MOBILE DATA COLLECTION SYSTEM BASED ON ARCGIS TO ACCOUNT FOR THE BIODIVERSITY OF THE PLANT WORLD OF RIVNE NATURAL RESERVE

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The problem

Human impact on the environment has resulted in the fact that thousands of species of animals and plants are on the verge of extinction. To prevent this, they create protected areas, including Rivne natural reserve (RNR), which is one of the largest (over 42 thousand hectares) in Ukraine and covers the territories of different categories. Natural complexes of the reserve are rich in flora and fauna, unique in biodiversity.

In the reserve, 831 species of higher plants are identified, of which 150 mosses, 681 species of vascular, including 7 species of horsetail, 8 species of lycopodiaceae, 9 species of pteridophytes, 1 species of isoetes, 5 species of gymnosperms and 652 of angiosperms [3, RNR information].

Therefore, to ensure a permanent monitoring of biodiversity, conservation planning, prediction of emergency situations and the analysis of their implications, it is not only feasible but also necessary to create cartographic models of the reserve based on GIS-technologies.

An important requirement for maintaining the relevance of information is the ability to edit data in the field or immediately after collection.

The analysis of recent research and publications that relate to this problem

The practice of implementing a geographical information system in management of natural protected areas in Ukraine is becoming more widespread. In particular, the geographic information system for environmental management of territories of Nikolaev [5], Kherson [2], Chernihiv [4] regions, "Roztochya" nature reserve [1] should be noted.

The need for such studies is confirmed by the fact that on December 25 2013 a unified geographic information system and database of the State cadastre of natural reserve Fund of Ukraine was represented in the premises of the Ministry of environment protection. It should provide a mutual exchange of information between state databases of inventories, their management based on a single software database, common approach to digitization and input of information, the existence of a unified cartographic basis. The information about the area boundaries and objects of natural reserve Fund and appropriate restrictions will be available for the public and will be used in the work of the authorities concerned [6].

Statement of the problem

The aim of this work is to create the concept of mobile geoinformation system for monitoring the reserve flora, which would increase the efficiency of collecting and processing information.

The main material

Currently, the majority of work in the RNR is performed on paper maps, and the attribute information is typically stored in Microsoft Excel spreadsheets.

To improve the efficiency of work it is necessary:
- to digitalize paper maps;
- to apply the data about the detected species in each forest allotment and block, together with attribute information about them, to the map;
- to automate the process of traversal route planning based on the topology rules;
- to perform the analysis of the database accumulated material, to visualize the results in the form of reports, graphs, thematic maps;
- to perform the area zoning according to various factors, in particular by building buffer zones.

The concept of such a geoinformation system which to some extent solves these tasks is proposed in [7, 8]. These works, in particular, state the main objectives of the suggested GIS, analyze the information flows, develop the structure of the relevant set of geospatial data and the corresponding structure of layers, present the created vector map of Biloozersky local forestry as ArcGIS software product.

In accordance with the suggested approach we have vectorized the maps of Karasinsky, Northern and Starosilsky forestries of RNR.

To publish the results of this work we have prepared a web map of Biloozersky, Karasinsky, Northern and Starosilsky (Fig. 1) forestries of Rivne natural reserve. We used an ArcGIS Online service, details of which will be described below.
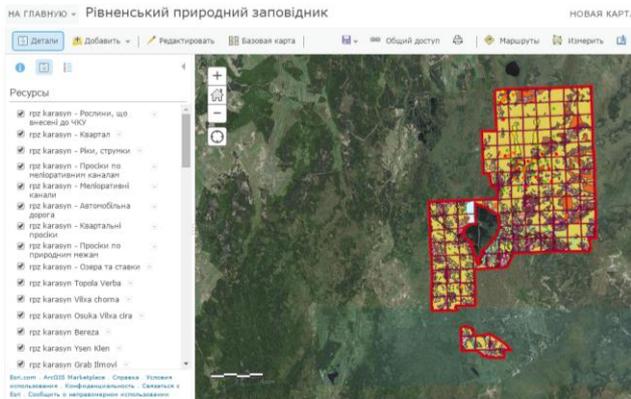
Fig. 1. Web map of Northern and Starosilsky forestries

To provide continuous monitoring of ecosystem conditions, to identify current and potential threats to the conservation of natural complexes and objects of the reserve, it is expedient to create monitoring routes. For automatic calculation of the routes, using the ArcGIS Network Analyst module we created topologically-associated network dataset which included existing roads and clearings.

