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## COMPUTER INTERACTIVE GIS "THE COASTAL ZONE OF THE SEVASTOPOL REGION OF CRIMEA"

### ABSTRACT

The information system based on the results of the study of the coastal zone of the Sevastopol region was developed in order to provide the available data to specialists who make decisions on the development of the region and the prevention of the destructive impact of the sea on land. The system presents materials obtained in the course of long-term monitoring, observations using space and aerial photography, including drones. It includes a detailed description of all sections of the coastline, the consequences of their transformation over a period of more than 100 years, assessment of the hydrometeorological and geomorphological conditions of the region, the results of ensuring coastal protection measures in certain areas and a detailed description of the coastal protected areas. Examples of the results of the cadastral assessment of recreational resources of beaches, developed earlier, are also given. GIS formats made it possible to implement quantitative statistics on individual objects, systematize landslide-prone areas in detail, and characterize the consequences of their occurrence. Special attention is paid to the description of the ecosystem conditions of numerous Sevastopol bays and the few estuaries of regulated rivers. Interactive GIS realization is providing access to the information in a visual interactive cartographic version.

**KEYWORDS:** Crimea coastal zone, information and reference system, satellite and contact information, sustainable development, protected areas, beaches recreational resources.

### INTRODUCTION

Interest in the development of the coastal zone of the Crimea is constantly growing following by expansion of the recreational sphere in the Crimea economy. Currently, this trend is developing even more, due to the objective conditions of the pandemic that has engulfed the whole world and the tendency to redirect the tourists flow to Russian resorts. The Sevastopol region of Crimea, previously famous for historical and patriotic tourism, is also currently making attempts to develop recreational tourism and improve the quality of the service sector to the required level. All these circumstances, as well as specialized high-budget federal programs for the development of Crimea and Sevastopol, are aimed, to a large extent, at transforming the coastal zone. For example, a large-scale project to create a cultural and historical cluster is being implemented at the Crystal Cape in Sevastopol<sup>3</sup>, a decision has been made on the fundamental development of the

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<sup>3</sup> In Sevastopol, the project of the cultural cluster on the Crystal was presented. FGBU Russian Newspaper. 2020. <https://rg.ru/2020/12/25/reg-ufo/v-sevastopole-predstavili-proekt-kulturnogo-klastera-na-hrustalnom.html>. (accessed 11.04.2021) (in Russian).

Northern side of the city<sup>1</sup> with its transformation into an independent recreational zone of world-class service. Due to the limited water resources, a grandiose structure was built on the Belbek River to accumulate water reserves and use part of the river's drains for the purpose of water supply to the city. At the same time, on some landslide-prone areas of the North Side, large-scale work is being carried out to removing the top layer of soil, which, together with potential beach material, is being realized for other, very dubious, purposes.

All of the above and potentially probable actions are accompanied or may be accompanied by a deterioration in the ecological and aesthetic condition of the coastal zone. This is significant, since even now some seashores are characterized by chaotic construction, which does not take into account natural conditions and the accumulated experience of nature management, primarily negative [Kunz, 1993; Oliferov, 2008; Gogoberidze, 2013; Gogoberidze, 2014; Afanasyev, 2018; Shuisky, 2018; Isaev, 2020].

This state is not least due to the lack of awareness of economic entities and decision-making bodies about the current changes taking place in the coastal zone, as the authors have seen at meetings at various levels. No less alarming is the fact that the managers and directors of individual coastal facilities, in most cases, are persons who have not lived in Sevastopol before and have not experienced the history of the development of the coastal zone of the region as their own experience.

In addition, organizations that do not have an elementary understanding of the lithodynamics of the coastal zones are sometimes involved in the development of construction projects in those zones and the preparation of shore protection schemes. Therefore, it is obvious that informing as many people as possible related to the nature management in the coastal zone about its current state and changes is very important task.

In order to solve this problem, the authors developed an electronic interactive version of the information and reference system corresponding to the current level of management, which combined the available data on the study of the coastal zone obtained by various organizations and is available to all interested parties. The system contains a large number of map features, including their characteristic data. In the future, it is planned to ensure the continuous development of the system by supplementing it with new materials.

