

ASSESSMENT OF RECREATIONAL SUITABILITY OF LAKE ALAKOL IN THE REPUBLIC OF KAZAKHSTAN ON HYDROLOGICAL INDICATORS

Rina AGYBETOVA 

L.N. Gumilyov Eurasian National University, Economic Faculty, Astana, Republic of Kazakhstan, e-mail: r.agybetova@gmail.com

Altynbek ZHAKUPOV 

L.N. Gumilyov Eurasian National University, Economic Faculty, Astana, Republic of Kazakhstan, e-mail: jakupov@gmail.com

Zharas BERDENOV* 

L.N. Gumilyov Eurasian National University, Faculty of Natural Sciences, Astana, Republic of Kazakhstan, e-mail: berdenov-z@mail.ru

Nurzhan ABISHOV 

International University of Tourism and Hospitality, Turkistan, Republic of Kazakhstan, e-mail: nurabish777@mail.ru

Alibek YLEMESOV 

Pavlodar Pedagogical University, Pavlodar, Republic of Kazakhstan, e-mail: alibek-ele@mail.ru

Azhar GIZZATZHANOVA 

L.N. Gumilyov Eurasian National University, Economic Faculty, Astana, Republic of Kazakhstan, e-mail: azhar-78@mail.ru

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Abstract: Kazakhstan has excellent nature and tourist resources, with their reasonable use, it is possible to increase profitability, study and evaluate the tourist potential of the regions, and determine their capabilities. Today, the number of visitors to Alakol lake as an object of domestic touristic destination interest has increased, one of the main factors of which is the favorable geographical location, the cross-border zone with China, and the significant impact of the lake on human health. It is necessary to study the basin of Lake Alakol in Urdzhar district of East Kazakhstan region and Alakol district of Almaty region. A functional assessment of the recreational use of lakes in the Alakol Lake basin was carried out according to a well-known methodology. Its essence is to determine the recreational potential based on an assessment of the possibility of developing various types of recreational activities. In order to increase the tourist and recreational potential of the Alakol lake Basin region, recommendations were made to repair the road system; develop cross-border tourism with China; monitor the environmental situation, organize landfills for solid and liquid household waste, and clean the beach, etc. It is possible to develop the Alakol resort area by providing high-quality infrastructure and finding ways to solve problems related to their development, and scientific research is needed to properly use the tourist and recreational potential.

Key words: Lake Alakol, geographical location, recreational resources, hydrological indicators, assessment of recreational suitability, favorable territories

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INTRODUCTION

Definitions of recreational activities that improve the rehabilitation and recovery of people, scientific, cultural, and cognitive development, methodological guidelines describing the natural conditions of the region, various approaches to the study of the dynamics of territorial recreational systems were published in the articles (Vedenin and Zorin, 1973; Dunets at el., 2020; Dmitriyev at el., 2021; Berdenov, 2021). In the concept of development of the tourism industry of the Republic of Kazakhstan until 2023, the issues of development of beach tourism are highlighted, the unique nature and tourist resources of the country have a special impact on tourists, allow them to improve their health and engage in various recreational activities. One of the unique Water Resources is included in the cluster «Pearl of Altai», the Urdzhar district of the Eastern region of Kazakhstan, and the Alakol lake basin in the Alakol district of the Almaty region (Mukayev at el., 2020; Dmitriyev at el., 2022). The lake basin is particularly popular among tourists, and today it has a huge potential for development, which should be developed and used correctly (On approval of the state program for the development of the tourism industry of the Republic of Kazakhstan for 2019-2025, 2019)**.

The region is surrounded in the north by the Tarbagatai Ridge, in the South by the Dzungarian (Zhetysu) Alatau, and in the East and South-East by the Barlyk ridge. Between the Barlyk ridge and the Zhetysu Alatau, there is a narrow mountain pass called the «Dzungarian gate». The area is 68,700 km², on the territory of Kazakhstan - 48,600 km² (the

* Corresponding author

rest is located on the border with China). 56% of the basin is a desert plain, and the following groups of lakes occupy the lower part: Alakol (2650 km²), Sasykkol (736 km²), Uyaly (120 km²), Zhalanashkol (38 km²) and 100 small lakes, covering an area of 0.5 to 600 hectares, formed a system of reeds and wetlands (Yaschenko, 2006).

