UDC 528.92

Andrii GALAYDA[1], Borys CHETVERIKOV[2], Ihor KOLB[3]

[1] Department of Development of National Infrastructure of Geospatial Data of the State Service of Ukraine for Geodesy, Cartography and Cadastre, 3, Narodnoho opolchennia Str., Kyiv, 03040, Ukraine
[2] Department of Photogrammetry and Geoinformatics, Lviv Polytechnic National University, 12, S. Bandery Str., Lviv, 79013, Ukraine, tel.+38 (063) 1671585, e-mail: chetverikov@email.ua, https://orcid.org/0000-0002-0992-5582
[3] Department of Photogrammetry and Geoinformatics, Lviv Polytechnic National University, 12 S. Bandery Str., Lviv, 79013, Ukraine, tel.+38 (063) 1671585, e-mail: ihor.z.kolb@lpnu.ua, https://orcid.org/0000-0002-1370-6235

https://doi.org/10.23939/istcgcap2022.95.065

METHODS OF CREATON A GEOINFORMATION ONLINE RESOURCE FOR GOVERNING A UNITED TERRITORIAL COMMUNITY

The aim of the work is to propose a method of creating a geographic information online resource for the management of Lisovohrynivetska UTC. To implement the tasks, a technological scheme was proposed, which consisted of 9 stages of work. The first stage involved the collection and analysis of disparate data in both vector and raster formats on the territory of the Lisovohrenivetska united territorial community. In the second stage, with the help of Global Mapper software, all vector data files in *.dxf and *.dmf formats, which were previously available, were converted to *.shp format for further processing in ArcGIS software. As a result of the conversion, graphic and attributive data were obtained in the required format and according to the layers they contain, the geodatabase with symbols according to the classifier was edited to create 1: 2000 scale plans. The next step was to unify the database of convertible files, as vector data was created with different construction of attribute tables. In addition, there is a need to enter vector data into the edited geospatial database. To do this, a ArcPy script was written that rearranges attribute tables and enters data into a geodatabase. Adjusted and populated the attribute database of vector objects for those columns where there was no information. The penultimate step was to develop the structure of the geoportal on the basis of ArcGIS-online to download the geodatabase to Lisovohrynivetska UTC on the server, to enable their external use with a unique login and password. The last step, after creating the structure of the geoportal, was to upload vector and raster geodata prepared by ArcGIS to the geoportal. As a result of the realization of the set purpose the technique of creating the geoinformation online resource for the management of the united territorial community is offered and described. During the implementation of the method the data of 24 disparate vector layers for the Lisogrynivtska community of Khmelnytsky region were processed and converted. Raster cartographic materials for UTC were collected and processed. The geodatabase according to the classifier for scale 1: 2000 is created. The structure of the geoportal based on the ArcGIS-online kernel with a connected map-base based on the online resource GoogleMaps, where all processed materials are downloaded, has been developed. The scientific novelty is to develop the concept of accumulation of heterogeneous vector and raster geospatial data in one geodatabase, by converting them into a specific format. Additional modules have been written in ArcPy to unify the database structure. Implemented geoinformation system is located on the geoportal and is designed for management decisions of community leaders. In addition, the created GIS can be used for land management and surveying work on community sites.

*Key words:*WEB-cartography, geoportal, data conversion, ArcGIS, geodatabase.

Introduction

The spatial factor plays an important role in the processes of creation and effective functioning of united territorial communities. In the process of managing community property and resources, when performing planning and control functions, it is necessary to operate with a large amount of geospatial data. In modern realities, the collection of such data, their accumulation in the relevant information systems, administration is also in the area of responsibility of local government. Therefore, the implementation of GIS technologies in the system of local administration is obviously an urgent task as a means to document, inventory, assess, monitor the condition of land and other real estate, justify management decisions on their use.

A large amount of spatial information is used for the needs of territorial administration. The best way to structure and administer it is to create geodatabases (GDBs). Obtaining reliable geodata from a certain frequency comes from up-to-date electronic maps, remote sensing data, global navigation systems, ground surveys, observations. In GDB it is also possible to organize storage of graphic and technical, reference documentation. In turn, these geodatabases operate in coordination with local geospatial data infrastructures (GDIs). This approach provides opportunities to operate on a variety of topics and origins of information. For example, topographic plans, administrative, cadastral and accounting maps, urban planning documentation, logistics data, utility data.

