Recreational resources of the coasts of the southern part of Sakhalin Island and the southern part of the Crimean Peninsula (problems and solutions)

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Abstract. The possibilities of recreational-oriented use of the coast are studied on the basis of the trend analysis in the development of the coasts and regional features of the exploitation of the coasts of Sakhalin Island and the Crimean Peninsula. It is shown that the loss of recreational capacity of coastal territories is the result of both man-made and natural components of development. The conclusion is made about the degradation of a significant part of the recreational resources of the coasts. The concept of a model of integrated use and sustainable development of natural mineral resources, hydrogeological and recreational resources is proposed.

1. Introduction
Recognizing that among the natural resources which determine the recreational potential of the coasts, climatic ones play a special role, one should not underestimate the importance of the state of natural complexes of recreational territories themselves [1]. Degradation of recreational resources of the coast of Southern Sakhalin is a process that, alas, is already coming to an end before our eyes. Not only does the loss of low sea terraces and dune systems as a result of erosion significantly reduce the recreational capacity of coastal areas, but also the extraction of common minerals on the coast has turned previously picturesque places into a desert. The total area of flooded quarries on sea terraces unsuitable for any kind of use is already about 45 unattended hectares. There are no urban beaches in any Sakhalin city located on the coast. The only embankment, which moreover exists in the system of coastal protection solutions only in Nevelsk But it is the embankment that is the face of the seaside city. The need to protect transport communications and residential areas also caused the loss of recreational capacity of coastal areas. Despite the fact that today 30 beaches have been officially opened in Sevastopol, morpholithodynamic features of the shores of the southern Crimea significantly complicate beach holidays. The purpose of the presented work is to substantiate the increase in the recreational capacity of the coasts in the conditions of accelerating evolutionary changes and increasing anthropogenic load.

2. Methods and results
The presented work implements the methodology of geomorphological research based on both traditional and modern methods of obtaining and analyzing geospatial and geological-
geomorphological information. The satellite digital terrain model SRTM (Shuttle Radar Topography Mission) was used to calculate the volumes [2]. The initial relief model for quarries in the vicinity of Sevastopol was reprojected in WGS 84 UTM Zone 36N. The volume is calculated for a figure bounded by two surfaces: by the SRTM model from the bottom, and by a surface constructed inside the calculated polygon from the top, taking into account the relief surrounding the quarry, using triangulation method.

Until recently, estimates of the anthropogenic load on the shores of Sakhalin were significantly underestimated [3]. When assessing the anthropogenic load on the shores of southern Sakhalin, it was found that the concrete, sheet pile and ridge walls have a length of about 100 km [4]. It is known that port hydraulic structures and shore-protecting concrete structures are localized mainly in areas developing according to the abrasive type. On accumulative sites, coast protection is not needed, port facilities are practically impossible to build, and portability is a significant obstacle to the functioning of the port. The need to protect transport communications and residential areas also caused the loss of recreational capacity of coastal areas and a decrease in the incoming part of the budget of sediments of the coastal zone.

Irretrievable removal of sediments from the coastal zone has a no less significant impact on the development of coastal morpholithystems than the limited stabilization of active coastal ledges by protected areas of residential territories and transport communications [5]. Only in the south of Sakhalin, for example, this is about 10 million m³ of sediment seized from the beach and avandune zones [6]. Given the morpholithodynamic mechanisms of coastal development, this is equivalent to the loss of about 3 km² of low accumulative coastal plain as a result of erosion, which, in fact, has already happened. Given the almost ubiquitous distribution of peatlands on low coastal terraces, the process of their erosion from the point of view, for example, of the carbon balance, can be characterized as a man-made carbon release into the atmosphere-ocean system.

The difficult sanitary and hygienic situation caused by the discharge of untreated wastewater into the Aniva Bay by several cities and the danger of contamination of the water area by a new LNG plant is the reason for the limited use of recreational resources of this southernmost water area of Sakhalin island. At the same time, the highest concentrations of harmful substances are found in coastal-marine sediments and during severe storms they are released into coastal waters [7, 8].

There are no official beaches on the entire coast of the island. Most of the places where people swim and rest are spontaneous places. Those, that are officially registered, are the places of rest near the water, where only sunbathing is allowed. Therefore, the development of beach infrastructure is the most relevant and necessary type of recreation. Only two beaches – in Yablochnoy and Pionery (specialized children's beach "Aquamarine" near the camp "Chaika") Kholmsky district – on the eve of the season were accredited and received the status of safe. Two more places: Lake Verkhnee in the Yuzhno-Sakhalinsky Park and the Sunny beach on the Tunaycha, are suitable only for relaxing near the water. It is impossible to swim there according to Russian norms [9].

