On the issue of the impact of adverse and dangerous natural processes on the use of coastal recreational areas of the Russian Federation

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Abstract. Adverse and dangerous natural processes are a deterrent factor in the economic, in particular, recreational use of the coastal territories of Russia. They significantly reduce their tourist potential. At the same time, a decrease in the recreational value of territories is one of the consequences of human impact on the natural landscapes of the coastal zone. It seems important to consider the impact of adverse and dangerous natural processes specifically for coastal recreational areas due to their exceptional importance for domestic tourism. It, in turn, plays a huge role both for the economy of Russia and certain regions of our country, and for Russians themselves: tourists and local residents.

As a result of the research, for each of the seaside recreational areas available in Russia, the study revealed the most characteristic adverse and dangerous natural processes. Some of them are more or less manifested everywhere, for example, abrasion processes or storms. Others, in particular, seismic threat, are characteristic only for certain coastal territories. Measures to counteract dangerous natural processes are also somewhat similar for all the regions considered. However, when developing measures to counteract adverse and dangerous natural processes, the peculiarities of coastal regions should also be taken into account. Such features include climatic and relief characteristics, the landscapes of the region, the existing structure of human activity and the intensity of economic development of the region, the types of tourism that are characteristic of it, and the level of popularity of the region among recreants, as well as its recreational potential.

1. Introduction
Mass tourism is characteristic for only a small percentage of the sea coasts and coasts of inland waters of the Russian Federation, but it is one of the key areas of domestic tourism, the role of which is great for both the country's economy and its citizens. Recently, the role of domestic tourism has been noticeably increasing due to the COVID-19 pandemic and its consequences, in particular, the falling incomes of many Russians and the complication of tourist trips abroad. Recreational activity should be recognized as a priority for those coastal territories for which, due to climatic conditions and other factors (the level of development of recreational infrastructure, preferences of tourists, transport accessibility, etc.), mass recreation is most characteristic, as it happens in many cases abroad [1]. The main purpose of the research is to study adverse and dangerous natural processes in coastal recreational areas. Due to the significant importance of such territories (they play a key role for domestic tourism) the research focused on them.
Tourism in the coastal zone is subject to the negative impact of adverse and dangerous natural processes, which leads to material damage and human casualties. A number of researchers have studied the influence of such processes for the territory of the Russian Federation as a whole, including for coastal territories [2, 3]. In general works on nature management in the coastal zones of the Russian Federation, the influence of adverse and dangerous natural processes is somehow taken into account [1,4–9], as well as in regional works. In some of them consideration of various adverse and dangerous natural processes is a key or one of the key issues [6, 10]. The authors identified and characterized the adverse and dangerous natural processes for the coastal recreational territories of the Russian Federation and in general terms for those that relates to inland water bodies, and offered recommendations to reduce their negative impact on human economic activity. The available scientific literature contains recommendations on counteraction adverse and dangerous natural processes, however, for the entire territory of Russia as a whole or for certain regions. The authors in this article have prepared and summarized them specifically for all seaside recreational areas, taking into account their peculiarities.

Different regions of the Russian Federation are characterized with a various adverse and dangerous natural processes. Some of them manifest themselves exclusively or to the greatest extent in the coastal zone (for example, the processes of abrasion and erosion of the coasts), others cover a significant area of territory, including coastal zones. They include abnormal air temperatures, strong winds, heavy precipitation and floods as a consequence, earthquakes, etc. Dangerous processes characteristic primarily to mountainous territories, in particular, slope processes (landslides etc.), are provoked by abrasion and are found on many parts of the coast [2]. Abrasive processes pose a significant threat to engineering structures, including future ones, which will appear on the areas of coastal zones currently being developed for recreational purposes. At present, they are characteristic of 41 % of the coasts of the seas and 36 % of the coasts of water reservoirs [11]. For some water bodies, this part is noticeably higher. For example, up to 70 % of the coasts of the Sea of Azov are subject to erosion [12].

