Natural prerequisites and socio-economic factors for the integrated development of lakes as water bodies (on the example of the Republic of Buryatia, Russia)

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Abstract. The lakes of Buryatia have been studied to varying degrees and described in numerous scientific works by well-known limnologists, geographers and biologists of Russia. The formation of lakes, their composition and the organisms that inhabit them have been investigated. However, very few and sporadic studies have investigated the use of lakes for economic purposes. The article analyses the activities of fisheries, the use of Buryatia's widespread minerals such as sapropels and peat, and also assesses tourism as an economic activity with a high positive effect for the Republic of Buryatia as a whole.

1. Introduction
The Republic of Buryatia, covering an area of more than 350 thousand km², there are more than 30 thousand large, medium and small lakes, with a total area of 1,795 km². The most important of them is Lake Baikal, an outstanding universal value from the point of view of science, biodiversity and the history of the Earth’s evolution, a huge reserve of fresh water of high quality. Most of the lakes are small in size; there are 16 lakes with surface area of more than 10 km².

The lakes of Buryatia have been studied to varying degrees and described in numerous scientific works of famous limnologists, geographers and biologists of Russia. Among the researchers of the lakes, the most valuable are the works of M M Kozhov, and his students: K I Misharin, O M Kozhova, N M Pronin, V V Khakhinov, B B Namsaraev, A A Dzyuba, etc. The formation of lakes, their composition, and the organisms that inhabit them have been studied. However, the use of lakes for economic purposes has not been sufficiently studied.

2. Models and Methods
The study is based on field observations, statistical analysis and a literature review.

3. Results and Discussion
Geographically, lakes are natural bodies of water that differ in many ways and therefore have different meanings and uses. From this point of view, the following uses of lakes in the economic and social sectors are highlighted:

- use of lake water area;
- use of lake bottom sediments;
use of lakeside areas;

• use (consumption) of water.

That is the lakes, located on the territory of the Republic of Buryatia as water bodies, are multifunctional.

In this regard, Lake Baikal is of universal importance. Therefore, the eyes are turned to Lake Baikal as a water object that can bring the republic out of a state of brief ecological depression. Lakes located on the territory of Buryatia can bring various benefits as water bodies.

Lake Baikal is of universal importance in this respect.

Baikal is seen as a water body capable of bringing the republic out of a brief ecological depression. It is connected with the possibility of large-scale attraction of tourists. In socio-economic terms, it is tourism that is capable of generating high income.

According to the World Tourism Organization, 1 tourist provides 4 jobs in the complex branches of regional economy. According to the number of tourist arrivals in recent years the republic has taken the first place among the subjects of the Russian Federation belonging to the Siberian Federal District [1]. These figures are related to the establishment of a visa-free regime between Russia and Mongolia, on the one hand, and the growing interest in Buryatia, in particular, in Lake Baikal, on the part of tourists from China and Korea, as well as a number of European countries.

According to I N Vladimirov and T I Zabortseva [2], the current tourist flow to Lake Baikal is 2.2 million people a year.

At that an increase by 5-10 % is expected in the nearest future; the share of foreign tourists is up to 10 %. In the distribution of tourist flow between the western and eastern shores of Lake Baikal, Irkutsk Region has the advantage, through which up to 60% of all tourists and the overwhelming majority of guests from near and far abroad pass (almost 84%).

On the shore of Lake Baikal there are more than 500 tourist accommodation facilities with a capacity of about 20 thousand people. Tourist bases and resorts of small capacity and seasonal type of service are predominant. On the east coast of Southern Baikal, according to official data, the number of tourist bases has a capacity of one-time tourist reception of 1,000 people, and on the east coast of Middle Baikal – up to 800 people, taking into account guest houses. This can be considered insufficient, so additional facilities for receiving tourists can be built on the Baikal coast to make Baikal a permanent tourist brand on a national scale.

Fishing is popular in Baikal. However, as the authors [2] point out, fishing, mainly of Baikal omul, has declined by more than 1/3 over the past 10 years.