Current digital maps require constant updating to keep them up to date. In the case of RNR, the information is updated by conducting field surveys according to standard procedures. In our opinion, the use of mobile devices and software to collect data in the field, operating on standards for geoinformation technologies is promising in this case. Among a significant number of solutions for the implementation of mobile system, we have chosen ArcGIS Online and the app Collector for ArcGIS.

ArcGIS Online is a platform with a "cloud" of data collaboration, which allows users in the organization to create, use, provide access to maps, scenes, apps and data, as well as to work with high-quality basemaps and ready-made applications [9]. That is, the data of field studies in real time can get at any stationary or mobile devices that operate in a single cloud environment.

An important feature of ArcGIS Online is the ability to use the free version (with certain limitations). The cost of the annual subscription to the paid version depends on the selected plan. Each plan includes a certain number of unique users and service credits. Minimum ArcGIS Online subscription includes 5 user accounts which can have administrator, editor and user rights, and 2500 credits. Credits are spent when using ArcGIS Online services – data storage, querying, spatial analysis, geocoding, etc.

Rivne natural reserve can apply for a grant from ESRI for the free software (including ArcGIS Online – 1 workstation). In case of acceptance of the application it would only require to make a contribution to cover administrative costs (about $100). Annual subscription cost for 5 workstations, with a 50% discount for non-profit organizations will be $1725.00 at the interbank rate.

Collector for ArcGIS is a mobile service collecting and updating data in the field whose main advantage is the ability to operate both connected and offline. It allows you to determine the current location of the researcher and to transmit the collected data to the ArcGIS Online server. The application has certain requirements to mobile devices, namely for OS Android [11]:

– Android 4.0 (Ice Cream Sandwich) or higher;
– an ARMv7 CPU or a x86processor;
– OpenGL ES 2.0 support;
– location support (based on GPS and/or mobile networks).

The Collector app also supports mobile devices running on the iOS and Windows Phone.

The work of collecting and updating data on the mobile device begins with checking the availability of the Internet and login through the Collector app for ArcGIS to ArcGIS public profile. So Fig. 2 shows the display of previously prepared digital maps of RNR forest areas on your mobile device (smartphone).
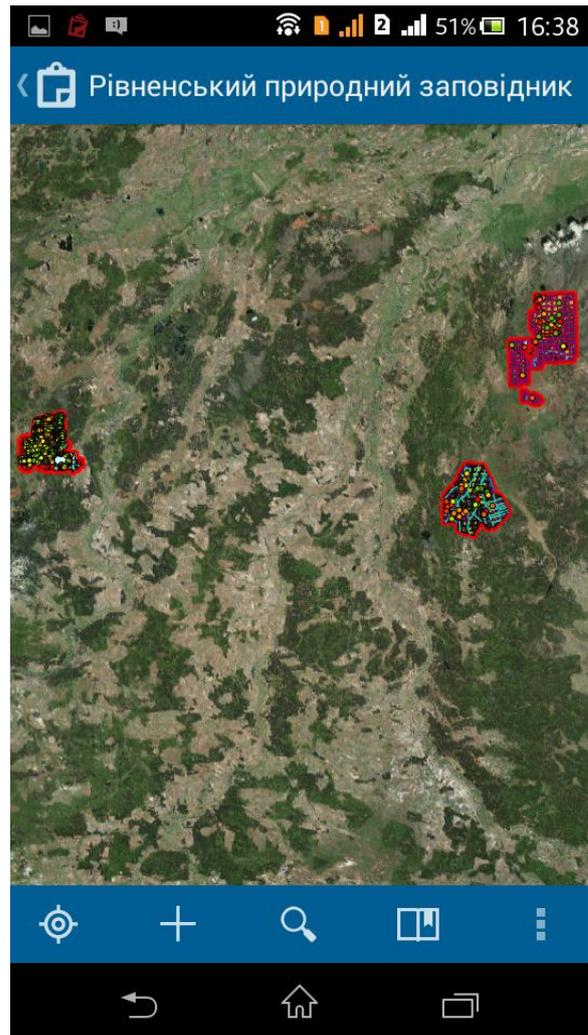

Fig. 2. Application reflection of ArcGIS Online web map of forest areas

The user has the option to download the required topographic map which will quickly reflect your own location. As a raster layer, satellite images of most of the open source map servers (like Google Maps) can be used.

