Vyacheslav V. Dolotov*¹and Andrey V. Dolotov¹
¹Marine Hydrophysical Institute, Sevastopol, Russia
*Corresponding author: vyadol@gmail.com

PERSPECTIVES OF POPULARIZATION OF OCEANOGRAPHIC INFORMATION SYSTEMS BASED ON INTERNET

ABSTRACT. The Internet version of the interactive geoinformation system names as «Crimea Sea Coast» based on javascript programming language and the modern open library «leaflet» is described. Development of a product supposed to use of the modern vector graphics technologies, such as D3, Flot and other superstructures over javascript. The main attention is paid to operational representation of full-scale results observations with assessment of Crimea coastal zone dynamics in general. Options of such approach are already realized with use of data on measurement of coast line position of the northwest coast now. In addition, the system reserves the special section described the basis and results of the implementation of the previously developed cadastral assessment of the Crimea beaches, including their recreational areas, economic assessment of recreational resources, as well as the results of comprehensive interdisciplinary monitoring of Sevastopol Bay environmental condition for the period from 1998 to the present, including a cartographic representation of the geographical elements of the region as a whole. The results of monitoring allow to realize visualization of spatial distributions of hydrological, hydrochemical and hydrobiological characteristics of the bay sea environment in the digital format defined by user, to perform the construction of vertical distributions, and also to calculate some ecological indexes. The final version of the system is expected to be posted on the official website of Marine Hydrophysical Institute.

KEY WORDS: Coastal zone, GIS, Internet, leaflet

INTRODUCTION

The global implementation of geographic information systems both into the practice of scientific research and cartographic data representation allows more naturally to perceive of the spatial distribution of different fields and objects on the earth's surface and even in sea depths. Detailed overview of the specifics of oceanographic GIS-tools is presented by CRCPress (2002) and Davey Jones' Locker (2018). However, it is difficult to imagine a single information system for the whole of the world's oceans and therefore they are most often developed in the form of regional structures. Thus a few GIS for Black Sea region have been developed in Marine Hydrophysical Institute (Zhuk 2016; Konovalov 2013).

Increased interest in GIS creates the prospects of geoinformation data dissemination not only among specialists, but also among management structures and even for open access. In this regard, it's appears the need of provision for possibility of geoinformation data presentation without prior acquaintance with costly GIS tools and the acquisition of the necessary expensive licenses (ESRI 2018a; MapInfo 2018; Golden et al. 2018). Additionally, using of these professional GIS requires prior training and education.

In this regard, completely new horizons are opening with the implementation of GIS-tools through the Internet (Web-GIS) which, unlike the usual desktop-analogues are either fully or conditionally accessible and do not require to send of finished projects to users. (OIAS et al. 2018), which, unlike the usual desktop-analogues are either fully or conditionally accessible and do not require to send of finished projects to users.

One of the solutions in this direction is the newly developed leaflet library (Leaflet 2018) to the popular programming language javascript. The main leaflet advantage is the ability to represent a vector graphics in the network with use of online map services like MapBox, OpenStreetMap, Google Maps, Yandex Maps, etc. This is a very important fact allows to exclude from developing of GIS tools the process of base map creating and to focused on the data representation.

Marine Hydrophysical Institute, over the long years has accumulated a huge arrays of oceanographic observations data, collected in a single internal database (DB), access to which, however, is limited even for the employees of the MHI and, in addition, is implemented in outdated formats that do not facilitate its use in operational analysis.
At the same time, due to the objective loss of all research vessels in the 1990s, the role of coastal observations has increased, the number of which is increasing too, along with the growing importance of these data for the economic development of the Crimea. In view of these circumstances, the institute has developed a strategy of popularization of coastal observation data in order to support decision-making on the management

of the sea coastal zone, aimed at ensuring the environmental sustainability of the territories for the development of recreational and economic factors. First and foremost, these decisions are aimed at counteracting both the sharply aggravated beaches degradation process and pollution of coastal areas. In this regard, the work on the formation of public media products that characterize the main trends in the state of the coastal zones has become quite popular (Konovalov et al. 2013; Dolotov 2007). However, of these, only the first work was framed in the form of freely distributed and updated information system, implemented, however, only in the form of personal computer application. At present, the above-mentioned technologies allow to prepare all the received materials in the form of Internet-oriented information systems, access to which does not require prior training. At the same time, unlimited Internet resources allow to saturate such systems not only with measurement data, but also with more general information about the coastal zone, which have an educational significance too.