Leading countries are implementing GIS technologies in the practice of state and municipal government. The widespread use of special software tools, telecommunications systems and training of geomatics are the manifistations of this. The beginning of this process in each country can be considered as the development of national geodata infrastructures. The next step is to move to the local level with the creation of the appropriate level of geodata infrastructure.This segment of GDI is currently in the focus of attention of the Ministry of Regional Development, the State Service of Geodesy and Cadastre, a number of commercial and public organizations. There is the support of international donors and academic research institutions. There are good examples of implementation, mostly at the level of large, economically self-sufficient municipalities. The expected result of the ongoing research work in Ukraine is the development of a typical geodata infrastructure for the united territorial communities and individual urban settlements. It is envisaged that such an infrastructure will operate on the basis of both proprietary and open GIS software tools.

Geoportals are an important component of local GDI. Here are examples of organizing access to data on geoportals and sites with Web-mapping functions.

The first example is the well-developed interactive regional statistical atlas of Germany (Interaktiver Atlas zur Regionalstatistik), posted on the website of the German Statistical Office (https://www.destatis.de/EN/Home/_node.html). In addition to the color design of maps and the ability to change the color scale, the atlas offers a choice of the number of classes, as well as the method of data classification (method of equal classes or equal intervals) until the independent introduction of class values. There are opportunities to scale and navigate the map, get more information, build auxiliary graphs. The basic cartographic layers are the borders of the federal states and their administrative centers, the hydrographic network and the relief.

The second example is the US National Atlas (http://www.geoconnections.org), which is part of the US NSDI. Visitors of the site are offered several options for working with cartographic information: create your own map for printing and review, print prepared maps, view dynamic geoimages, and download data for use in "desktop" GIS applications. The section "Population" contains maps of population density, gender and age structure, as well as ethnic groups (the share of a nationality in the total population within the mapping unit) for the three census years: 1980, 1990 and 2000. There are opportunities to scale, view additional information when clicking on the object of interest, switching to the mode of viewing the legend to the map, as well as search (mainly by administrative-territorial units, cities). Elements of the cartographic basis (hydrographic and transport networks, borders and settlements, their geographical names) can be added to the thematic layer. One way of cartographic image cartogram is used. In addition, it is possible to freely download data from all sections of the atlas for further use.

It is easy to see that the cartographic tools in these examples are quite limited. This is a common feature of almost all Web-mapping systems on geoportals. First of all, it concerns the possibilities of thematic mapping – map diagrams, localized diagrams and structural icons, which are expressed graphically by diagrammatic figures with a complex structure.

We will provide an overview of the functionality of other foreign geoportals.

Discovery Portal is part of the GDI of Canada. CGDI is a full-featured geoportal, part of the GeoConnections service, which plays the same role as the US IP Geospatial One-Stop initiative. The CGDI project was launched in 1996 at the initiative of the IAGG Interagency Committee on Geometry and the Canadian Geometry Council CCOG. The main page of the geoportal contains a full set of search functions: search for spatial data, organizations and services, ie geographic information services according to the list of their functional types and application areas with recommended software.

The Australian Spatial Data Directory (ASDD), established in 1998 as part of the Australian Spatial Data Infrastructure (ASDI) (http://asdd.ga.gov.au), also implements all full search functions.

Finland's NSDI MapSite portal is currently replacing the "official" national geoportal. It contains two independent blocks that serve the interests of the general public and professionals, the interface is duplicated in Finnish, Swedish and English (http://www.karttapaikka.fi/karttapaikka/default.asp?id=787).

The National Geo-Portal of the Spanish IPE IDEE was opened in June 2004. Along with it, according to the three-level structure of the Spanish GDI, more than ten regional GDIs with geoportals are being developed or implemented. Of these, the IDEC geoportal of the province of Catalonia deserves special attention (http://www.idee.es). In terms of autonomy and relative independence from the center, the Spanish regional GDIs and their geoportals are different from the national ones.