App Collector for ArcGIS supports the ability to view and edit the layers (both graphical and attribute information). The implementation of viewing objects attribute data is done via the Show details (Fig. 3) after you select it.
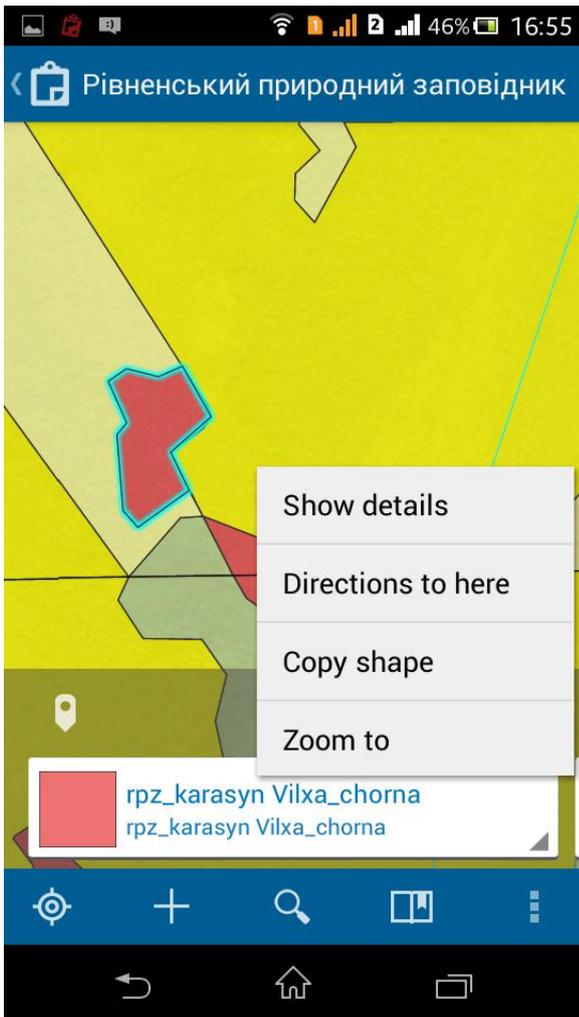
Fig. 3. Select an object to view the attribute data

Fig. 4. Table of the object attribute data

Fig. 5. Table of the new object attribute data input

As a result, viewing the entered attribute data window will open (Fig. 4).

An important feature of the app is the ability to create a new object. After clicking on the image of the plus sign that is located on the tool panel Collector for ArcGIS, a table will appear with the list of all layers from the web map available for editing.

Selecting the appropriate layer on which we want to add the object, attributes are entered in a special window. Clicking on the icon in the upper left corner of the screen we perform maintaining the attribute data (Fig. 5).
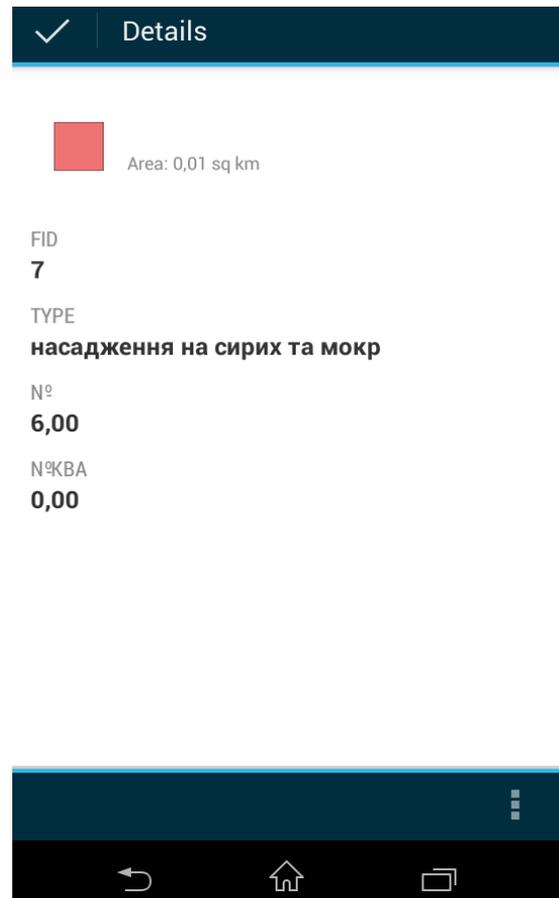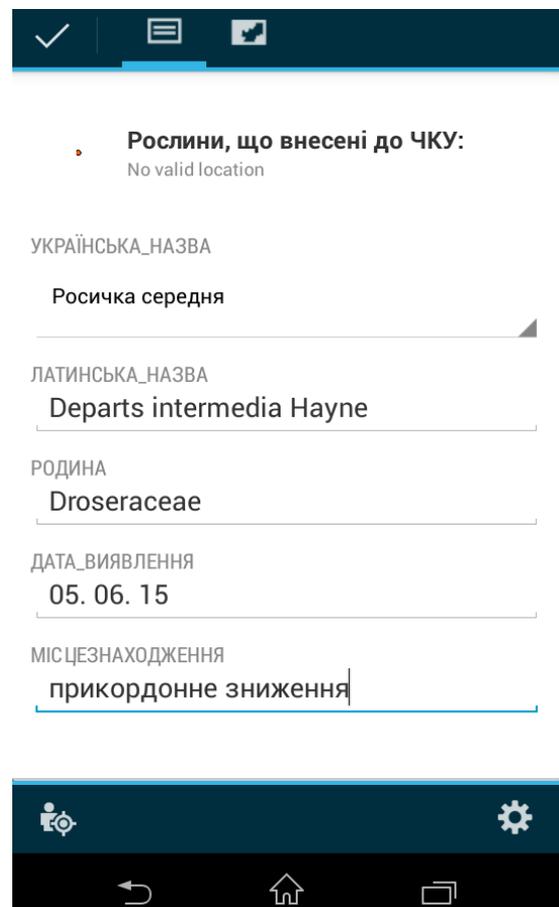
Next, the user, with the command Go to map, is able to indicate the location of the object on the map. The location of the detected object, as a rule, is the location of the user. For a spatial reference to the current location of the user, the icon located in the lower left corner of the application is used (Fig. 5).