In Baikal and other large water bodies, poaching has undermined the number of commercial fish (Baikal omul, Baikal white grayling, Baikal whitefish).

The latter two species are included in the Red Book of Buryatia. Due to the human factor, the fish in Lake Kotokel has disappeared. The only Istok channel connecting Lake Kotokel with Baikal served as a channel for the migration of fish from Lake Baikal to Kotokel and back in different periods.

During the Great Patriotic War of 1941-1945 and during the first after-war years, Lake Kotokel served as an object of commercial catching of trout, perch, pike, ide, burbot and bream. The fish freely passed through this channel into Lake Kotokel for spawning and feeding, and then into Lake Baikal [3]. In 1955, according to the data of M M Kozhov and I K Spelit [4], 1,071.2 tons of fish were caught on Lake Kotokel.

As the authors point out, these values are less than the gross catch, where about 15-20% of the caught fish is consumed by fishermen, and probably the same amount is sold on the local market, not included in the statistics. On the lake, in addition, more fish went to feed the dogs serving the fishing crews.

It is clear that in the past Lake Kotokel has long been the most highly productive reservoir in the basin of Lake Baikal. Unfortunately, as the authors note [3], most of the fish died out by 2008 (its number decreased by 13 times) in Lake Kotokel. The authors incorrectly point out, that the water contamination of the Istok duct probably served as one of the most important reasons for the sharp
reduction of fishing. We must admit that it was poaching and fishing during the spawning season that undercut the ability of effective reproduction of the fish mass.

Of all large lakes in Buryatia following lakes retain their fisheries, therefore, economic significance: Lakes Dukhovoye, Baut, Arangatuy, Gusinoye and Eravninsky. Lakes Amut and Balun-Tamur remain important for amateur fishing.

The bottom sediments of lakes in many areas have great prospects in the regional economy. The therapeutic mud of the Kiran, Khuzhirta, Kuchiger, Barmashevoe, Kotokel lakes is widely popular among the local population. Their use for the treatment of various diseases is of great social importance.

A mud clinic of a seasonal functioning has been created on the basis of therapeutic mud of Lake Kiran, the territory of the Kyakhtinsky district. Its capacity is 50 customers at the same time in 2016. There is a mud clinic Khuzhirta functioning during summer season on the territory of the Kizhiginsky district, local residents are treated here. Mud of Lake Kotokel is taken to the current resort “Goryachinsk”.

The Kuchiger mud and hydrotherapy clinic, located on the territory of the Kurumkansky District, is widely known among the residents of Buryatia and the Irkutsk region. The total capacity of boarding houses and guest houses is more than 100.

Bottom sediments of sapropel lakes could play a huge role in increasing fertility. Sapropels are unique natural formations that represent organo-mineral bottom sediments of freshwater lakes. Compared with peat, the organic mass of sapropels is characterized by a higher content of easily hydrolysable substances, including nitrogen-containing compounds. Sapropels are rich in nitrogen. No mineral resources have such a high nitrogen content as Sapropels do. Many microorganisms that “populate” sapropel deposits synthesize vitamins, enzymes, antibiotics, and other biologically active substances. They contain vitamins of B group (B1, B2, B3, B6), E, C, P. It is known that using of sapropel as a mineral gives a significant increase in the yield of potatoes, beets, barley. The effectiveness of sapropel increases when used together with manure, peat, wood waste and mineral fertilizers [5, 6].

In total 27 sapropel deposits with a total area of 1,171 hectares with total reserves of 11 million 116 thousand tons by industrial categories (category A) have been identified and explored on the territory of Buryatia, i.e., size, shape and conditions of the sapropel deposit have been established; sapropel species, their ratio and spatial position have been identified; substandard sites have been identified and outlined; hydrogeological and other natural conditions have been studied to provide the initial data necessary for drawing up a field development project [7].

According to the reserves, the sapropel deposits of Buryatia are mainly small (fractions of million tons), including

- up to 0.5 million tons – 23;
- from 0.5 to 0.9 million tons - 2;
- from 1 to 3 million tons – 2 deposits.

