Environmental problems of the Crimean coast territories

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Abstract. The article describes the nature and degree of deformations of the coastal zone of the sea and coastal protection structures on the coast of the Kalamitsky Gulf of the Black Sea. In 2022, a team of authors made a visual survey of the coast on the territory of the Bakhchisarai district of the Republic of Crimea with a total length of 11.5 km. from the village of Beregovoe to the village of Uglovoye. As a result of the inspection, coast areas potentially dangerous for human health and life that are not suitable for normal use for recreational purposes were identified. Long-term field observations show that the creation of coastal protection in certain local areas, giving only a temporary positive effect for these areas, can have a very negative impact on neighboring and even remote areas; that is why the coastal protection issue should be solved at least on the scale of the coast of settlements, considering the conditions of a single system. When designing coastal protection measures, it is necessary to consider that separate protection of small areas of erodible coastal territories within a large area of the eroded coast is ineffective, since adjacent unprotected shores will recede under the action of a system of natural factors.

1 Introduction

At the present stage of human development, the coastal zones of the Crimean Peninsula for recreational purposes are subject to an increased negative impact of anthropogenic factors that affect the environmental safety level in this region: high growth of construction work in coastal areas, wear of coastal protection structures, incorrect organization of surface water runoff into the sea, emissions from cars, overflow of landfills, due to which the dynamics of environmental pollution increases. Considering that the coastal zone belongs to highly dynamic territories, recreational activities contribute to the intensification of changes in its natural complexes.

The manifestation of problems with the violation of the stability of the "land-sea" ecosystem in the coastal zone creates environmental threats to the population and the use of territories for recreational purposes, which leads to the formulation of an important complex scientific and practical task to ensure the environmental safety of the Crimean coast, which combines elements of nature and man-made objects of vital activity.

The purpose of the article is to conduct a study of the ecological state of the recreational areas of the Crimean coast.

Accounting of modern dynamics and processes of the formation of shores, beach strips,

preservation of the integrity of coastal territories in the conditions of the development of recreational activities is relevant in solving the problems of environmental safety of the Crimea coast territory. At the same time, it is important to use modern tools of engineering and environmental survey, both of the territory and of coastal protection structures.

At the end of the XIX century, the formation of a system of information on the coastal zone of the Crimean Peninsula was initiated, which was facilitated by such scientists as Levandovsky I.F., Vutechich V.I., Musketov I.V., Slutsky A.F., etc. But only by the 30s of the XX century began a deeper study of the shore transformation patterns, including beach areas (Bozhich P.K., Belov N.A., Dobrynin V.R., etc.). Since 1945, expeditions of the USSR Academy of Sciences have been working in the Crimea under the leadership of V.P. Zenkovich consisting of A.A. Aksenov, V.L. Bonginov, E.I. Nevessky. The results of these works were published in the books "The Shores of the Black and Azov Seas" [1], "Morphology and dynamics of the Soviet shores of the Black Sea" [2], "Fundamentals of the doctrine of the sea shores development", "Dynamics of the coastal zone of tideless seas". Goryachkin Yu.N. [3-4], Romanyuk O.S. [5], Ryzhiy M.N. [6], Sapronova Z.D. [7], Tlyavlina G.V. also contributed to the research of seashores in terms of the shelf zone dynamics [8].

It should be noted that in the conditions of increasing urbanization, to ensure environmental safety, the issues of coastal territories survey and the state of coastal protection structures come to the fore of representatives of various scientific fields – geographical (Bagrov N.V., Bokov V.A. [9]), environmental (Tarasenko V.S., Luschik A.V. [10], Sigora G.A., Khomenko T.Yu., Nichkova L.A. [11], and many others. At the same time, Zhdanov A.M., Hiroi I., Logvinovich G.V., Shuleikin V.V., Dzhunkovsky N.N., Petrashen V.I., Birkhof J. K., Zhdanov A.M., Zagryadskaya N.N., Zenkovich V.P., Kosyan R.D., Kuznetsov S.Yu., Lappo D.D., Leontiev I.O., Makarov K.N., Goryachkin Yu.N., Tlyavlin R.M., Mishchenko S.M., Zuev N.D., Shunko A.S., Shunko N.V. [12], Shakhin V.M. [13], Kuklev S.B., Radionov A.E. and other scientists whose work as a result formed the theoretical basis of hydrophysics of the coastal zone were engaged in studies of the destructive effect of waves in the coastal zone.