The terrain changes from the middle mountains (Tarbagatai Ridge, Zhetysu Alatau) to the flat steppe (Alakol plot). V.P. Blagoveshchensky considered the recreational potential of 2 districts, 7 complexes, 30 sites in the Zhetysu Alatau (Blagoveshchensky, 2015), located in the Alakol lake basin, with an assessment of the distribution of areas terrain, vegetation cover, water resources, climate, aesthetic value, anthropogenic changes, transport accessibility, etc. Y.A. Tokpanov, based on the results of the study and assessment of the tourist and recreational potential of the Zhetysu Alatau, indicates the regions of Altynebel-Uygentas, Bayanzhurek, which are favorable for tourism and recreation (Tokpanov, 2021).

MATERIALS AND METHODS

There are more than 500 lakes in the Alakol lake basin. Of the 4 largest lakes in the region (Alakol, Sasykkol, Koshkarkol, Zhalanashkol), 95% of the total water area, 90% of the water reserves, and the rest are small lakes. Alakol Lake is the most suitable lake for the development of beach and resort recreation. Other reservoirs of the Alakol lake basin mentioned above are suitable for the development of beach, swimming, and sports recreation. From the point of view of the organization of recreation, sanitary and hygienic, microclimatic conditions are favorable, not swampy, but dry coastal lakes are valuable (Figure 1). Swampy areas corresponding to the Alakol lake basin are found on the eastern slopes of Sasykkol, on the northern slopes of Alakol along the Katynsu and Urjar rivers (Erdavletov and Aktymbayeva, 2012).

Based on the methods proposed by (Sevastyanova, 2008; Kolotova, 1999) we proposed criteria for a component-wise integral assessment of the recreational potential of landscapes. This methodology is based on a component-wise landscape assessment, which is composed of the main landscape components (topography, climate, water bodies, and soil and vegetation cover). The main assessment criterion is the degree of favorableness of landscape components and its functional suitability. There are various methods for assessing natural recreational resources. In our opinion, the most appropriate comprehensive recreational analysis of the territory is to assess the degree of favorability of certain parameters for the recreational use of landscapes. It is optimal to use a three-point system, since it allows you to compare the terrain, climate, water, and soil and vegetation assessment of the territory and obtain a comprehensive characteristic. When assessing the recreational potential of the landscape is the main factor that affects the development of tourism, as well as the aesthetics of the territory.

Landscape research focuses on holistic approaches, in which landscape is understood as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Burgi et al., 2017; Safarov, 2020; Niyazova, 2022). Landscape determines the aesthetic value-the suitability of space, and as a set of specific properties that determine the development potential