Adverse and dangerous natural processes in coastal areas are also currently characterized with activation due to human impact. So, the removal of sand and pebbles within the coastal zone enhances abrasion processes, deforestation on slopes intensifies mudslides, as well as floods, there are some other examples. Consequently, adverse and dangerous natural processes can be considered as a geoecological problem along with a decrease in the recreational potential of landscapes under human influence, environmental pollution and some others.

However, the nature-human system is characterized by two-way connections. If adverse and dangerous natural processes are the most noticeable negative consequence of the human impact on nature, it is also necessary to take into account the human impact on nature, which leads to a significant change in natural landscapes. The negative consequences of human impact on both the recreational potential of coastal territories and their natural landscapes as a whole are described both in Russian [4, 5, 7, 9] and foreign [13–16] literature.

The purpose of the research is to characterize adverse and dangerous natural processes characteristic of coastal recreational areas of Russia and to propose measures to counteract them. The objectives of the research include at least four:

1) List the areas of the coast on which dangerous natural processes is manifested quite acutely and for which it is recommended to minimize their economic use.
2) Show the importance of informing the public society about dangerous natural processes.
3) Outline ways to combat dangerous natural processes on the most valuable parts of the coast.
4) Justify the necessity to ban capital construction in beach areas.

2. Research methods and materials used
The following methods were used to conduct the research and prepare the current article:

- Comparative descriptive, which made it possible to compare the coastal territories and those related to inland water bodies, as well as Russian and foreign coastal territories, to identify their geocological risks and their features.
- The method of scientific synthesis, which made it possible to generalize and compare with each other the information previously obtained from large-scale topographic maps, navigation maps for coastal waters, thematic maps, in particular, maps of the spread of adverse and dangerous natural phenomena, published literature and information taken from other sources.
- The method of keys, which, in turn, allows applying the method of analogues, of course, taking into account the individual characteristics of coastal territories. It was used to interpolate characteristics of adverse and dangerous natural processes in the territory for which there was a lack of information.

3. Research results
Adverse and dangerous natural processes characteristic for all coastal regions of Russia, which are characterized by mass recreation, as well as for coastal zones of inland water bodies, are shown in Table 1 below. The table is compiled based on author’s research, the above and other literary sources, available maps and remote sensing data of the Earth. Here natural dangerous processes are typified into atmospheric, hydrological and hydrogeological (first group) and geological.

Table 1. Adverse and dangerous natural processes typical of coastal recreational areas and possible measures to counteract them.

| Coastal region of Russia | The most typical atmospheric, hydrological and hydrogeological natural dangerous processes peculiar to the region | The most typical geological natural dangerous processes peculiar to the region | Possible countermeasures against natural dangerous processes minimization the damage from them. |
|--------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| The southern coast of Crimea | Upwelling of cold waters in the coastal zone, thunderstorms, storms, sudden jumps in atmospheric pressure and humidity, droughts, hail. | Rockfalls, landslides (including man-made ones) and landslides, mudslides (especially in the South-Eastern Crimea), abrasion processes), earthquakes (which, in turn, are the "trigger" for rockfalls) and landslides), karst processes (as a rule, in areas adjacent to the coastal zone). | Minimization of economic use of the coastal areas with the most active manifestation of natural dangerous processes, creation of coast protection structures (and maintenance of existing ones) on the most valuable sites. Consideration of seismic hazard in the construction of any engineering structures. Prohibition of capital construction in the area of beaches and in river valleys with increased mudflow hazard. |
| The West Coast and all the other coasts of Crimea | Storms, extreme heat, dry winds and dust storms. | Landslides, abrasion processes (the rate of retreat of the coasts in some areas reaches 1 meter per year or more [7]), water erosion. | Minimization of the economic use of coastal areas with the most active manifestation of these processes, the creation of artificial beaches, the prohibition of capital construction within the beaches. |
| Black Sea coast of The Caucasus | Heavy rainfall and thunderstorms, tornadoes, floods, surges in the mouths of large rivers, extremely high temperatures, droughts, sudden jumps in | Mudslides, avalanches, landslides and rockfalls, landslides, abrasive processes, seismic threat. Landslides are especially active in the southern part of Large Sochi, where they | Restriction of construction in the valleys of gullies, for which mudslides are most characteristic, informing the population about safety measures in case of avalanches and stopping them in those areas where they threaten the |
atmospheric pressure and humidity, sea storms, bora in the surroundings of Novorossysk affect the slopes for 50–80%. The capacity of mudslides is up to 100 thousand m³ or more [17]. Landslides and mudslides are also provoked by a technogenic factor (deforestation, pruning of slopes during road construction, etc.). The repeatability of mudslides is 10–20 years.