Nevertheless, solving the problems of construction and/or modernization of coastal protection structures in accordance with the principles of environmental friendliness of structures still require research, which became the purpose of the article.

2 Materials and Methods

Studies of the state of coastal territories are based on the geomorphology of the surface and underwater parts of the coast, patterns of sea hydrophysical parameters in the coastal zone, climatic and seismic conditions. The research used methods of field observations and experimental studies in the wave basin to account for the effect of natural and anthropogenic factors on the environmental parameters of the coastal zone of the Crimean coast.

3 Results

At the Department of Environmental Management and Water Use of the Academy of Construction and Architecture (a structural subdivision of the V.I. Vernadsky KFU), studies of coastal protection problems on the Crimean Peninsula have been conducted since 2010 [14]. In the development of research, in 2022, full-scale surveys of the coast were carried out on the local territory of the Republic of Crimea - in the Bakhchisarai district in terms of assessing the ecological condition of the beach area and the technical condition of coastal

protection structures. The total length of the studied territory is 11.5 km – from the village of Beregovoe to the village of Uglovoe.

On the surveyed area, the shore is abrasive-collapse, with an actively retreating cliff up to 25 m high. The coastal slope is composed of easily erodible soils.

As a result of field observations in the northern part of the site (near the village of Beregovoe), potentially dangerous to human health and life areas of the coast were identified, where serious violations of the integrity of the slopes and the beach strip occurred, violating the environmentally safe conditions of their normal operation for recreational purposes.

Fig. 1. Abrasive-landslide bank to the north of the reconstruction site.

To the south, the coast is not fixed (Fig. 2) and has a pronounced abrasive character with landslides and landfalls. Actively retreating cliff up to 25 m high, composed of loam. There are traces of recent collapses, and there are also stabs and cracks in 1-3 m from the cliff edge. The few beams are filled with fine detritus material and form small beaches up to 9 m wide.

Fig. 2 Abrasive-landslide bank to the south of the reconstruction site.

Within the boundaries of the village of Peschanoe, Bakhchisarai district, on the territory of the Rainbow boarding house, the width of the surface part of the beach is 12 m. The shore protection structures have been destroyed and dismantled; the natural retreating cliff on this site has a height of up to 6 m, and the edge of the cliff is very close to the boarding house fence, there is a threat of collapse of the soil masses (Fig. 3).

Fig. 3. Natural cliff on the site of destroyed shore protection structures in the area of the boarding house "Rainbow".

On the site of the recreation center "U Lukomorya" (Fig. 4), the beach is washed away, the beach material is completely washed away. The coastal fortifications were destroyed: to strengthen the shore, the marching slabs were stacked in the form of a breakwater wall; currently, the walls of the marching slabs and the embankment are destroyed, the building foundation is being eroded. The pier is destroyed. In the southern part of the site, the shore is being eroded, a section of the road is partially destroyed.

Fig. 4. A natural cliff on the site of destroyed shore protection structures in the area of the recreation center "U Lukomorya".

On the territory of the pioneer camp "Lukomorye", a section of the beach with a width of 17 m in the surface part is fenced. The bulk of the beach material is shifted to the north and the retaining wall of the 1st tier.

Further to the south of the studied section of the beach area in the area of the pioneer camp "Magarach", the coast is not protected. The coastal slope in the northern part of the site is subject to abrasion processes, there is a 2-2.5 m high cliff, as well as the access road destruction (Fig. 7). In the southern part of the site, the coastal slope is relatively smooth. The width of the beach in the surface part is 15 m.

Fig. 7. Active cliff in the area of the pioneer camp "Magarach".