MATERIALS

The work used the modern open library leaflet in conjunction with ESRI leaflet (2018b). The main page of the site is quite traditional (Fig. 1) and includes 6 information sections (Table 1).

The first and last sections is implemented using the traditional HTML language, and includes information on climate, cyclonic activity, storm surges and waves, atmospheric precipitation, changes in sea level and coastline position, anthropogenic impacts and coast types. As examples the Fig. 2 describes the coast types (a) and storm surge features (b).

The other sections in contrast include cartographic material with maximum use of interactive tools. So, three data sources are proposed for the cartographic representation of the base map in this implementation: MapBox, OSM and Yandex Map, the list of which can be later increased. It is important to note that, since the Internet base maps are represented by bitmaps, the diversity of their thematic options is realized by a map simple redrawing. For example, the well-known ser-
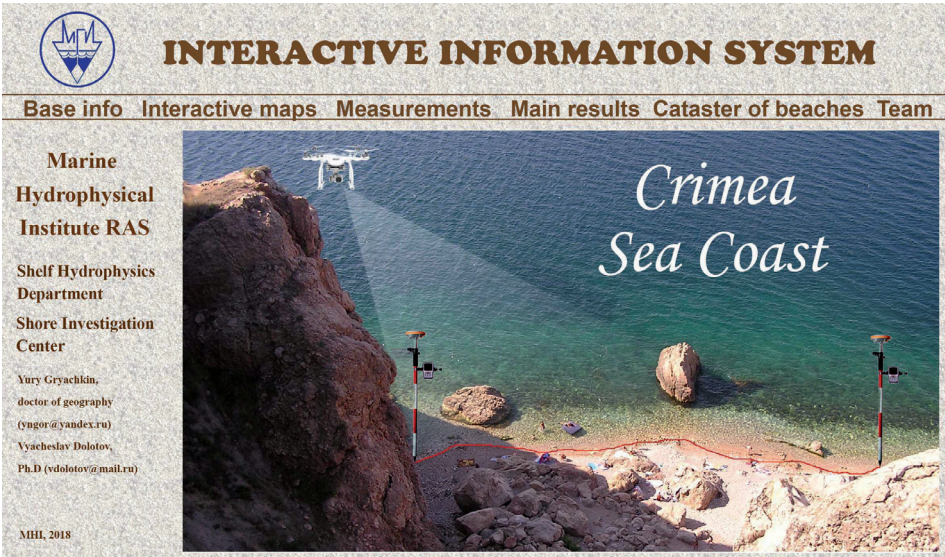
Fig. 1. The main page of interactive system

