable quantity - radiance, expressed in watts per square meter per steradian per micrometer (presented in Figure 3). This is the first and necessary stage of thermal data calibration, without which it is impossible to conduct accurate temperature. The calculated brightness temperature (TB) is typically used as an intermediate metric for the subsequent determination of Land Surface Temperature. However, the obtained value does not reflect the physical properties of the underlying surface, particularly its emissivity. Therefore, to improve calculation accuracy and ensure physical interpretability, an additional correction accounting for the emissivity coefficient was applied.

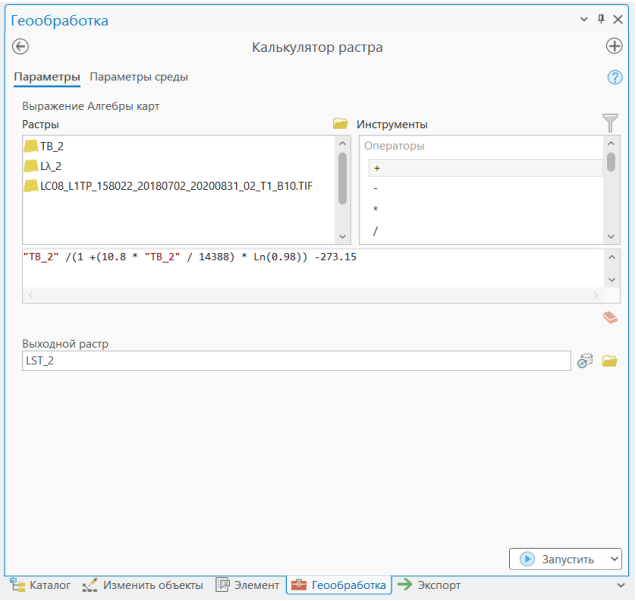

Figure 3. Example of a calculation in the Raster Calculator in ArcGIS Pro

3. Calculation of land surface temperature (LST):

At this stage, the formula for calculating land surface temperature (Land Surface Temperature, LST) was used, which allows converting brightness temperature into values close to the actual temperatures of land surface objects. This enabled a more accurate assessment of microclimatic conditions and facilitated a comparative analysis between different land cover types, including green spaces, water bodies, and residential areas (Le et al., 2015). To derive Land Surface Temperature (LST) from brightness temperature, a correction for surface emissivity is applied. The formula accounting for emissivity is presented below (Artis & Carnahan, 1982).

$$LST = \left(\frac{TB}{\left(1+\left(\lambda\times\frac{TB}{c_2}\right)\times ln\ln\left(\varepsilon\right)\right)}\right) - 273.15$$

where: LST - land surface temperature, °C; TB - brightness temperature of the upper atmosphere layers, K; λ = 10.8 μm - wavelength for Band 10 channel; c_2 = 14,388 μm·K - Planck's second constant; ε = 0.98 - surface emissivity coefficient; ln - natural logarithm (Artis et al., 1982; Kurolap et al., 2023).

Assessment methodology. The character of shallows and shores determine the ecological stability of the coastal strip and biodiversity of the coastal zone. Accessibility to water reflects the practical possibilities of using the lake for recreational purposes. Along with this, these characteristics ensure the safety, convenience and comfort of recreationists, the possibility of beach recreation. The above parameters were determined and evaluated during field research, as well as morphometric analysis of satellite images and photographs of water bodies. Landscape diversity is important for the visual perception of the lake and its surrounding landscape. This indicator was determined expertly during field research, as well as through visual perception and evaluation of a series of photographs of the water bodies under consideration.