Life and health of people, buildings and structures. Defense of coasts of coastal areas where slope processes and abrasions threaten the health and life of recreants. Monitoring of railways and highways in areas subject to landslide processes. Prohibition of capital construction in the area of beaches and in mudslide-prone river valleys. Consideration of the seismic threat.

Driving-surge processes. Storms, strong winds (including wringing wing, which can lead to deaths among recreational swimmers) extreme temperatures, droughts, dry winds, thunderstorms, ice hummocks. Abrasive processes. The rate of coastal retreat in some areas is higher here than on the coasts of all other recreational coastal territories, up to several meters per year [12]. Landslides within the coastal zone.

Compliance with safety measures to avoid human casualties during storms. Avoiding the placement of engineering structures near the edge of the sea on the abrasive areas of the shores and near them. Coastal protection works, in particular, the creation of artificial beaches on the most valuable sites.

Strong winds, storms, dust storms, dry winds, extremely hot temperatures, droughts. Driving-surge processes, storms, fluctuations in sea level (only in 1975–1995 he rose two meters [9]). Abrasion, slope processes on the shores and in mountainous areas, seismic threat, erosion processes in the coastal zone.

Economic development, with consideration to the significant amplitude of both short-term and long-term fluctuations in sea level, protection of the most important areas from them. Positioning the region as an “autumn” resort to avoid trips during hot temperatures.

Storms, blizzards, snowfalls, fogs, icing, ice hummocks. The superimposition of driving-surge processes on storms leads to a rise in the level by 3–4 m [6]. Abrasion processes, slope processes on the coasts, water erosion.

Creation of protective dams for the most important sections of the coast to protect from driving-surge processes, shore protection in certain areas, avoiding the use of areas with the greatest manifestation of natural dangerous processes.
### 4. Conclusion

As follows from Table 1, for most recreational coastal areas, many measures to counteract adverse and dangerous processes are also similar. It is possible to distinguish such common measures for all studied areas:

1) Minimization (if possible) of the economic use of coastal areas where adverse and dangerous natural processes are most acute. These include, in particular, the bottoms of beams, especially their estuaries facing the seashore, areas of the coast with active abrasion processes, landslide slopes, etc.

2) Informing recreants and local residents (residents, however, as a rule, have a much better idea of the threats from dangerous natural processes than recreants) about the risks and dangers caused by adverse and dangerous natural processes. So, tornadoes approaching the shore can become the object of photography, and storm waves encourage some recreationists to swim in the sea, despite the risk.

3) The struggle for the most attractive areas of the coast for economic activity: the implementation of coasts protection works (methods of so-called soft and hard shore protection can be applied), anti-landslide measures, etc.

4) Prohibition of capital construction in the area of beaches in connection with the threat from storm waves, and in some cases, driving-surgeing processes for such engineering structures on the seashores and on the coasts of large inland bodies of water.

Without taking into account the negative impact of adverse and dangerous natural processes, effective environmental management is impossible in coastal tourist areas, as they threaten the life and health of local residents and existing engineering objects. Without due regard to adverse and dangerous natural processes both recreational and other types of economic use of territories in the present and its planning for the future are impossible.
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