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THE STUDY OF SALINE AND SODA LAKES OF KAZAKHSTAN (REVIEW)

Abstract. This article provides information about the degree of study of soda and salt lakes in Kazakhstan. Salt lakes are unique natural ecosystems that contain a significant amount of mineral salts. Soda lakes are considered a special type of such reservoirs.

Currently, the use of natural resources is inhibited due to poor knowledge of soda and salt lakes. Biomonitoring will allow us to assess the ecological state and solve some scientific and practical problems on topical issues of salt and soda lakes in Kazakhstan.

Keywords: environment, ecology, salt lakes, soda lakes, biodiversity.

Introduction. There are more than 48 thousand lakes on the territory of the Republic of Kazakhstan, and only 21 large ones, reaching an area of 100 km². Most of the lakes are concentrated in the North of Kazakhstan (about 45% of all lakes), in the Central and southern – 36%, in other regions there are only 19% of lakes [1].

The study of lakes located on the territory of Kazakhstan includes three stages. The first lasted until the early 90-ies of the XIX century. During this period, the lakes were considered only as a source of fishing, water transport, and salt fishing; facts about the physical properties of the lakes were collected. The second period covers the 90th year of the XIX century. At this time, the theoretical and methodological foundations of lake science were accumulated and approved. The third period lasts from the beginning of the XX century to the present. At this time, we began to consider other issues that were directly related to the problem of using new resources, a sufficient number of fresh water bodies, etc. Research was conducted in the interests of economic use of their natural resources.

However, most of the lakes are still not fully explored. This is due to the lack of research and the lack of reliable data, low efficiency in collecting and processing information, as well as analysis of the use of available lake resources.

Taking into account the tasks of the State water resources management program of Kazakhstan (decree Of the President of the Republic of Kazakhstan dated 04.04.2014 N 786), it is relevant to analyze the distribution and specify the estimates of quantitative and qualitative characteristics of lakes in Kazakhstan, whose resources can be used efficiently and effectively in various sectors of the state economy [2].

On the territory of Kazakhstan, most of the lakes (about 90% of the total number) have an area of no more than 1 km². Moreover, a significant part of them is occupied by so-called temporary lakes: in the spring, they are overflowing with water, and by autumn, they dry up and turn into litter and salt marshes. In recent years, there has been an increase in the tendency to instability of the area and regime of lakes, as well as the overall salinity and salt composition of waters. This is due to the variability of climatic conditions. The water and salt balances of lakes are directly related to zonal features [3, 4].

The main reason for the mineralization of lakes is the lack of runoff and high evaporation. Therefore, there are quite a lot of lakes with brackish and salty water on the flat territory of Kazakhstan. In the most arid areas, self-seeding lakes are found, which contain a significant amount of various salts.

Currently, the study of salt and soda lakes is given increased attention, since the unique chemical composition of water and the diversity of life gave reason to believe that such reservoirs existed at the early stages of the origin of the global ecosystem of the Earth, moreover, they serve as important natural resources with significant aesthetic, cultural, economic, recreational, scientific, environmental and environmental values [5].

Salt lakes are unique natural ecosystems that contain a significant amount of mineral salts. Soda lakes are considered a special type of such reservoirs. They are characterized by fractions of alkaline carbonates Na and K, which cause a consistently high pH level in these reservoirs. The ecosystems of the world's salt lakes are important natural resources that have significant aesthetic, cultural, economic, recreational, scientific, environmental and environmental value [6]. This is especially true for the unique accumulation of trace elements [7, 8] and biodiversity [9-11] of soda lakes and basins.

Soda lakes are a unique permanently haloalkaline system. Despite the harsh conditions, they are inhabited by abundant, mostly prokaryotic, microbial communities. Soda lakes differ greatly from other high-salt systems in terms of microbial richness and activity. The main physical and chemical features of the two dominant salts - NaCl determine the reason for this difference in neutral salt systems and sodium carbonates in soda lakes, which affect the amount of energy required for osmotic adaptation [12].

Soda and salt lakes are common around the globe, but are most commonly found in terrestrial biomes such as deserts and steppes.

Many studies on salt and soda lakes have been conducted at the microbiological level.

According to research by Russian scientists, Namsaraev B. B. and Barkhutova D. D., the distinctive characteristics of soda lakes is high salinity and extreme alkaline pH values. The main role in the production of organic matter in these ecosystems is played by cyanobacteria, which are the structural basis of the local population. Since many studies have traditionally relied on microscopy, identification has been hampered by the fact that many soda lakes contain poorly studied species that are unique to these relatively unusual habitats and in many cases considered endemic [13].

Scientists E. Y. Zarubina and D. A. Durnikin were engaged in taxonomic, ecological-biological and arealogical analysis of the flora of 18 salt lakes of the Kulundy plain (Russia), located in the South of Western Siberia. They proved that the degree of mineralization directly affects the composition and structure of the flora [14, 15].

In Russia, E. G. Rachenkova has been studying aquatic and coastal vegetation since 1995, which is one of the most important components of aquatic ecosystems, so its study is of great interest and has a significant practical significance. Aquatic and coastal plants act as a mechanical filter and participate in the detoxification of harmful substances of various chemical nature. It was found that aquatic and coastal plants are able to secrete phytoncides that affect the surrounding plant and animal organisms. It was also found that in thickets that are submerged in aquatic plants, the content of pathogenic bacteria is significantly lower than in open areas. With intensive overgrowth of reservoirs with higher plants, the amount of phytoplankton decreases sharply. Among higher aquatic and coastal aquatic plants, many species have a variety of practical significance as raw materials for the pulp and paper, medical, perfume industry, construction materials, fertilizers for fields, food for people and pet food [16-18].