## MATERIALS AND METHODS

Taking into account the traditional presentation of most information systems, based on the list of its sections [Dolotov, 2013; Vetsalo, 2008] and also traditional GIS structure with the display of a list and map representation of objects [Filatov, 1997; Goodchild, 2000; Svidzinska, 2011; Chumachenko, 2014; Dolotov, 2017], the system user interface is implemented in the format shown in Fig. 1 (a).

The user interface implements both the viewing of the system's text materials and the main features of GIS tools, in particular: the selection of individual types of objects with information about each of them, the shifting and scaling of the map. Detail map representation can be configured by the user. So, the map includes the main database of geographical names, which can be displayed depending on the scale, which is clearly seen in Fig. 2 (a) and the insets in Fig. 1 (a). In addition, the system implements a mechanism for creating spatial bookmarks, calculating distances, and some other useful functions. The base map, also traditionally, is based on the use of a number of vector layers that display its individual components (Fig. 2 (b)). The map representation uses the well-known ESRI shape file formats

<sup>1</sup> What obvious-incredible solutions for the Northern Side were offered to the residents of Sevastopol. 2019. <https://sevastopol.su/news/kakie-ochevidnye-neveroyatnye-resheniya-dlya-severnoy-storony-predlozhili-zhitely-am> (accessed 11.04.2021) (in Russian).

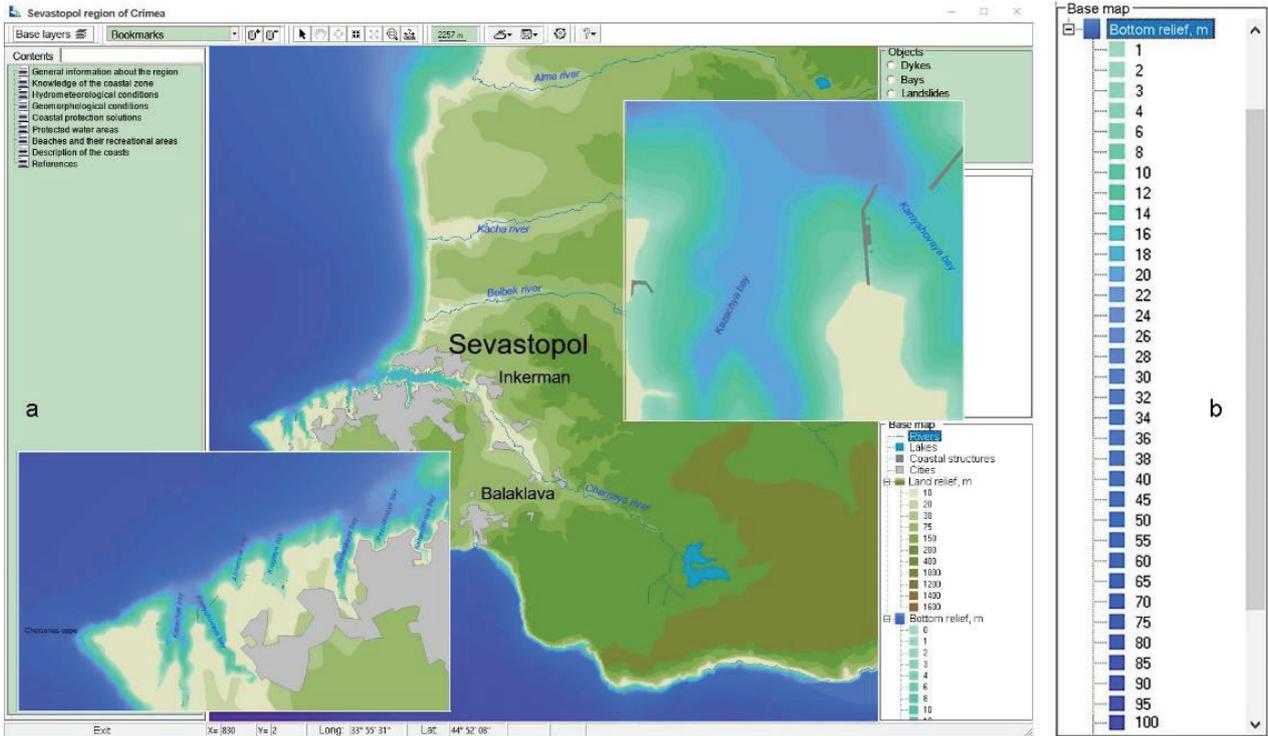


Fig 1. User interface (a) and bathymetry legend (b)