On the territory of public beaches, boarding house "Iskra", boarding house "Stroyindustria", boarding house "Minmontazhspetsstroy", boarding house "Volna" (Fig. 8) for 835 meters, the installations of shore protection structures were destroyed. The elements of the slope-stepped embankment collapsed into the sea (marching slabs, embankment covering blocks) and the retaining wall near the coastal slope formed a "talus" (5-7 m wide). Currently, the shore is not fixed in conditions of complete destruction of coastal protection; there are many abrasive niches at the base of the cliff, further destruction of the shore, landscaping elements, shedding and collapses of the soil. For recreational purposes, this section of the coast is not suitable, it is traumatic for people to stay on it.

Fig. 8. Destroyed coast protection in the area of the boarding houses "Iskra" of LLC "Ukrtelekom", the pioneer camp "Stroyindustria", shore protection structures of the public beach, boarding house "Minmontazhspetsstroy", boarding house "Volna".

To the south, in the area of the boarding house "Peschanoye", the children's health camp "Yuzhny", the children's health camp "Peschanoye" (Fig.9), the beach is 6 to 16 meters wide in the surface part. The volume of the beach is insufficient to completely extinguish the wave effect. There are deep gullies in the root part of the groin No. 5, there is no filler in the chambers, corrosion of the groin metal structures occurs. No significant deformations were found in the shore protection structures, but there are surface defects. The base of the stairs to the beach is washed away, cracks are revealed on the side face.

Fig. 9. Coast protection of the boarding house "Peschanoe" and the children's health camp "Yuzhny".

On the site of the recreational area of the village of Uglovoye coastal protection is a retaining wall with buttresses made of monolithic reinforced concrete (Fig. 10).

Fig. 10. Coast protection of the village of Uglovoye.

The width of the surface part of the beach in some areas reaches 20 meters. At the same time, the presence of calcareous monoliths in the underwater part of the sea near the village of Uglovoye was previously revealed. The formation of underwater elevations by 1-3 m leads to the transformation of the shore and waves – a change in their internal structure and external shape along the route [15] and according to the results of the survey of these sites it can be concluded that the identified process of formation of underwater elevations leads to the preservation of the beach width in this place.

4 Discussion

Based on the results of field studies of the state of the Bakhchisarai district coastal zone, a tendency of shore erosion was revealed: abrasion of the loose shore and destruction of existing shore protection structures, steady degradation of accumulative beaches. This confirms the conclusion that the implementation of previously local coastal protection measures did not allow solving the problems in a complex. Long-term field observations [16] show that the creation of coastal protection in certain local areas gives only a temporary positive effect and can have very negative effects on neighboring areas of the

beach territory, without considering the patterns of directions of long-shore sediments and wave loads. Consequently, the coastal protection issue should be resolved within the boundaries of morphological units of territories, considering the conditions of a single system.

When choosing the method of coastal protection and the type of coastal protection structures, both favorable and unfavorable factors should be considered, especially with regard to maintaining the level of ecological condition of the protected area of the coast with an additional assessment of the degree of impact of these factors on the environment. In addition, the reduction of wave impacts on the coastal zone must occur due to an increase in the wave-extinguishing ability of coastal protection structures, when designing which, it is necessary to consider the natural laws of each territory.

5 Conclusion

According to the results of the observations made in the Western Crimea, the established trend of the coast development was confirmed: the abrasion of the loose shore and the destruction of already built shore protection structures, the steady degradation of accumulative beaches. The only exceptions are a few separate sections adjacent to the mouths of rivers.

Potentially dangerous sections of the coast and broken shore protection structures were also identified. Thus, to date, most of the coastal protection structures in the village have been destroyed. Peschanoye: out of 1407 m, 1390 m of coastal protection were destroyed. The remaining ones are in a critical condition. When designing coastal protection systems, it is necessary to consider that separate protection of small areas of erodible coastal territories within a large area of the transformable coast is ineffective, since adjacent unprotected shores will recede under the action of a system of natural factors.

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