Transport accessibility - the distance from the nearest paved road to the lake was calculated from satellite images (GoogleEarth) in the ArcGIS Pro program with clarification during field surveys. The evaluation parameters were collected and systematized in a single database. The latter was linked to the cartographic base. Geoinformation mapping of lakes was carried out using topographic maps with the involvement of electronic cartographic resources (GoogleEarth, Gis-lab.info, etc.). GIS mapping and spatial analysis was performed using the ArcGIS 10.8, ArcGIS Pro software package. To assess the level of recreational potential of the lakes, a composite (integrated) index (Ri) was applied, calculated using the Weighted Linear Combination (WLC) method, which is widely employed in multi-criteria spatial analysis (Malczewski, 1999; Eastman, 2012). The index was computed as the weighted average of the analyzed parameters, taking into account their relative significance. The calculation was performed using the following formula (USGS, 2025):

$$R_i = \sum k_i \sum a_i$$

where k_i - indicators of the i-th parameter, points; a_i - coefficient of importance of indicators k_i, unit fractions (weight) ($\sum a_i = 1$)

This approach allows simultaneously taking into account many factors affecting recreation comfort and obtaining comparable values for different water bodies. The assessment was carried out using a point system. Due to the fact that the selected parameters are characterized by significant heterogeneity, for the possibility of their comparison, absolute units of measurement were converted into relative ones (points). 5 points were assigned to the most favorable conditions for recreational use of lakes, 1 point - to unfavorable ones. Each evaluated indicator-parameter (i) was assigned a weight coefficient of significance (k_i), reflecting its contribution to the recreational use of lakes.

The methodology for determining the coefficient of significance included several steps. The significance of indicators was preliminarily evaluated expertly and ranked by 5 levels (very high, high, medium, low, etc.). Indicators were grouped into five blocks important for recreational use of lakes. Thus, indicators assigned to higher levels of significance received greater weights, less significant ones - smaller weights, while maintaining the overall consistency of the weight system. This ensured a certain hierarchy of evaluated parameters. The normalization of the initial indicators was carried out using the linear standardization method, whereby each parameter value was converted into a relative proportion within the overall set of analyzed indicators. This approach ensures the comparability of heterogeneous data (Malczewski, 1999). The calculation was performed using the following formula:

$$a_i = \frac{si}{\sum_{k=1}^{n} sk},$$

With this, $\sum a_i = 1$, which makes the weights comparable with each other. The higher the initial level of significance s_i, the greater the weight a_i, which means the stronger the influence of this indicator on the final recreational index.

The obtained values were normalized taking into account weight coefficients, and their sum became the resulting assessment of the recreational potential of lakes.

The following scale for assessing the recreational potential of lakes was adopted in the study (Table 1).

Table 1. Assessment of Recreational Potential of Lakes (Source: Developed by the authors, based on data from Kyzylzhar su LLP, 2025; USGS Landsat data USGS, 2025; RSE Kazhydromet, 2025)

Evaluation Criteria	Score Values					Weighting Coefficient
	5	4	3	2	1	
Area, km²	>150	150-100	100-50	50-10	<10.0	0.07
Average depth, m	>3.0	3.0-2.6	2.5-2.1	2.0-1.1	<1.0	0.09
Water mass volume, mln. m³	>6.0	6.0-4.1	4.0-2.1	2.0-1.1	<1.0	0.03
Water mineralization, mg/dm³	<1000.0	1000.1-1500.0	1500.1-2500.0	2500.1-4000.0	>4000.0	0.06
Water hardness, mg-eq./dm³	≤4.0	4.1-8.0	8.1-12.0	12.1-16.0	>16.0	0.03
Oxidizability (permanganate), mg/dm³	≤1.0	1.1-10.0	10.1-25.0	25.1-35.0	>35.0	0.03
Dissolved oxygen in water, mg/dm³	>8.0	8.0-7.1	7.0-6.1	6.0-5.1	≤5.0	0.06
Overgrowth percentage, %	≤5.0	5.1-10.0	10.1-25.0	25.0-50.0	>50.0	0.03
Fish resources stocks, t	>30.1	30.0-20.1	20.0-10.1	10.0-1.1	≤1.0	0.03
Air temperature in summer, °C	19.9	-	19.8	-	19.7	0.03
Air temperature in daytime during summer, °C	-15.9 and below	-	-16.0	-	-16.1 and below	0.02
Water temperature, °C	>25.1	25.0-24.1	24.0-23.6	23.5-23.1	<23.0	0.08
Wind speed during warm period, m/s	2.6	2.7	2.8	2.9	>3.0	0.02
Wind speed during cold period, m/s	2.6-2.8	2.9-3.1	3.2-3.4	3.5-3.7	3.8-4.0	0.02
Nature of shallow (beach)	Wide gentle shallow: bottom gradually deepens to 1.5-2 m from shore, further to 2.5-3 m, sandy-silty soil, with sandy-loamy soil, vegetation development is well-expressed.	Gentle shallow: shore depth 1.5-3 m with gradual deepening at 0.5-2 m from shore, sandy bottom with soil; participation of underwater vegetation in coastal strip, rocky sites, developped plant groupings, coastal vegetation is well-expressed.	Moderate shallow: shore depth increases from 0.5-2 m to 10-15 m from shore; stony-sandy bottom; vegetation varies; shore and underwater vegetation development; coastal plants are rare.	Steep shallow: shore depth reaches 5-10 m at 5-10 m from shore, stony or rocky bottom without vegetation; bank vegetation; water entry is polluted.	Shallow absent: shore overgrown, immediately >10 m depth; solid (boulders, rocks), without bank or aquatic vegetation, shoreline plants on adjacent areas.	0.05