Table 1. List of potential system's features

| Base info	Hydro meteorological information and shore structure
Interactive maps	Detailed description of individual sections of the coastal zone
Measurements	Operational results of surveys and measurements
Results	Modern and historical results of the coastal zone study
Cadaster of beaches	The concept and the pilot implementation of the results of Crimean beaches cadastral assessment
Team	Personality and contacts
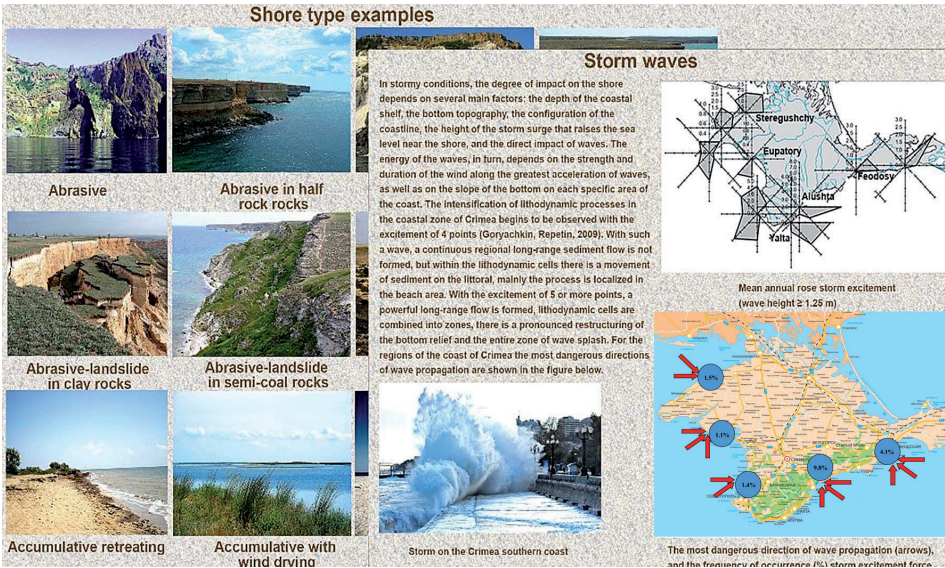
Fig. 2. Traditional visualization of HTML page format

vice ESRI offers the following set of thematic maps: navigation, topographic, geographic, monochrome and satellite. Additionally, we use additionally MapBox_light and Map-Box_dark, extremely convenient for focusing the user's attention on the represented data. Moreover, the Internet providers offer up-to-date maps on some indicators, such as air temperature, humidity, directions and speed of the wind, which can even be animated.

METHODS

Recently, Marine Hydrophysical Institute released a monograph in the form of an Atlas of the Crimea sea coast current state, published, unfortunately, in a very small edition. Atlas consists of detailed description of 170 coast points belong all the shore. The first task of the work was to compare the complexity, quality and options for the convert of all Atlas materials into the new Internet format. The first positive decision was obtained at the beginning of the project development and was associated with the possibility of map zooming. This allowed to combine separate shore fragments of the printed Atlas into a single combined map. In addition, it is quite simple to implement additional mapping tools, such as coordinate grid, measuring ruler and some others.

Another important task was to check the spatial coincidence of the available data measured in the coastal zone with the Crimea coastline of the map services on maximum zoom levels. For this purpose, these maps were overlaid with a digitized image of the contour of the Crimea for July 2014 in the ESRI shape format. Fig. 3 presents the quite

satisfactory results of the comparison. In this regard, it should be noted that the Internet maps are constantly updated, and some discrepancies are noticeable in the Fig. 3 on the right can be caused by natural changes in comparison with the test contour 2014. Confirmation of this conclusion is the exact match of fixed objects such as concrete piers. In the implementation of the online version of the Atlas, used a relatively small number of leaflet tools, allowing, however, to evaluate the prospects for the development of the system as a whole. So, the Atlas abounds with photos showing the current state of individual sections of the coastal zone, as well as historical photos in comparison with modern ones.

All these photos are geographically linked to points on the map, and the information output is easily implemented using standard leaflet markers and popups (Fig. 4).

Fig. 5 shows a more informative design options of interactive page implementation. Moving the mouse over the elements displays the length of the lines, the area of the polygons and some other characteristic information.