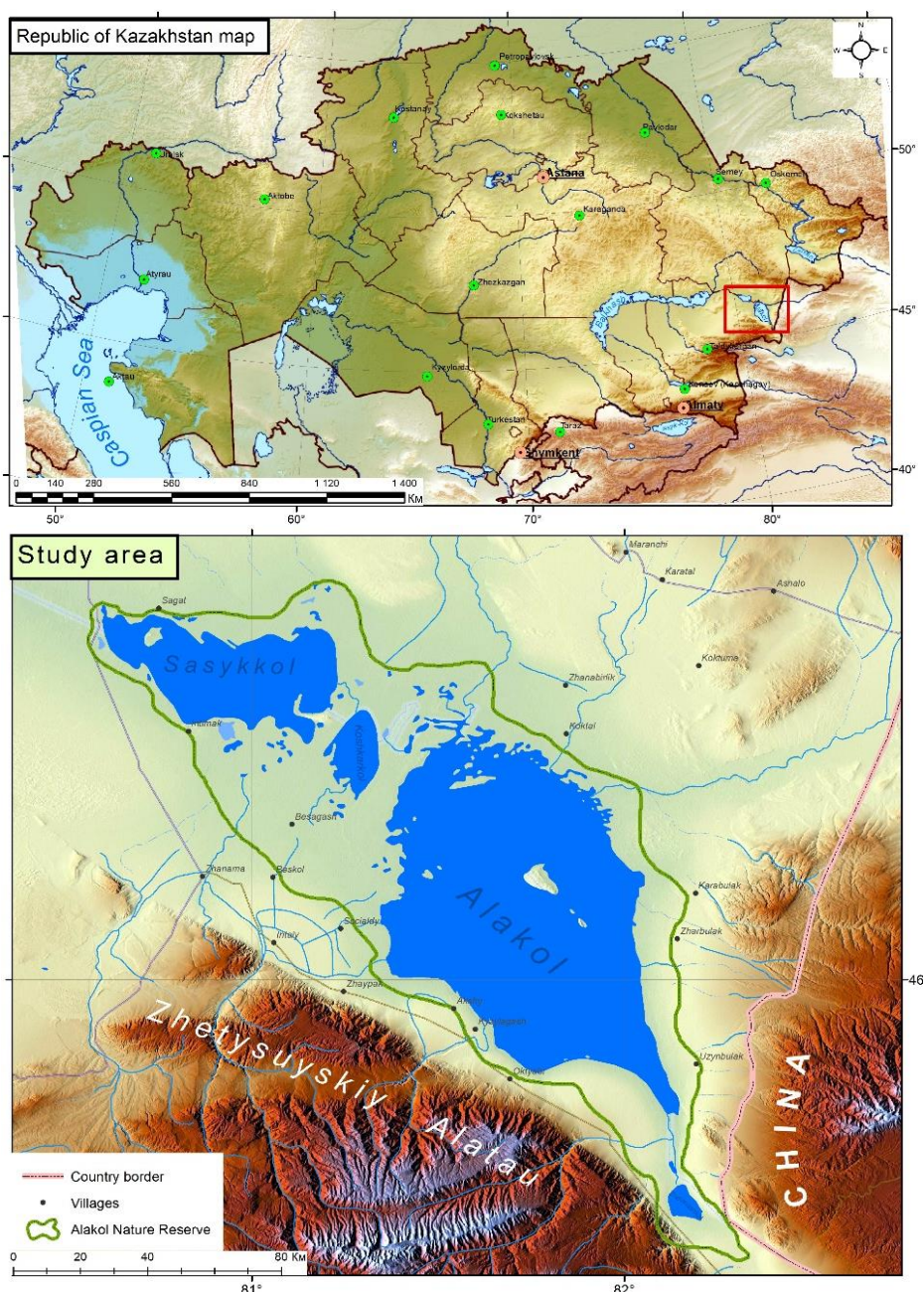


Figure 1. Map of the study area (Source: Author, created in the program ArcGIS.10)

of a particular type of recreational activity. From the point of view of landscape diversity, the number of landscapes forming elements (terrain, reservoirs, vegetation), their proportionality, mosaic contours, contrast borders are important. The most attractive recreational resources in the territory of the Alakol lake basin are concentrated in the southern part of the northern mountain slopes of the Zhetysu Alatau. Swampy areas are most common between the Sasykkol and Alakol lakes. Swampy areas are one of the factors hindering the development of hiking and mass tourism. Shallow waters with reeds are suitable for hunting, but not suitable for diving. The most favorable territories in the Zhetysu Alatau are located in the middle part of the mountains, and some in the lower and upper areas of the mountains, which cover 30.6% of the territory. The northern slope of the Zhetysu Alatau is characterized by a sufficient number of water objects and a large distribution of spruce forests (Figure 1).

These territories are suitable for all forms of active tourism. The most attractive ones are located in the valleys of the Tentek, Tastau, Koksuat rivers and on the forest-covered slopes of the Zhetysu Alatau range. Favorable territories include the southern slope of the Tarbagatai range, the hilly-Foothill slope of the entire mountain range, and Lake-alluvial plains. Low-altitude natural areas have less attractive landscapes. Semi-desert plains are landscapes with minimal aesthetic value. Relatively favorable territory includes areas of desert, semi-desert, and hilly sands located on the western side of the Alakol lake basin, covering 26% of the total area (Iskakova et al., 2013). First of all the recreational value of the territory is determined by the features of the most important natural factors for recreation: relief, climate, and water. The study of the natural recreational resources of the territory for the purposes of recreation and tourism development allows its zoning by taking into account the totality of certain types of resources (Erkkilä, 2006; Hall and Stoeffels, 2003; Gartner, 2006). To study the hydrological attractiveness of the natural waters of the Alakol Lake basin, the territory of the Alakol Reserve was chosen. The zoning of the territory according to the degree of attractiveness of natural waters (lakes Alakol, Sasykkol, Koshkarkol, Zhalanashkol) provides initial information about the resource possibilities of meeting the recreational needs of the population.