In Ukraine, among the well-known scientists involved in the creation of geoportals (mainly the development of a state-level geoportal with NIGD) are Karpinsky Yu., Lyashchenko A., Chernyaga P., Cherina A., Bubyr N., Khazova N. and others. [Karpinsky, Lyashchenko, 2006; Chernyaga et al., 2010; Bubyr, Khazova, 2016].

Note the achievements of scientists from Poland and Germany [Fiedukowicz et al., 2018; Wachowicz et al., 2007], Italy [Corongiu et al., 2016; Giuliani, Peduzzi, 2011], Belgium [Crompvoets, 2017], Austria and the Netherlands [Crompvoets et al., 2004], the Czech Republic [Gkonos et al., 2018], India [Chandra et al., 2013; Reddy et al., 2022], Indonesia [Kinasih, 2019] and Ecuador [Tombo et al., 2021]).

Having considered all the most popular geoportals of different countries and based on their experience, we have developed our own vision of the components of the geoportal for UTC, which we implemented in this project. Our solutions were tested on the example of Lisovohrynivetska village united territorial community in Khmelnytskyi district of Khmelnytskyi region (https://lisovogrynivecka-rada.gov.ua).

The territory of the community is 257.9 km^2. Distance from the community center – with Lisovi Hrynivtsi to the regional center – Khmelnytsky – 10 km. The distance of most settlements to the administrative center of the community does not exceed 20 km. The H-03 Zhytomyr-Chernivtsi highway passes through the community. Distance to the nearest railway station – Khmelnytsky – 10 km.

The Lisovohrynivetska village united territorial community includes 8 Starostyn districts (14 villages).

The settlements that are part of Lisovohrynivetska UTC are provided by bus with the administrative center of the region. Road pavement to settlements is gravel and asphalt.

As of January 1, 2019, the permanent population of the Lisovohrynivets United Territorial Community was 7,628 people, which is 14.6 % of the population of Khmelnytskyi district (53,075 people) and 0.6 % of the population of Khmelnytskyi region (1,267,138 people). Population density on the territory of Lisovohrynivetska UTC – 30.02 people/km^2, (population density in Khmelnytsky region – 62 people/km^2).

Aim

The aim of the work is to develop a methodology for creating a geographic information online resource for the management of rural and urban UTC. This methodology should take into account the existing conditions in modern Ukrainian realities for obtaining geodata and the ability of communities to deploy their own information systems. Approbation of the developed methodology was performed on the example of Lisovohrynivets village united community of Khmelnytsky region.

Methods and results of work

To achieve this aim, a technological scheme is proposed, which provides for the consistent implementation of 9 stages (Fig. 1).

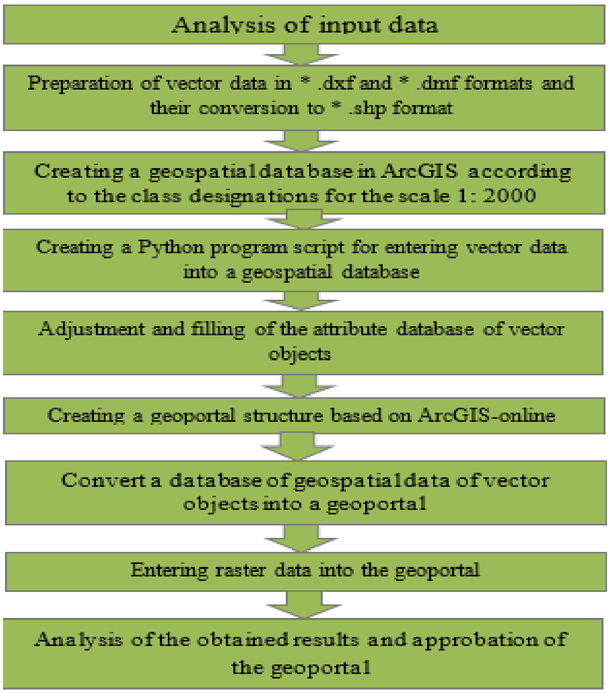

Fig. 1. Technological scheme of creating a geographic information online resource for the management of a united territorial community