At the same time there is a zoom to the element spatial extent. The greatest attention in the work is supposed to be paid to the options of interactive presentation of the results of field observations. Thus, the interactive map shown in Fig. 6 at the left presents the results of measurements of the coastline position in the area of the North-Western Crimea near the Bakal lake.
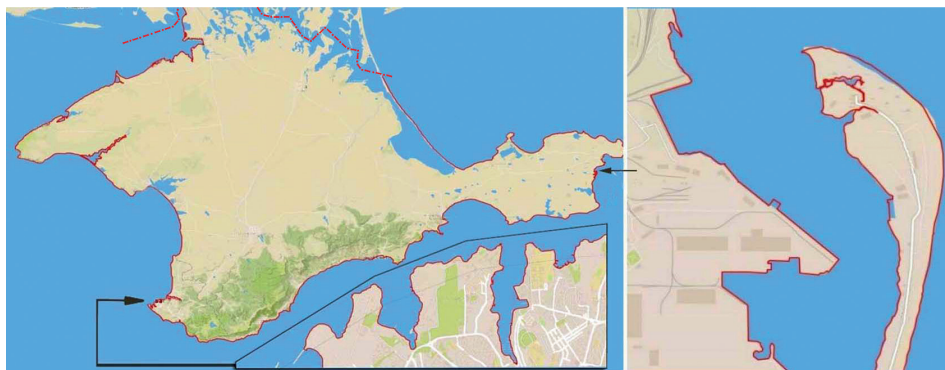

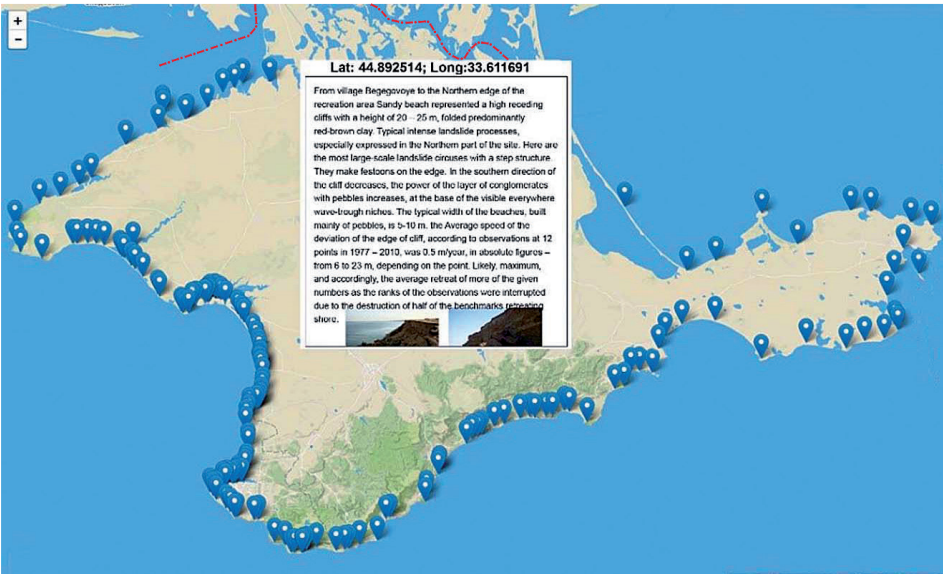
Fig. 3. Results of Crimea contour overlaying on the MapBox

Vyacheslav V. Dolotov and Andrey V. Dolotov   PERSPECTIVES OF POPULARIZATION OF ...

01|2019

GES

141

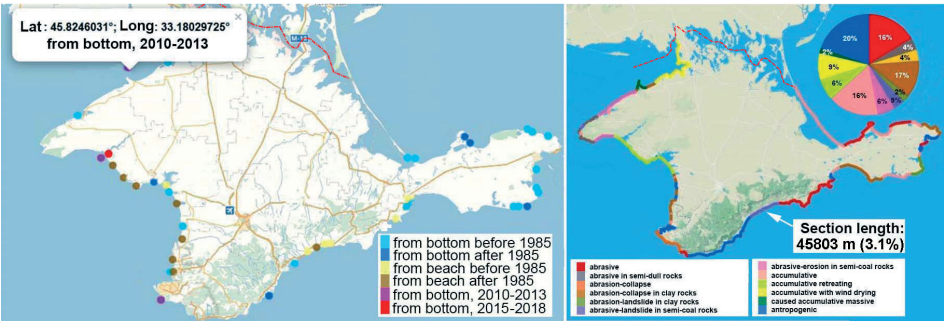**Fig. 4. The simple implementation of leaflet technology**