The most interesting for the development of water recreation are the shores of lagoon lakes (Lake Busse, Lake Iznemchivoye, Lake Tunaycha, etc.) and the south-west of Sakhalin, washed by the warm branch of the Tsushima current of the Sea of Japan. The favorable period for bathing here lasts up to two months from July to August [10, 11].

The climate in most of the territory of the Sevastopol region belongs to the subtropical oceanic with hot summers and without a pronounced dry season [12, 13].

The tourist season begins with the May holidays until the end of September, the peak is reached in July-August. The possibilities of beach recreation are limited by the abrasive-topple-landslide type of shores and a high degree of technogenic development of the coast. Thus, despite the approximately 2.5 times longer duration of favorable climatic conditions, the possibilities of beach holidays in the Sevastopol region are quite limited. There is no infrastructure to provide winter recreation here.

Considering that the increased intensity and activity of coastal erosion in the southern part of Sakhalin Island and the Crimean Peninsula is an objective reality, the strategy for reducing economic
and environmental damage in coastal areas is thus determined by the forecast of vulnerability of the coast to expected changes and the possibility of implementing a system of measures to reduce it.

One of the solutions to the problem may be the development of tourist and recreational complexes for year-round use, which can literally become high-tech factories for the production of recreational services. We are talking about the reclamation of spent quarries in the form of equipped artificial reservoirs (figure 1, 2). Until recently, a similar project, in its most advanced form, functioned in Japan. Located in Miyazaki, on the Island of Kyushu, the world's largest indoor water park was called the Seagaia Ocean Dome [14].

![Figure 1. A sand pit on the coast of southern Sakhalin.](image1)

![Figure 2. Swan Lakes Recreation Center – on the site of old swampy sand pits.](image2)

Based on the developed principles, the possibilities of recultivation of quarries of flux raw materials in the vicinity of Sevastopol are very promising (figure 3).
The project Swan Lakes Recreational Zone\textsuperscript{a} is based on three artificial lakes with an area of 7.9 hectares each, with ground feeding and one with an area of 2.6 hectares without hydraulic connection with groundwater (pools covered with domes) with which all architectural solutions are connected \cite{6, 15}. It is around the lakes that tourist facilities and a beach will be built. It is assumed that 250 thousand people will be able to rest under the dome for a year with an average rest duration of six days and up to 3 thousand people at a time.

![Figure 3. Perspective isometric projection of the relief model of the quarries of flux raw materials in the vicinity of Sevastopol.](image)

Great potential for use is the Balaklava quarries – Kadykovsky (flooded with groundwater, now used as a backup source for the water supply of Sevastopol, the volume of excavation is 53,143,870 m\textsuperscript{3}) and Psilerakhsky (flux limestone is being mined, the volume of excavation is 46,156,827 m\textsuperscript{3}).

Previously, options for recreation-oriented recultivation of quarries have been repeatedly proposed \cite{16}. However, in our case we are talking about structures with artificial climate \cite{15}. The length of the coastline of the artificial reservoir of the Kadykovsky quarry is 2 km. When creating a 40 m wide beach, the capacity of the recreational area will be 16,000 people (a unit of 5 m\textsuperscript{2}/person). The perimeter of the bottom of the Psilerakhsky quarry is about 1300 meters and when creating an artificial reservoir, its recreational capacity will exceed 10,000 people.

3. Conclusion
The development of recreational areas with an artificial climate will allow:

- to increase the contribution of the southern part of Sakhalin Island and the Crimean Peninsula to the development of the tourist and recreational complex in the Russian Federation;
- to create conditions for attracting domestic and foreign investments aimed at creating modern, meeting international standards, tourist and sanatorium-resort complexes;
- radically and for the better change the image of the Sakhalin Region and the Sevastopol region not only in Russia, but also in the countries of the Asia-Pacific region and the EU;
- to promote the positive dynamics of economic development by creating a favorable investment climate and not only in the field of tourism;
- to use the scientific and technical potential, market infrastructure, transport, geographical and historical advantages of the Sakhalin Region and the Republic of Crimea,
- to create several tens of thousands of new jobs in the highly profitable sector of the economy;
- to compensate for the loss of recreational capacity of coastal areas as a result of both man-made and natural components of development.

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