The Alakol Nature Reserve was established on April 21, 1998 on the territory of Almaty and East Kazakhstan regions (Urdzhar district) in order to preserve natural complexes, flora and fauna of the Tentek River, as well as a unique population of relict gulls and other colonial birds on the islands of Lake Alakol. Alakol State Reserve is a unique reserve of flora and fauna. Up to 5 million birds accumulate on the lake during seasonal migrations for recreation and feeding, in the protection of which the reserve also plays an important role. Negotiations are currently underway with the secretariat of the Ramsar Convention on the inclusion of the Alakol lake system in the list of wetlands of international importance as stopping and nesting sites for aquatic and shorebirds (Chigarkin, 2003). When assessing the tourist and recreational suitability of natural complexes for organizing fishing tourism in the Alakol lake basin, the degree of diversity of fish resources was taken into account. According to the analysis of the map, the lakes Alakol and Sasykkol are of great interest to fishermen. There are more than 7 species of fish (roach, perch, bream, carp, walleye, etc.). Thus, the Alakol lake basin has a variety of biological resources that create optimal conditions for the organization of hunting activities, educational, environmental, and scientific tourism. Assessment of the recreational suitability of the Alakol lake basin by hydrological indicators (Erkkilä, 2006). When assessing the tourist and recreational suitability of natural complexes for organizing fishing tourism in the basin of Lake Alakol, the degree of diversity of fish resources was taken into account. According to the analysis, lakes Alakol and Sasykkol have a great interest from fishermen. There are more than 7 species of fish (roach, perch, bream, carp, pike perch, etc.). Thus, the basin of Lake Alakol has a variety of biological resources that create optimal conditions for organizing hunting activities, educational, ecological, and scientific tourism. Assessment of the recreational suitability of the Lake Alakol basin by hydrological indicators. A point scale has been developed for the expert assessment of the attractiveness of the water resources of the Alakol basin (Table 1). The final data serve as the basis for drawing up an assessment scale, which, in turn, is the base for zoning the territory adjacent to Lake Alakol, according to the degree of tourist attraction of natural waters. Functional assessment of the recreational use of lakes in the territories basin can be carried out according to the methodology proposed by S. V. Akhmatov. Its essence is to determine the recreational potential based on an assessment of the possibility of developing various types of recreational activities (Table 1, 2) (Akhmatova, 2010).

It is possible to find out whether tourism can be developed in the region using water resources by conducting an assessment according to the formula (Bramwell, 2007):

$$\sum RFC = \sum_{types} + \sum_{QC} \quad (1) \quad \text{Where:}$$

$\sum RFC$ – is the total coefficient of recreational fitness;

\sum_{types} – total number of suitable recreational activities;

\sum_{QC} – coefficient of total quality of recreational activities.

Table 2. Types of recreational activities on water bodies, \sum_{types} (Akhmatova, 2010; Bramwell, 2007)

Recreational groups	Types of recreational activities
I. S – swimming, beach holidays	Swimming, etc.
II. B – types of boat holidays	Bs - sailing; Bo - rowing boat ride; Bm - motorboat ride;
III. F – fishing	Fb - fishing; Fs-fishing on the shore; Fi-ice fishing;
IV. H – hunting	Hw – waterfowl hunting
V. E – extreme sports	Courage-windsurfing; Ed-diving; Ek-kiting; Es-skateboarding

Table 2. Scale of assessment of the attractiveness of water resources, \sum_{QC} (Source: Author)
3 points – indicates the maximum degree of recreational conditions

Conditions	Mark	Tourism potential	Proposed territory
Very favorable conditions	3 points	Low-mountain landscapes, foothills, forests, developed infrastructure, mineral waters, therapeutic mud, resort resorts.	Lake Alakol, the eastern and western part of the lake
Favorable conditions	2 points	Steppe landscapes, developed coasts for swimming, mineral waters, therapeutic mud, fishing.	Northern part of Alakol Lake, Sasykkol lakes
Unfavorable conditions	1 point	Dry-steppe landscapes, lack of swimming places, sport fishing, hunting tourism	lake Zhalanashkol, lake Koshkarkol

RESULT AND DISCUSSION

The deep part of the basin is occupied by the main lake of the system- lake Alakol, a deep-water, non-flowing lake. Along the longitudinal axis of the basin, there are Koshkarkol and Sasykkol lakes in the North, and Zhalanashkol lakes in the South, which drain their excess water into Alakol. The surface water network in the area is formed by regularly flowing rivers and lakes. The rivers are formed along the mountain edges (Tarbagatai Ridge, Barlyk ridge, Zhetysu Alatau) and flow into lake Alakol. The density of the hydrographic network and the composition of water depend on the terrain and climatic conditions of the basin (Newsome et al., 2022; Tokpanov et al., 2021).