Shore character	Low gentle shore (≤0.3-1 m height) with uniform natural vegetation cover (grasses, reed); sandy-silty substratum, bereg, shore relatively flat, minimally dissected.	Moderately gentle shore (≤1-1.5 m) with herbaceous vegetation; alternating grassy and reed sections interspersed with gallery-forest sections and reed areas.	Moderate elevation (1.3-2 m): alternating marshy and elevated shoreline sections; coastal vegetation varies; vegetation traces visible to eroded soils; shoreline vegetation is rare.	Steep shore (2-3 m): elevated and reinforced sections of the coastline, signs of erosion; overgrown with stone, gravel, shrubs (willow, birch); shore deeply dissected erosion.	Very steep or artificially reinforced shore (>3 m): denuded or covered with retaining walls or riprap structures; no or sparse vegetation.	0.05
Water access	Free access: equipped path, no dense vegetation, soft silty entrance (sand/silt), safe access for person and equipment.	Moderately free: there is grassy path or soft grassy area, minor areas of difficult access in water up to soft ground, accessible in most areas, small natural obstacles.	Difficult access: path present, shore overgrown (reeds, cattails, rushes), limited access, water entry requires overcoming natural obstacles.	Very difficult: dense marshy or culturally overgrown shore (marshes, bushes, dense undergrowth), possible access along shore, steep descent only from narrow paths.	Absent: shore strongly degraded or absent, shore impassable (silty marshes, floodland, bog), physical or legal barriers (restrictions); practically no access to water.	0.10
Multi-plan landscape	High: pronounced multi-plane relief – foreground (coastal-shore vegetation by promenade, near plains with coastal edge), middle plane (open water surface or lake, water elements), and background plane (distant trees, shrubs). Viewpoints: diverse, abundant colorful natural textures and contrasts.	Moderate: two-three planes for example, near lake and distant shore, or near shore and lake background, less variety, landscape elements present (shrubs, rare trees, poles).	Medium: one-two planes – open lake and shore or coastal shore with lake, possibly one dominant element (solitary landmark, prominent tree, shrub area).	Low: one plane only – monotonous flat or swampy area, single or two perspective plane elements (distinctive landmark, plains in visible surrounding areas).	Absent: absolutely flat landscape – single plane, swampy or artificially dominated elements; no distinctive elements, excessive agricultural use; lack of recreational spatial dominant elements.	0.04
Transport accessibility, km	<1.0	1.1-10.0	10.1-20.0	20.1-30.0	>30.1	0.07
Anthropogenic load	Absence of human impact signs: natural condition, no buildings, roads or dumps; water is clean, minimally affected by eutrophication.	Weak impact: insignificant anthropogenic changes or rare dispersed campsites - infrequent activities, sporadic parking, small-scale grazing or hay making, infrequent waste accumulation or footpath, trash, minor traces of livestock grazing.	Moderate impact: proximity of fields, pastures or villages; visible logging and waste dumpsites; moderate shoreline overgrowth and presence of noticeable trash accumulation, slight colored plant-related trash.	Strong impact: directly adjacent farms or land use or industrial facilities or roads; regular discharge (waste, wastewater), significant amounts of trash and traces of mass tourism, regulated canals, colored water.	Critical load: presence of heavy industrial or acute facilities directly adjacent to water; significant water surface pollution (waste, chemical, oil spills, discharge eutrophication), shore transformed into dump, ecosystem extremely polluted.	0.09