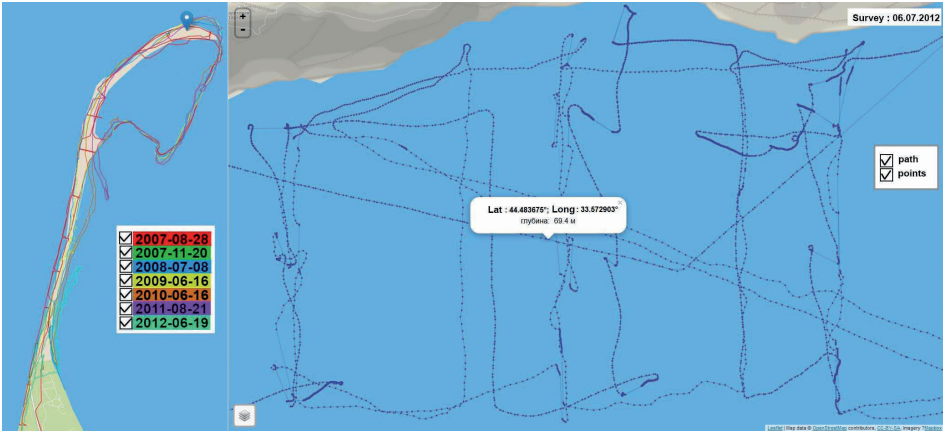**Fig. 5. The simple example of popup windows based on leaflet markers**

Fig. 6. Results of shoreline location (left) and depth measurements (right) as an interactive map

At the same time, the user can toggle the list of the presented data, as well as information about the characteristics of objects (length for lines and area for polygons). On the right, the results of depth measurements in the form of points and interpolated contours are presented in a similar way. A special switch allows you to select the type of data displayed. In comparison with coastal measurements, marine surveys are performed with high vertical resolution for analyze the vertical profiles of the distribution of individual elements (Fig. 7).

The grid format (Golden 2018) is most suitable for detailed investigation of numerous surveys of the Sevastopol Bay, which is a long-term system for monitoring its environmental condition. In this regard, the most interesting is the European system of environmental status indices with the assessment of indicators in certain areas of the Bay. Spatial distributions can be represented in three ways: a traditional gradient, a "traffic light" or a more familiar one – in the form of contours (Fig. 8).

The Table 1 shows that the system reserved a special Section for cadaster of Crimea beach-es. The Crimea government have been trying to create it since 2004, but it is still in the state of the project. This may be due to either a lack of understanding of the cadaster concept or the importance of the project. In spite of the fact that MHI repeatedly represented the technique of beaches cadastral assessment developed by it the product still is absent. The inclusion of existing best practices, tools and proposals in the structure of the information system can serve the starting point to the beginning of the implementation of a systematic cadastral beach area studies, which, however, are performed by MHI since 2005. In contrast to the materials presented above, the content of cadaster of the beaches involves the calculation of a significant number of calculated indicators, which are usually formed the special cadastral database.