The latter are the precursors of the formation of large peat deposits of lake terraces of Lake Baikal (“Bolshoi Kaltus”, “Southern Swan Lake”). The usual thickness of sapropel deposits is 1-3 m, the maximum is 5 m, the water depth in lake deposits is 1-2 m, and only in two cases it reaches 3-3.9 m. In two cases, sapropel deposits are overlain by a peat deposit [7].

Until now, economists have not evaluated their importance in agriculture. Also, the role and importance of peat have not been evaluated, which is a widespread in Buryatia.

Peat contains biologically active substances that can influence the intensity of vital processes in plant and animal organisms. There are vitamins of group A, B, PP, microelements, including iodine up to 2 mg/kg or more [8]. Peat is used both in raw and processed form. Untreated peat is most widely used in agriculture. It is used as a litter on livestock farms, poultry farms, for mulching the soil, storing vegetables and fruits. However, the overwhelming volume of extracted peat is used in the form of processed crumbs and products from it (fertilizers, pots, briquettes, plates), which are widely consumed by agriculture, energy, construction and chemical industries. In agriculture, various organic
fertilizers are used from peat in the form of compost, peat mineral fertilizers for various soils and substrates of greenhouses, nutrient briquettes and micro-seedlings, from top (sphagnum) peat – carbohydrate-protein feeds, growth stimulants.

Specialists of agricultural industries believe that the use of peat in the current condition is a necessary, non-alternative measure, since the resources of all other sources of organic matter (animal husbandry, crop production) are extremely insufficient to provide humus in the soil. In the Republic of Buryatia, the main funds of agricultural land are steppe, forest-steppe and meadow areas located in wide valleys with a low humus content, requiring the introduction of a large amount of organic and mineral fertilizers. Therefore, peat can play an important role in increasing the fertility of arable land and increasing agricultural production.

The lakes of Buryatia, their main components – bottoms with bottom sediments, shores and coastal territories representing recreational areas, water areas and water mass – all this together from a social point of view represent an unlimited field of activity. The integrated development of lakes and their components can provide a significant increase in the employment of the local population.

In our opinion, improving the quality of life and the level of employment of the local population can contribute to the civilized development of a tourist and recreational activity on the shores of Lake Baikal. In this conditions, many Baikal residents will have the opportunity to earn income from renting areas for tents and camping, sports and fishing equipment, guest houses, selling agricultural products from their personal farmstead, including vegetables, potatoes, bakery products, meat and dairy products, berries, mushrooms, ferns, nuts, medicinal herbs; sales of handicrafts and art products, rental of a bakery, laundry, a Russian sauna ‘banya’ with birch brooms, a coffee shop, a pastry shop, as well as the organization of excursion services.

In addition, in our opinion, it should be noted that the lakes of the region are a wealth and an invaluable gift of nature for the inhabitants of Buryatia. On the territory of the Asian part of Russia, this territory of the Republic is distinguished by a large number of lakes of various origins, chemical composition, and food conditions.

Over the past two decades, for example, about 450 lakes have dried up and disappeared on the territory of Mongolia. Despite the fact that the water level on many lakes of Buryatia has decreased, there is no such catastrophic phenomenon as in the neighbouring country. The lakes of Buryatia and any other region are an integral and necessary part of the natural landscape. They create a magnificent picture of nature, serve as areas and centres of attraction for many generations of residents of the Siberian regions.

The state should pay great attention to their protection and regional use. A flexible social policy is needed here – a compromise between the interests of local residents and the protection of lakes by the authorities and controlling law enforcement agencies.

From a social point of view, it should be noted that there are still insurmountable obstacles in the field of regulating water relations. This is due to the fact that with the adoption of the order banning the fishing of the Baikal omul, residents of the republic are experiencing a shortage of fish products. At the same time, there are very favourable prerequisites for the stocking of many large and small lakes with such a delicious and well-established breed of fish as the Amur carp.

4. Conclusion
Thus, there are very favourable natural prerequisites for the integrated development of lakes in the interests of the economy and the social sphere in the Republic of Buryatia.

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