Kazakhstan is located in the very center of Central Asia, and therefore, in addition to environmental problems associated with unstable weather conditions, it faces the problem of lack of access to the World's oceans. Previously, there was no comprehensive study of salt and soda lakes on the territory of Kazakhstan. For a long time, the practical significance of studying such lakes was limited to the study of their mineral content.

For many years, one of the authors of the article, Hungarian scientist Emil Boros, has been studying the internal salty surface waters of Eurasia on a large geographical scale [19, 20]. He also carried out a number of studies on the chemical composition and trophic state of small salt steppe lakes in Northern Kazakhstan, taking into account the potential consequences of anthropogenic disturbances. Water depth, temperature, pH, electrical conductivity, basic ions, total dissolved solids, total organic carbon, total nitrogen and phosphorus, nitrates, soluble reactive phosphorus, and chlorophyll a were measured. The

trophic state of these lakes in most cases exceeded the hypertrophic level. The increase in salinity causes changes in the chemical composition and affects the development of phytoplankton regardless of the size of the water surface, and anthropogenic interventions have slightly affected the trophic state of shallow salt lakes in this region of Kazakhstan [21].

However, including this kind of limited aspect of the study of soda and salt lakes at the present time does not limit all the possibilities of using such a wide range of their natural resources. For example, it can be mineral (various salts, zeolites, uranium, lithium, bromine, iodine, etc.), energy (conversion of thermal energy into electrical energy), biological (cultivation and extraction of individual algae *Spirulina*, *Dunaliella*, and one of the main forage aquacultures – crustacean *Artemia salina*) and recreational [22].

Kazakhstan has a variety of habitats that are also associated with a unique and diverse flora and fauna. They differ in location, properties, ecosystems, and other relevant factors. Each area is characterized by its own biodiversity, and currently the study of each system is in demand.

In the coastal areas of lakes, you can observe a greater variety of animals and plants. Higher aquatic plants, mollusks, represent benthic species diversity etc. Their number is directly proportional to the increase in depth increase.

In temperate climates, there is a certain pattern of vegetation distribution that depends on depth: *Carex sp.* it grows in the coastal zone and at a depth of no more than 8-12 cm, *Phragmites sp.* it occurs at a depth of up to 1 m, *Scirpus* – 2 m, *Nymphaea* – 2.5 m, *Potamogeton* – about 3 m [23]. Towards the center of the lake, the amount of plankton is noticeably reduced.

The unusual Geochemistry of soda lakes contributes to an increase in an impressive number of microorganisms of ecological and economic importance. Comprehensive studies of phytoplankton communities of cyanobacteria in fresh and soda lakes have shown that the type of reservoir has a significant impact on the species composition of this group of organisms. It was found that in fresh lakes, the species diversity of cyanobacteria is on average greater than in soda lakes, where filamentous forms of cyanobacteria predominate. The contribution of cyanobacteria to the production of organic matter is determined. It is shown that the development of cyanobacteria in the studied fresh and soda lakes depends on temperature, pH, and the content of sodium chloride and carbonate [24].

Soda lakes belong to extreme ecosystems where high salinity, high alkalinity and pH of water cause the development of alkalophilic microorganisms [25]. Due to the high pH of the environment, soda lakes are unique habitats of extremophilic fauna and flora, for example, some autochthonous microorganisms that are not found in other ecosystems [26]. This indicates the need and importance of studying the biodiversity of hypersalted and hyperalkaline habitats, mechanisms of adaptation of organisms to extreme environmental conditions [27].

The number of studies on soda and salt lakes, in comparison with other ecosystems, is very small. Therefore, biomonitoring will allow solving some scientific and practical problems on topical issues of salt and soda lakes of the Republic of Kazakhstan. Biomonitoring, in other words, studies of soda lakes, can allow scientists to look at soda lakes from the outside, understand the similarities and differences with other ecosystems, and analyze and predict the state of lakes in more depth.

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ҚАЗАҚСТАННЫҢ СОДАЛЫ ЖӘНЕ ТҰЗДЫ КӨЛДЕРІН ЗЕРТТЕУ (ШОЛУ)

Аннотация. Қазақстанның тұзды және содалы көлдерінің зерттелу дәрежесі туралы ақпарат берілген. Тұзды көлдер минералды тұздардың едәуір мөлшері байқалатын бірегей табиғи экожүйелерге жатады. Мұндай су қоймаларының ерекше түрі-сода көлдері болып келеді.

Қазіргі уақытта табиғи ресурстарды пайдалану сода мен тұзды көлдерді нашар білетіндіктен тежелуде. Биомониторинг жүргізу Қазақстанның тұзды және содалы көлдерінің өзекті мәселелері бойынша экологиялық жағдайын бағалауға және кейбір ғылыми және практикалық міндеттерді шешуге мүмкіндік береді.

Түйін сөздер: коршаған орта, экология, тұзды көлдер, содалы көлдер, биоалуантүрлілік.

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ИССЛЕДОВАНИЯ СОЛЕННЫХ И СОДОВЫХ ОЗЕР КАЗАХСТАНА (ОБЗОР)

Аннотация. Представлена информация о степени изученности содовых и соленых озер Казахстана. Солёные озёра относятся к уникальным природным экосистемам, в которых отмечается значительное количество минеральных солей. Особым видом таких водоёмов считаются содовые озёра.

В настоящее время из-за слабой изученности содовых и соленых озер тормозится использование естественных богатств. Проведение биомониторинга позволит дать оценку экологического состояния и решить некоторые научные и практические задачи по актуальным вопросам соленых и содовых озер Казахстана.

Ключевые слова: окружающая среда, экология, соленые озера, содовые озера, биоразнообразие.

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