In your layers menu you also have the option to turn on/off the visibility of any particular layer to leave only the required layers without cluttering the image as a whole. This is especially important for mobile devices that typically have relatively small screen sizes.

Data transfer from a mobile device of a user who is in the field to the ArcGIS Online server is accomplished instantly with an Internet connection.

So, created on the smartphone, the planar object (Fig. 6) can easily be open in a web browser ArcGIS Online (Fig. 7). Both the location of the object and attribute specifications entered in the field are saved.

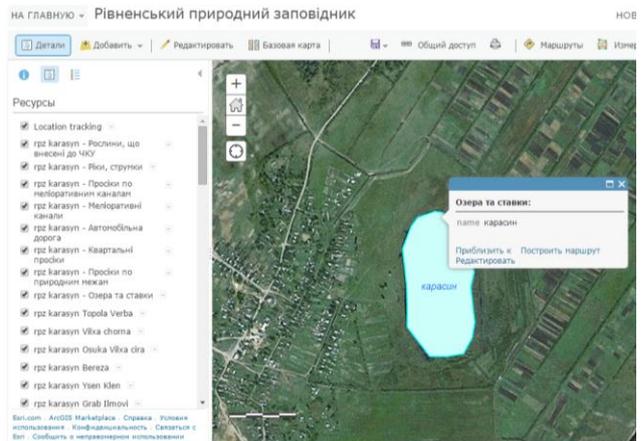*Fig. 6. Vectorization of the object on a mobile phone*

Fig. 7. The object (from Fig.6) formed in the app Collector for ArcGIS

The user can remain in the field while researchers in the office are able to process the information.

App Collector for ArcGIS also offers customization capabilities of regular messages (with a given time interval) to the server concerning the location of field workers, creating data about the routes of their movements with time [10].

Fig. 8 shows an example of recording our movements that we were doing in the area of NUWMNRU campus to verify the function.

Fig.8. Display of user's movements

Conclusions

The developed GIS contains mapping and attribute materials for Biloozersky, Karasinsky, Northern and Starosilsky forestries. Digital maps include the location of rare plant species with information about them. Using

ArcGIS Online service, the web map was published in the Internet. Using app Collector for ArGIS, a mobile system for collecting and updating the information by field employees of the reserve was suggested.

For the given mobile system to function, you must have Internet connection while collecting data. We plan to implement an offline data collection mode, when data synchronization will be performed upon the return to the office.

Implementation of such a system based on free software with open source also seems to be relevant.

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Mobile data collection system based on Arcgis to account for the biodiversity of the plant world of Rivne Natural Reserve

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The experience of creating geoinformation system for collecting data on the location of rare plant species on the territory of Rivne natural reserve is provided. The basic functions of the system based on ArcGIS software are described. The possibilities of mobile data collection and editing using ArcGIS Online and app Collector for ArcGIS are shown.