The main attention in the preparation of the digital map was paid to the study of the bottom relief, which largely determines the processes of mass transfer in the coastal zone. That is why the bottom relief on the map is represented by isobaths with detail increasing towards the shore as shown on Fig. 1, (b). The scanned navigation maps of scales from 1:100 000 to 1:5000 as of 1992<sup>1</sup>, were used during preparing the map. Both individual depth points and isobates were digitized simultaneously, and line figures were later converted into points by GIS tools. After that, the resulting arrays of points were combined and the common array was used for generating a given

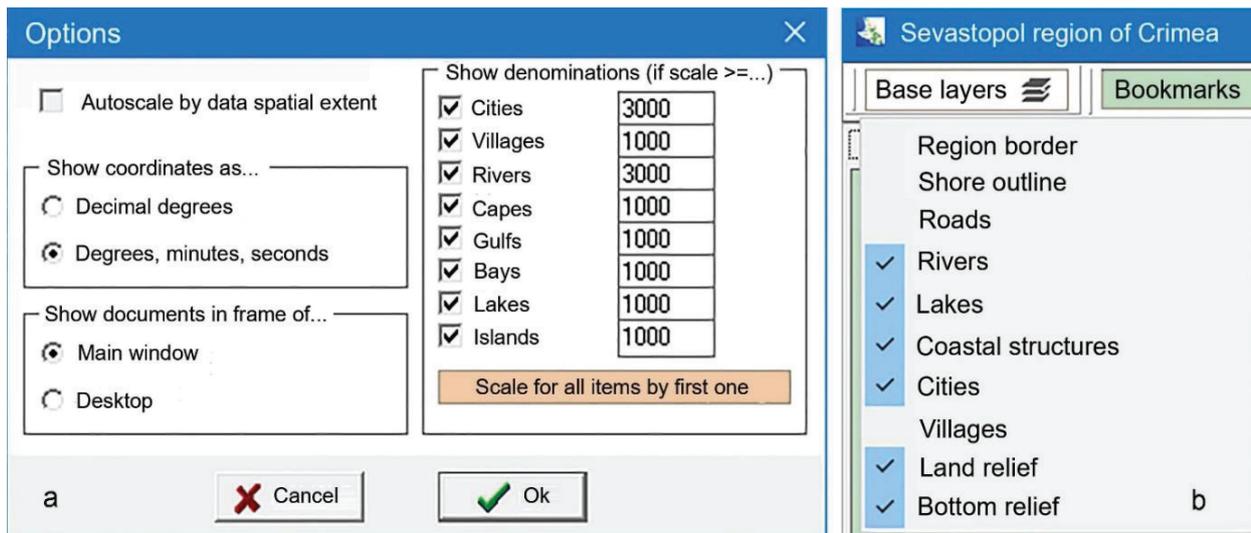


Fig. 2. Options window (a) and map representation panel (b)

<sup>1</sup> Collection of navigation maps of the Black and Azov Seas [2000-2008, BMP, PDF]. 2016. <https://www.liveinternet.ru/users/skyready/post396766569/> (accessed 11.04.2021).