Table 2. Scale for assessing the recreational potential of North Kazakhstan Region lakes (Source: developed by the authors)

R Value	Level of Recreational Potential
< 2.0	Low
2.0-2.5	Below average
2.5-3.0	Medium
3.0-3.5	Increased/Good
> 3.5	High, Very high

RESULTS AND INTERPRETATION

The highest assessment score is for Lake Peschanoye - 3.52, the lowest for Lake Stadnoe - 2.38. The average indicator was 2.87 points. The result of the assessment of the recreational potential of lakes showed that most of the water bodies under consideration have a sufficiently high recreational potential, are favorable for various types of recreation. Peschanoye is the only lake assigned to the group with very high recreational potential. Good prospects for recreation development on this lake are associated with a favorable combination of conditions for organized recreation (morphometric, fish resource reserves, transport accessibility, etc.). This lake is popular among "wild" tourists. Increased recreational potential (>3.0) is

possessed by 8 lakes (24%) (Belochubino, Galkirkol, Karykpandyk, Meshalkino, Slivnoe-Dubrovnoe, Ulkenkol, Musino, Gorkoe). These lakes are characterized by favorable morphometric and climatic parameters, convenient approach to water, pronounced landscape attractiveness and moderate anthropogenic load, high prospects for recreation development.

The majority of lakes (15 or 46%) belong to the "medium" class of recreational potential (2.5-3.0), which indicates the presence of reserves for improving the quality of the recreational environment and developing infrastructure (Suatkol, Bolshie Slivki, Bolshoe Krivoe, Maloe Beketskoye, Mully, Kamystykol, etc.).

Below average (2.0-2.5) received an assessment of 6 (18%) lakes (Strelbishche, Isnovskoye, Dolgovo, Mikhailovskoye, Suatkol-Shorokhovo, Kolshbay). Low recreational potential (<2.0) is characterized by 3 lakes (9%) (Solenoe Dalnee, Alykpash, Stadnoe). The main factors that determined insufficiently favorable conditions for recreational activity are: increased water hardness, inconvenient approach to water, high overgrowth, anthropogenic load, etc. (Figure 4).