From the southern slope of the Tarbagatai range to the Alakol lake basin, such rivers as Tansyk, Ai, Karakol, Urjar, Katynsu, and Emil flow. The Urdzhar, Katynsu, and Emil rivers flow into Lake Alakol itself. The first three lakes do not reach Lake Sasykkol. The Tansyk River loses its water in large quantities in the plains, near Mount Kaldar, between Balkhash and Sasykkol. According to such conditions, the Ai River drains 30-40 kilometers from Sasykkol. The Karakol River is more watery than the Tansyk and Ai rivers, but it supplies its waters to Sasykkol only in the spring period, when there is a lot of water. In the summer period, the water of this river is used for full irrigation. In the basin of Lake Alakol, such large rivers as Tokty, Olenty, Yrgayty, Zhamanty, and Tentek flow from the Zhetysu Alatau. The Tokty and Olenty rivers lose their waters immediately after leaving the mountains. The Yrgayty river supplies its waters to the swamps between Alakol and Zhalanashkol. Only the Zhamanty river flows into lake Alakol. Optimal orographic conditions allow this (Erdavletov, 2010).

An important natural factor in the formation of recreational activities can be called the presence of warm mineral water sources, which are used for therapeutic and health-improving purposes. In the entire valley, 20 kilometers from lake Alakol, at a height of 579 m above sea level, there are healing mineral springs. All Arasan mineral waters are thermal (+42°C). It contains silicic acid (50-57.5 mg/l), chloride-sulfate, calcium-sodium (mineralization 1.7 g/L) and fluorine. These mineral waters are used as a bath, shower, and drinking water, which is used for the treatment of diseases of the organs of movement and support, nervous system, gastrointestinal tract, skin diseases (Cooper, 2006). The Alakol lake region is adjacent to the cities of Almaty, Semey, Taldykorgan and neighboring China with approximately 6 million population. If we provide good service in the region, the profitability indicator will increase and the indicator will increase every year, for example, the number of tourists resting on the lake in 2020 is 336 thousand people, and the number of accommodations is 370 units**. If we divide the region based on two regions, then the indicator for 2020 is shown in the following table 3.

Table 3. Number of visitors to the Alakol resort area in 2020**

Alakol resort area	Number of visits and internal visitors	Accommodations, units	Accommodation stops	Number of rooms, units	One-time capacity, bed	Recommended bed per day
East Kazakhstan region	113 092	171	42 551	4 353	12 115	99 044
Almaty region	225 206	199	225 206	3 873	10 852	285 422

**Note – Agency for Strategic planning and reforms of the Republic of Kazakhstan

The poor quality of accommodation facilities and the lack of 4*, 5* star hotels make it difficult to analyze the level of infrastructure and assess the quality of services provided. In the following years, the number of visitors to the Alakol resort area is increasing. For more than a decade, attention has been paid to the development of tourism in the region (Dunets, 2020; Kochurov, 2003; O zgeldinova et al., 2017). Currently, the construction of modern roads is underway. There is an airport in Usharal, and a railway service is established.

The water of Alakol lake, with the exception of estuarine areas of rivers, is brackish, very hard (19-32 mg-eq/l), and unsuitable for drinking. The pH value during the year ranges from 7.6-9.2. Water transparency increases from 0.6-0.8 m in the shallow northwestern part to 6 m or more in the central part of the reservoir (Petr, 1998).

The water mineralization and ionic composition of Alakol Lake are noticeably changing in the water area of the reservoir. The overall increase in mineralization occurs towards the center of the lake, the smallest value is observed in the northwestern part of the lake (near the mouth of the Urjar River), as well as in the estuaries of other tributaries. The Barlyk-Arasan underground mineral water deposit is located on the northwestern branch of the Barlyk ridge, on the right bank of the Arasan River, 16 km east of the village of Zharbulak, located on the eastern shore of the Alakol Lake.