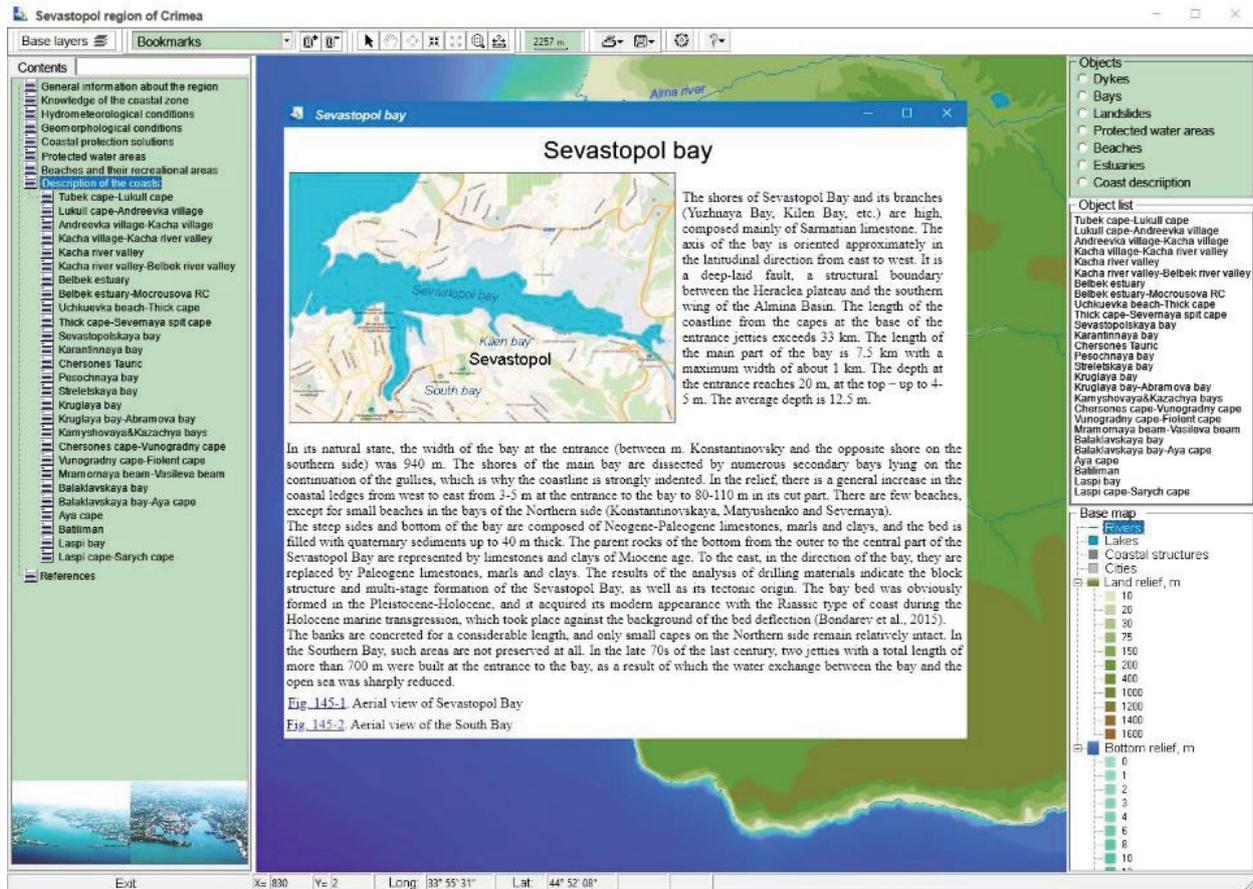


Fig. 3. Coast's description window format

list of depths in form of isolines. The resulting linear shapes were carefully checked for topological irregularities and then the digital linear map was converted to adjacent polygons. Thus, by analogy with the earlier work of the authors [Dolotov, 2013] the ability to represent the depth map both as isolines and as a gradation fill was implemented. It is also possible to use both options together. In practice, an overly detailed isobates map in the coastal zone interferes with detailed viewing and analysis of processes occurring near the shore, and therefore, the map is most often displayed in the form of polygons, as shown in Fig. 1 (a). In addition, when the mouse cursor moves over the Black Sea, the current depth is displayed in the system status bar.

The traditional content of the system includes the following main sections with drop-down subsections:

- General information about the region;
- Knowledge of the coastal zone of the region;
- Hydrometeorological conditions;
- Geomorphological conditions;
- Coastal protection solutions;
- Protected water areas;
- Beaches and their recreational areas;
- Description of the coasts.

The last section corresponds to the individual pages of the previously published Atlas [Goryachkin, 2019], presented as their copies (Fig. 3).