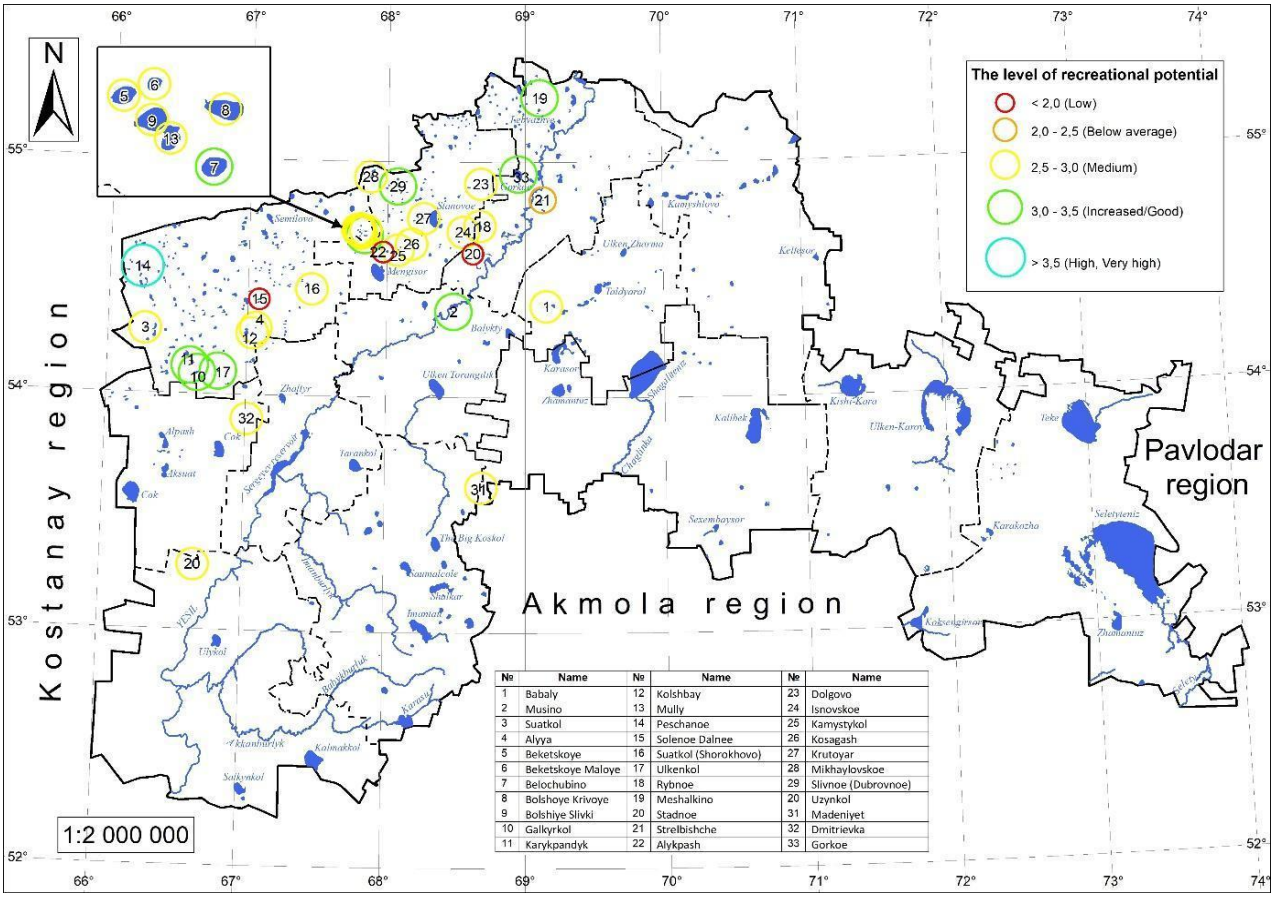

Figure 4. Map of assessment of recreational potential of North Kazakhstan Region lakes (Source: developed by the authors)

Recommended types of tourism activities

For lakes characterized by increased recreational potential, a list of recommended types of tourist and recreational activities and the most suitable season (period) for their organization and conduct were determined. For the summer period: beach-swimming, fishing, walking-excursion, boat riding, event tourism (Ivan Kupala, fisherman's day), ecological trails. For the winter period: ice fishing, walking-excursion, sledding, skating, skiing, winter swimming (walrus swimming), event tourism (Epiphany). According to hydrological parameters and fish reserves, the following can be included in the group of lakes for organizing recreation of local significance (fishing, swimming): Lake Musino, Lake Beketskoye, Lake Bolshie Slivki, Lake Galkirkol, Lake Karykpandyk, Lake Peschanoye, Lake Suatkol, Lake Suatkol (Shorokhovo), Lake Ulkenkol, Lake Meshalkino, Lake Karabul, Lake Dolgovo, Lake Isnovskoye, Lake Kosagash, Lake Mikhailovskoye, Lake Slivnoe (Dubrovnoe); Lake Stadnoe, Lake Dmitrievka (the last two lakes - swimming only).

For the organization of sport (amateur) fishing of local significance, Lake Madeniet (Shunkyrkol) can be recommended.