The main task of cadaster visualization is a cartographic representation of a complex cadastral structure (Fig. 9), including their recreational areas, as well as a variety of comparative and chronological charts of changes in individual cadastral indicators. The last task, which usually requires additional comments, is supposed to be implemented using spe-
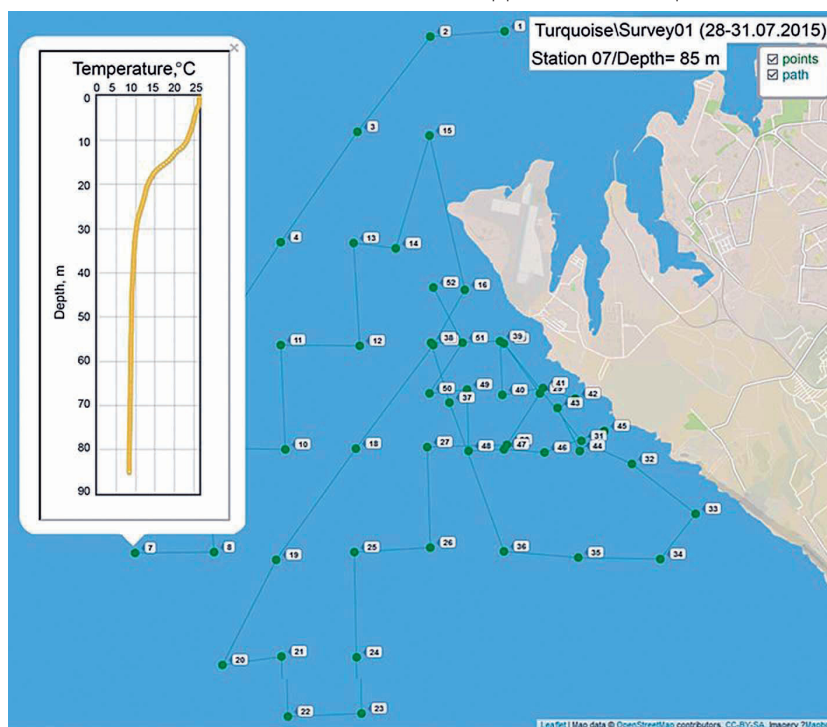

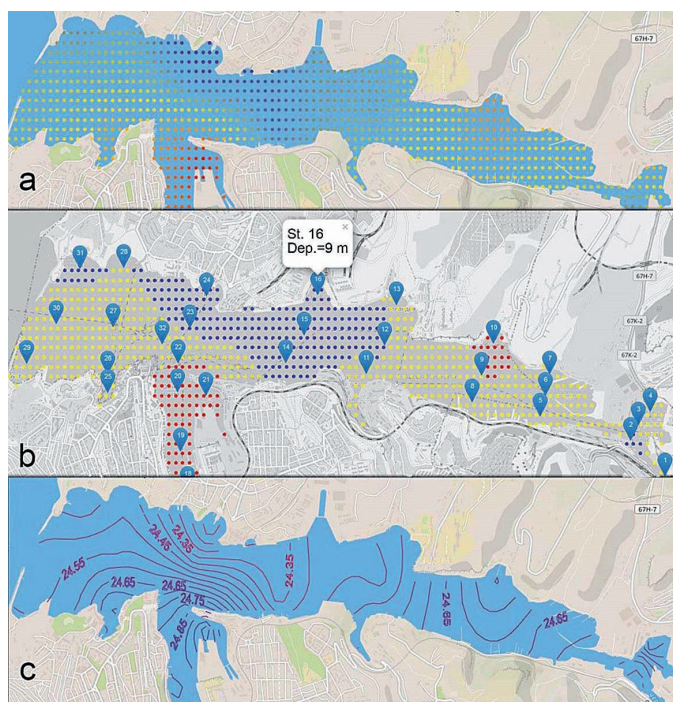**Fig. 7. The result of visualization of marine hydrological surveys**

Fig. 8. Different kinds of spatial distribution of temperature: gradient (a), traffic light (b) and contours (c)
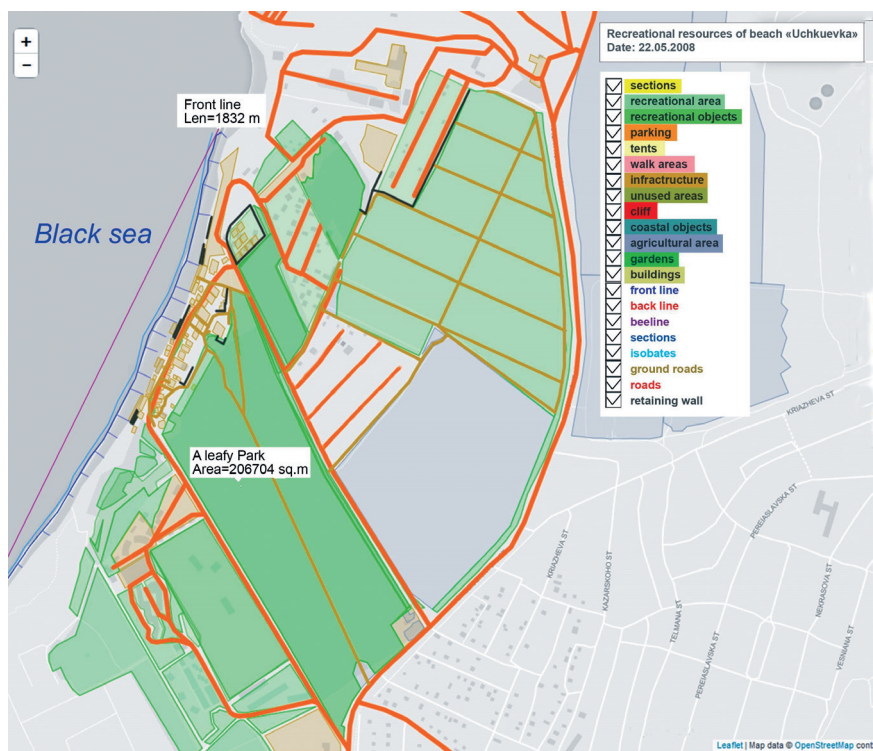