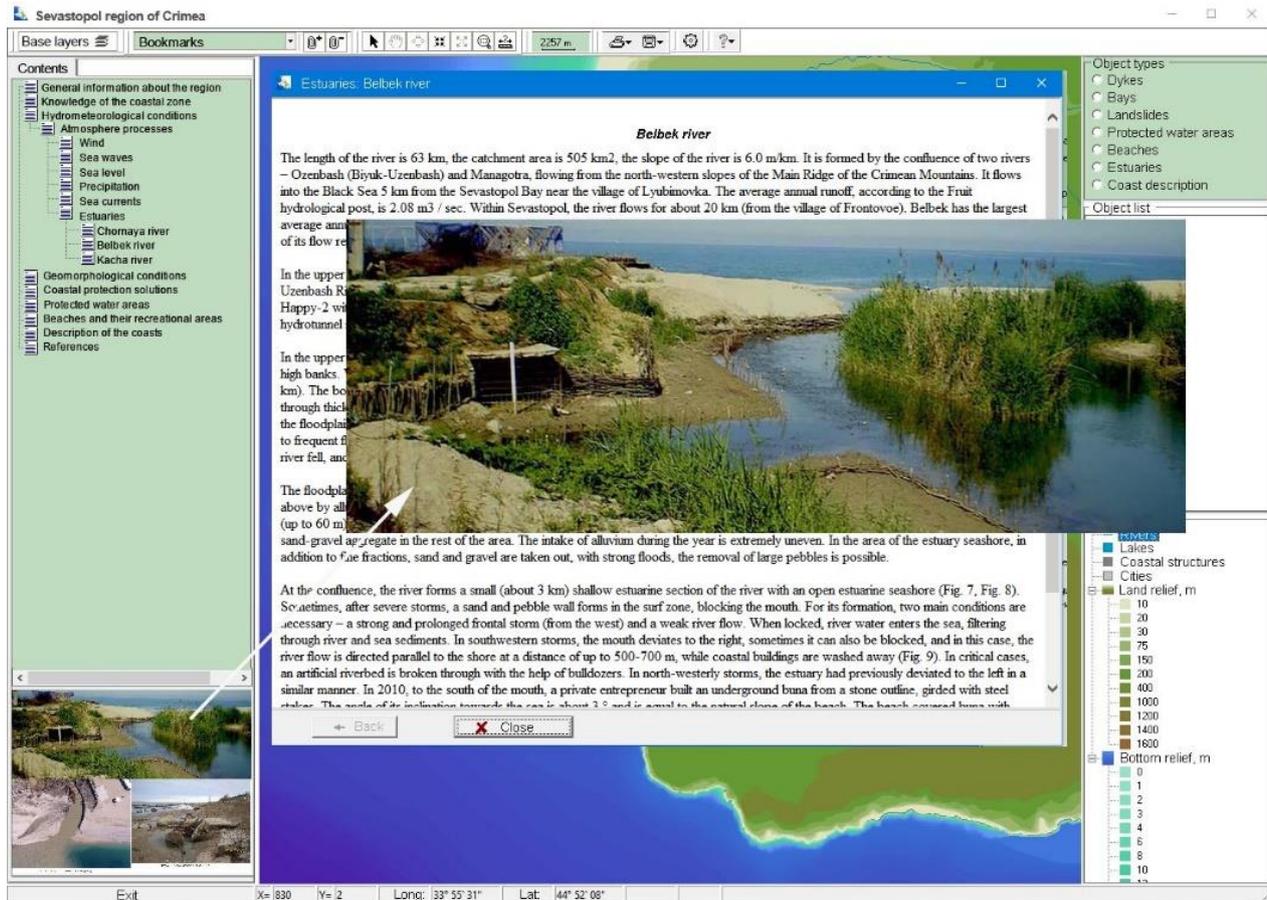


Fig. 4. Example of text materials visualization

All text documents are displayed in the < html> format with images presented either directly in the text or as thumbnails displayed at the bottom of the content panel. The latter format seemed to be the most convenient, since it does not take up a significant part of the text space with the ability to immediately see the approximate content of all images (Fig. 4).