A number of lakes have relatively large fish reserves, which can contribute to the development of commercial tourism here. The following can be included in the group of fishery water bodies of local significance for commercial fishing: Lake Uzynkol, Lake Alya, Lake Beketskoye Maloe, Lake Belochubino, Lake Bolshoe Krivoe, Lake Kolshbay, Lake Strelbishche, Lake Alykpash, Lake Kamystykol and Lake Krutoyar. Lakes with increased mineralization can be used for local salt extraction, balneotherapy and treatment of skin diseases, joints (Lake Madeniet, Lake Kosagash, Lake Solenoe Dalnee). Small lakes in size can be used for recreation primarily by local residents living in nearby villages. Medium and large lakes have higher potential for the development of various types of health and sports recreation and are able to meet the demand for recreational services of residents not only of local residents, but from nearby districts and regions.

Lake Gorkoe should not be included in the list of water bodies for organizing recreational activities. This water body is part of the water supply and sewerage facilities of Petropavlovsk. It is a second-order storage pond for sewage treatment facilities of Limited Liability Partnership (LLP) "Kyzylzhar Su" Limiting factors. The following unfavorable (limiting) factors for the development of recreational activities on the lakes under consideration were identified: Most water bodies are located at an insignificant distance from settlements, experiencing anthropogenic impact. The catchments are heavily plowed, limited by the road network, which unfavorably affects the hydrological and hydrochemical regime.

Significant overgrowth of lake surfaces limits approach to water, acts as an unfavorable factor for organizing beach-swimming recreation, water walks, fishing, reduces visibility. On the other hand, aquatic plants protect coastal areas of lakes from wind well, reduce wave speed. In a number of the lakes under consideration, ichthyofauna was not detected (Lake Stadnoe, Lake Kosagash, Lake Dmitrievka), which excludes them from the list of water bodies for organizing such a type of recreation as fishing. A number of lakes are characterized by an unfavorable hydrological regime and cannot be recommended for use as recreation objects (Lake Babaly, Lake Mully, Lake Rybnoe). These water bodies can be used for recreation (fishing, swimming) only in case of restoration of a favorable hydrological regime.

CONCLUSION AND FINDINGS

An assessment of the recreational potential of lakes was carried out using a complex of criteria. Of the 33 lakes under consideration, 24 (73%) have sufficient potential for organizing recreational activities on them. On 6 lakes, anthropogenic impact and any types of nature management should be limited until their hydrological and other parameters improve. 3 lakes have low potential and are not recommended for inclusion in recreational nature management.

Based on the assessment results, measures for the development of recreation (tourism) on these lakes were proposed.

Recommendations

Infrastructure development: The reconstruction of existing and construction of new dirt roads and access roads to lakes is necessary. This work should be carried out by relevant services and regional administrations. Almost all water bodies need clearing of shores from reed and rush thickets. Hydrological restoration: On lakes: Lake Babaly, Lake Mully, Lake Rybnoe, restoration of the hydrological regime is required. This work should be carried out by relevant services.

Tourism infrastructure: For lakes characterized by sufficiently high recreational potential, it is necessary to: create safe swimming zones, equip convenient descents to water, install information stands, navigation. Organization of tourist infrastructure is required: light modular changing rooms, gazebos, canopies, benches, picnic areas, toilets, installation of trash bins, garbage tanks (containers) for waste, regular cleaning in the recreation zone. Ecological tourism: The development of ecological and educational tourism is promising: development of eco-trails around lakes with a description of natural features, observation of landscapes, local flora and fauna, creation of observation points with minimal interference with nature.

It is possible to include a number of lakes in tourist routes of the NKR, develop excursions "Lakes of the North Kazakhstan Region". Fishing tourism: On lakes that have potential for sport (amateur) fishing, it is necessary to create places for fishermen to stay, develop fishing routes. Monitoring and regulation: An important aspect of effective and ecologically balanced organization of recreational and tourist activities on lakes is its regulation taking into account the structure and features of their recreational potential, compliance of recreational infrastructure with the ecological capacity of aquatic and terrestrial natural-territorial complexes. A mandatory condition is periodic monitoring of overgrowth, the eutrophication process, oxygen regime of lakes, conducting periodic microbiological and toxicological studies. Educational use: Lakes with low recreational potential are inappropriate to consider as tourist objects of mass visitation. Possible use for ecological-educational purposes. Ecological-educational routes. School excursions on topics of hydrobiology, ecosystem processes, overgrowth of water bodies.

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