Fig. 9. The main cartographic cadastral visualization

cialized technologies C3-D3 (C3 2018), providing excellent interaction between digital data and graphics.

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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REFERENCES

C3.js (2018). D3-based reusable chart library. [online] Available at: http://c3js.org/examples. html Leaflet (2018) A JavaScript library for interactive maps. [Accessed 01 Aug. 2018]

CRCPress (2002). Geographic Information Systems in Oceanography and Fisheries. [online] Available at: https://www.crcpress.com/Geographic-Information-Systems-in-Oceanography-and-Fisheries/Valavanis/p/book/9780415284639 [Accessed 03 Dec. 2018]

Davey Jones' Locker (2018). Seafloor Mapping/Marine and Coastal GIS. [online] Available at: https://marinecoastalgis.net/soft [Accessed 03 Dec 2018]

Dolotov V., Ivanov V. (2007). Cadastral Assessment of Crimean Beaches as an Instrument for Sustainable Coastal Development. Geography, Environment, Sustainability, 2, 98-119.

ESRI (2018a). [online] Available at: http://www.esri.com [Accessed 03 Dec. 2018]

ESRI (2018b). A lightweight set of tools for using ArcGIS services with Leaflet. [online] Available at: http://esri.github.io/esri-leaflet/ [Accessed 01 Aug 2018]

Golden (2018). Surfer 7 Binary Grid File Format. [online] Available at: http://surferhelp. goldensoftware.com/surfer.htm#t=topics%2Fsurfer_7_grid_
[Accessed 01 Aug 2018]

Konovalov S., Vladymyrov V., Dolotov V., Sergeyeva O., Goryachkin Yu., Alyomov S. Moiseenko O., Orekhova N., Zharova L. (2013). Environmental Assessment Tools in the PEGASO Case - Sevastopol Bay. Proceedings of the Global Congress on ICM: Lessons Learned to Address New Challenges, Marmaris, Turkey, 30 Oct – 03 Nov 2013, 59-70.

Leaflet (2018). An open-source JavaScript library for mobile-friendly interactive maps. [online] Available at: https://leafletjs.com [Accessed 01 Aug 2018]

MapInfo (2018). MapInfo Pro Desktop GIS. [online] Available at: https://www.pitneybowes. com/us/location-intelligence/geographic-information-systems/mapinfo-pro.html [Accessed 03 Dec. 2018]

OIAS (2018). Oceanological information and analytical system. [online] Available at: http://oias.poi.dvo.ru/ [Accessed 01 Aug 2018]

Zhuk E., Khaliulin A., Zodiatis G., Nikolaidis A., Isaeva E. (2016). Black Sea GIS developed in MHI. Proc. SPIE 9688, Fourth International Conference on Remote Sensing and Geoinformation of the Environment (RSCy2016). 2016, 9688, p. 96881-96888.

01|2019

GES

145