If you need a more detailed view of the images, they can be displayed in a separate window at the click of the mouse.

Map features are displayed on the map as points, lines, and polygons. The list of individual categories of objects represented in the system is displayed in the corresponding panel at the top right. Selecting a specific category, such as "Bays" (Fig. 5), provides a complete list of objects in this category and displays them on the map.

At the same time, when the mouse cursor moves through the list of objects, each of them is highlighted on the map for quickly determine their spatial location. You can select an item to display its associated information from either the list or the map.

## RESULTS AND DISCUSSION

The usual result of the development of information systems is the created tool in the form of a computer program that includes its own special database. This tool allows you to quickly get information about the state and dynamics of any section of the coast of the Sevastopol region, its ownership, purpose, cost and other indicators. In the developed tool, all the information is presented as correctly and accessible as possible. A large number of maps and illustrations are used.

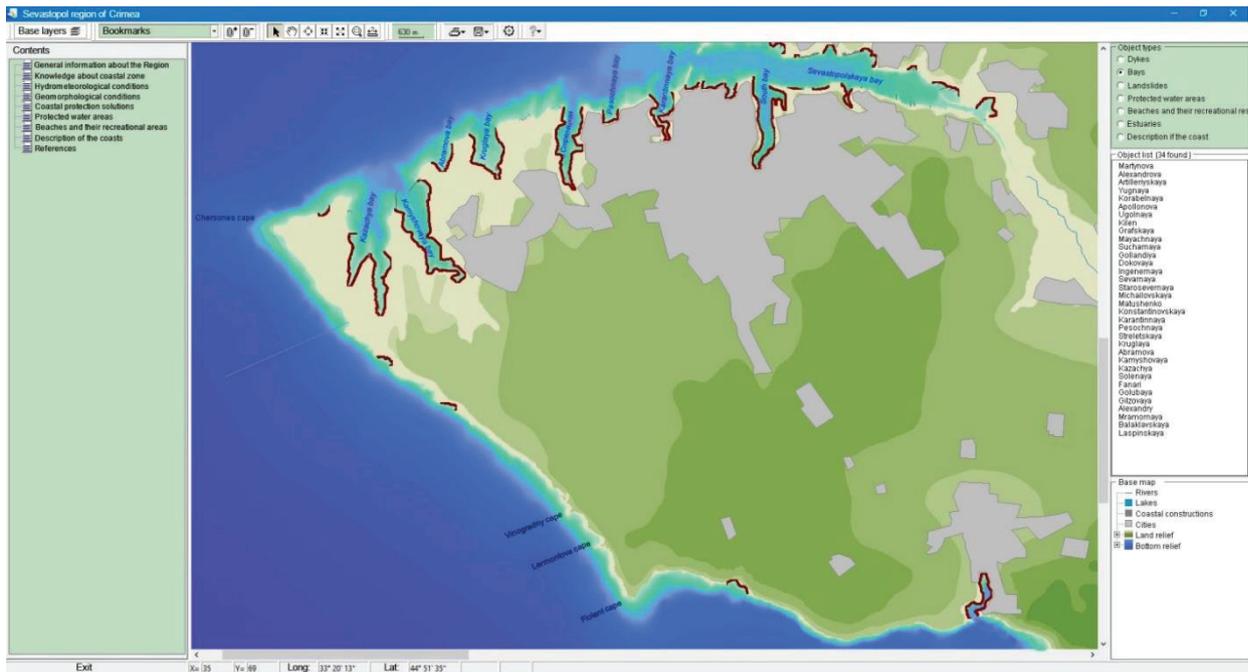


Fig. 5. Visualization of map objects on the example of bays

The feasibility of developing such systems is confirmed by the implementation of the described GIS-oriented tool in the Sevastopol Main Department of Natural Resources and Ecology.

## CONCLUSION

Comparative variants of different GIS implementation allow us to assert that Internet products using modern open technologies can significantly speed up the work and the capabilities of such products often exceed the capabilities of traditional programming methods. In this regard, it should be noted that there is no need for careful preparation of the base map and zooming technologies. An additional advantage is the ability to use GIS on any platform, including tablets and smartphones.

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