The deposit is confined to the main Barlyk fault, traced along the right bank of the Sanarka River, where mineral waters come out of tectonic cracks. There are up to 13 warm springs concentrated along the gorge for 1.5 km (Mamilov, 2022). Their flow rates vary from a tenth to 0.34 l/s. The water temperature in various sources varies from 20 °C to 42 °C, and its mineralization ranges from 1.4 to 1.8 g/l. The water contains (mg/l): silicic acid (12-44), boric acid (from traces to 1.8), and bromine (up to 0.5), as well as radon (0.6-2.5 mg/l).

According to the results of hydrogeological work, the reserves of underground thermal mineral waters of the deposit were calculated and approved in the amount of 3.95 l/s (340 m³/day). Today, an important role in the healing process is played by natural factors (clean air, a peculiar landscape, steppe grasses), as well as balneological procedures and bathing in the bitterly salty lake Alakol. The favorable period is May to October. The popularity of the resort on Lake Alakol is growing. The water of the springs is similar in chemical composition and low radioactivity to the mineral waters of the Tskaltubo health resorts (Georgia). In the area adjacent to the sanatorium, there are 12 exits to the surface. The water temperature in the two main sources is 43 °C. Water gives a high effect both for external and internal use. Aquariums and sanatoriums on the shore of Lake Alakol have equipment for various procedures, including baths and shower installations. There are physiotherapy, massage, and gynecological rooms, as well as a therapeutic gym.

The total coefficient of recreational fitness of lake Alakol was calculated using Formula 1 as follows:

$$\sum RFC=(S)1+(Bs)1+(Bo)1+(Bm)1+(Fb)3+(Fs)2+(Fi)1+(Hw)1+(Ew)2+(Ed)1+(Annex)2+(Es)1 =12+25/3= 20.3.$$

That is, the coefficient of recreational suitability of lake Alakol ($\sum RFC$) is 20.3. If we open the formula, we will find a very good diving position (S3), a satisfactory sailing position (Bs1), a good rowing position (Bo2), a very good motorboat position (Bm3), a very good fishing position (Fb3), a satisfactory coastal fishing position (Fs1), a very good waterfowl hunting position (Hw3), and a good and satisfactory position for extreme sports (Ew)2, (Ek)2, (Ed)1, (Es)1.

Lake Sasykkol belongs to the Balkhash-Alakol basin and is located on the border of Almaty and East Kazakhstan regions, in the eastern part of the Balkhash-Alakol basin in southeastern Kazakhstan, at an altitude of 350 m above sea level.

Sasykkol is located northwest of Lake Alakol. Between these lakes, there is a small flowing lake – Koshkarkol. Lake Sasykkol is also flowing, fresh has a tectonic origin. The surface area of Sasykkol reaches 736 square kilometers (together with the islands – 747 km², length – 49.6 km, width – up to 20 km, average depth – 3.3 m, water volume – 2.43 billion cubic meters. The shores are low, indented by bays, and bordered by reed thickets. The lake is fed by several small rivers – Tentek, Karakol, Ai, and Urjar. Moreover, the Urjar River, which flows into the lake from the northwest, dries up in summer. Only the Zhenishkesu River flows from Sasykkol. At the end of July, the water temperature in the lake is 29 ° C. Water mineralization from 0.27 g/l to 2.16 g/kg, long-term - 0.38 g/l. The approximate reserves of dissolved salts in the lake are 925 thousand tons. By chemical composition, water belongs to the bicarbonate class. Various species of ducks, geese, loons, cormorants, pelicans, swans, gulls, herons, and sandpipers live in the coastal zone. Wild boars, foxes, and spotted cats are found in the reed thickets. Carp, pikeperch, marinka, perch, and other commercial fish inhabit the waters of Sasykkol. The muskrat is acclimatized. If we determine the coefficient of Lake Sasykkol:

$$\sum RFC = (S)1 + (Bs)1 + (Bo)3 + (Bm)2 + (Fb)3 + (Fs)2 + (Fi)3 + (Hw)3 + (Ew)1 + (Ed)1 + (Ek)1 + (Es)1 = 12 + 22/3 = 19.3$$

In the area of lake Sasykkol, there is a satisfactory condition for swimming (S1), sailing (Bs1), excellent rowing (Bo3), excellent motorboat (Bm2), excellent fishing (Fb3), excellent coastal fishing (Fs2), excellent waterfowl hunting (Hw3), and satisfactory conditions for extreme sports (Ew1, Ek1, Ed1, Es1).

Lake Zhalanashkol in translation from the Kazakh language means a naked lake. Height - 433 m above sea level. Near the lake are the settlement of the same name and the railway station. Balneological resort. The infrastructure is practically non-existent. Recreational fitness coefficient of Zhalanashkol lake:

$$\sum RFC = (S)3 + (Bs)1 + (Bo)2 + (Bm)1 + (Fb)2 + (Fs)2 + (Fi)1 + (Hw)2 + (Ew)1 + (Ed)1 + (Ek)1 + (Es)1 = 12 + 18/3 = 18$$

In the area of the Zhalanashkol lake there is a very good condition for swimming (S3), satisfactory sailing (Bs1), good rowing (Bo2), satisfactory motorboat (Bm1), excellent fishing (Fb2), good coastal fishing (Fs2), good waterfowl hunting (Hw2), and satisfactory conditions for extreme sports (Ew1, Ek1, Ed1, Es1).

Lake Koshkarkol (Uyaly) is a fresh lake in the south-east of Kazakhstan, in the Alakol basin, at an altitude of 350 m above sea level, is part of the Alakol group of lakes. The area with high filling is up to 120 km², length - 18.3 km, maximum width - 9.6 km, average depth - 4.1 m, maximum - 5.8 m, volume - 0.5 km³. The main feeding watercourse is the Zhenishkesu River (from Lake Sasykkol), a drain into Lake Alakol. Mineralization of water - 945 mg / l, composition - sulfate-chloride-magnesium. Recreational fitness coefficient of Koshkarkol lake:

$$\sum RFC = (S)1 + (Bs)1 + (Bo)2 + (Bm)1 + (Fb)1 + (Fs)1 + (Fi)1 + (Hw)1 + (Ew)1 + (Ed)1 + (Ek)1 + (Es)1 = 12 + 13/3 = 16.3$$

A lake with a low tourist and recreational potential has a total recreational fitness coefficient of less than 10, a lake with a good potential from 10 to 20, and a lake with a very good tourist potential of more than 20. The maximum indicator of the coefficient of total recreational fitness is 23. At the same time, excellent conditions for all types of recreational activities should be created (Goossen, 2006).

CONCLUSION

According to the coefficient of recreational suitability, the main recreational load falls on the beach of Lake Alakol (Koktuma, Kabanbai, Akshi). Alakol Beach has the most favorable conditions for the development of a health resort, beach economy, and many types of recreation and tourism. This is due to the favorable natural and climatic, economic, and geographical conditions. Tourism and recreation occupy an important place in the economy of Alakol.

To increase the tourist and recreational potential of the Alakol Lake Basin region, it is possible to propose the following measures: repair of the road system; opening of air routes to Usharal; development of cross-border tourism with China; monitoring the environmental situation, construction of a floodplain against coastal destruction, marking of beach lines; organization of landfills for solid and liquid household waste, cleaning; digitalization of the labor market and statistical indicators (Tanguay, 2013). The materials of the expedition studies conducted by the authors on the territory of the water objects of the studied area (lakes Alakol, Sasykkol, Koshkarkol, Zhalanashkol) allowed to determine the main criteria for the development of recreational water use:

1. For amateur fishing – a variety of commercial biota; an accessible approach from the shore to the water; the thickness of the freezing of water masses in winter.
2. For swimming and beach holidays - temperature indicators of the aquatic environment, sanitary and hygienic indicators, sand beach.
3. For kayaking tourism – the width of the water space, its depth, the presence of aquatic vegetation, the absence of structures on the water and other obstacles on the way, pleasing to the eye landscapes, accessible parking places.
4. For motor boating - extensive water spaces, sandy and gently sloping shore.
5. For amateur hunting of waterfowl – shallow rivers, swampy areas, the presence of thickets.

Lake water, with its exceptional purity, has very valuable balneological qualities, is the main factor attracting tourists to the region and can be the basis for the functioning of medical and preventive institutions of a wide profile with a year-round cycle of public services. Taking into account transport accessibility and infrastructure equipment, the southeastern

coast has good prospects for development today. It is ideal for swimming, as it has a gently sloping shore with a gradually increasing depth, which is important for the organization of beaches. This factor increases the attractiveness of the construction of recreation centers for family visitors.

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