The input data for the task were both vector and raster geodata in the settlements of Lisovohrynivets territorial community:

· raster plans of settlements of Lisogrynivtsi UTC and other graphic materials of town-planning documentation (fig. 2);

Fig. 2. General plans of settlements of Lisogrynivetska UTC

· Vector topographic plans of settlements, compiled and designed according to the symbols for the scale of 1: 2000. Vector layers of plans are available in exchange formats * .dxf (AutoDESK) and * .dmf (Digital Map Files of Geosystem) in coordinate systems SK-63 or USK-2000 (Fig. 3);

Fig. 3. Example of cartographic vector layers of settlements of Lisogrynivtsi UTC

· Orthophotoplans of scale 1: 2000 of the settlements of Lisogrynivtsi UTC (Fig. 4), obtained from aerial survey materials from the Abris Arrow UAV;

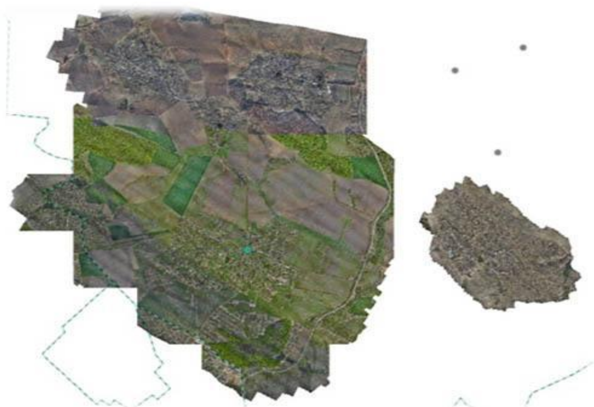

Fig. 4. Orthophotoplanes of Lisogrynivtsi UTC, created according to aerial survey data from UAVs

· data of the Public cadastral map of Ukraine.

According to the technological scheme, the second block after the analysis of input data is the preparation of vector data in * .dxf and * .dmf formats and their conversion into * .shp format. Since all existing vector topographic plans for the settlements of the Lisovohrynivets community were created in software Digital * .dmf format, we had a task to convert them to ArcGIS format. Exporting these plans to shape format reveals some problems with using different versions of *.dmf document templates.

From just one sheet of the plan in * .dmf format, 60 to 83 shapefiles are created for a typical rural community in the community. When creating shapefiles for ArcGIS and Digitals there are also differences in the dictionary of allowed characters (punctuation, apostrophes, spaces, parentheses, etc.), syntax and ways of encoding Cyrillic entries in file names, field names and values of attribute tables and a number of other features. In addition, the export of vector plan data to shape format should take into account their subsequent placement as object classes in geodatabases format ArcGIS software, the need to create cartographic representations for the correct display of plans by symbols. The software batch redesigns the data into the coordinate systems USK-2000 and WGS1984 Mercator Auxiliary Sphere. The latter coordinate system is used to reconcile geodata with the data of GOOGLE and ESRI mapping internet services. We solved the described conversion problems based on the experience of Kailas-K specialists by creating Python programming scripts for use in ArcGIS software.

The next step of the technological scheme is to create a geodatabase in ArcGIS to further fill it with vector data of UTC settlements, so that when converting data to the geoportal, the symbols of objects and the attribute database are preserved. We have chosen the existing structure of the geodatabase in * .GDB format, which is used by Kailas-K to form topographic plans at a scale of 1:2000. This structure includes sets of data classes with a corresponding description of attribute data (GDB provides the ability to use 301 classes of objects in accordance with the symbols for topographic plans at a scale of 1:2000), topological rules related to classes of geodata annotations and other database elements geodata.

One of the accompanying conversion tasks, which we have programmed in the scripts, is to combine the same type of data and reformat the attribute tables of each layer according to the modified structure of the geospatial database. Only after such multi-step preparation, this data is software downloaded to the geodatabase file.

Fig. 5 shows the ESRI ArcMAP software window with the project of filling the geodatabase with topographic information from shapefiles exported from software Digitals.

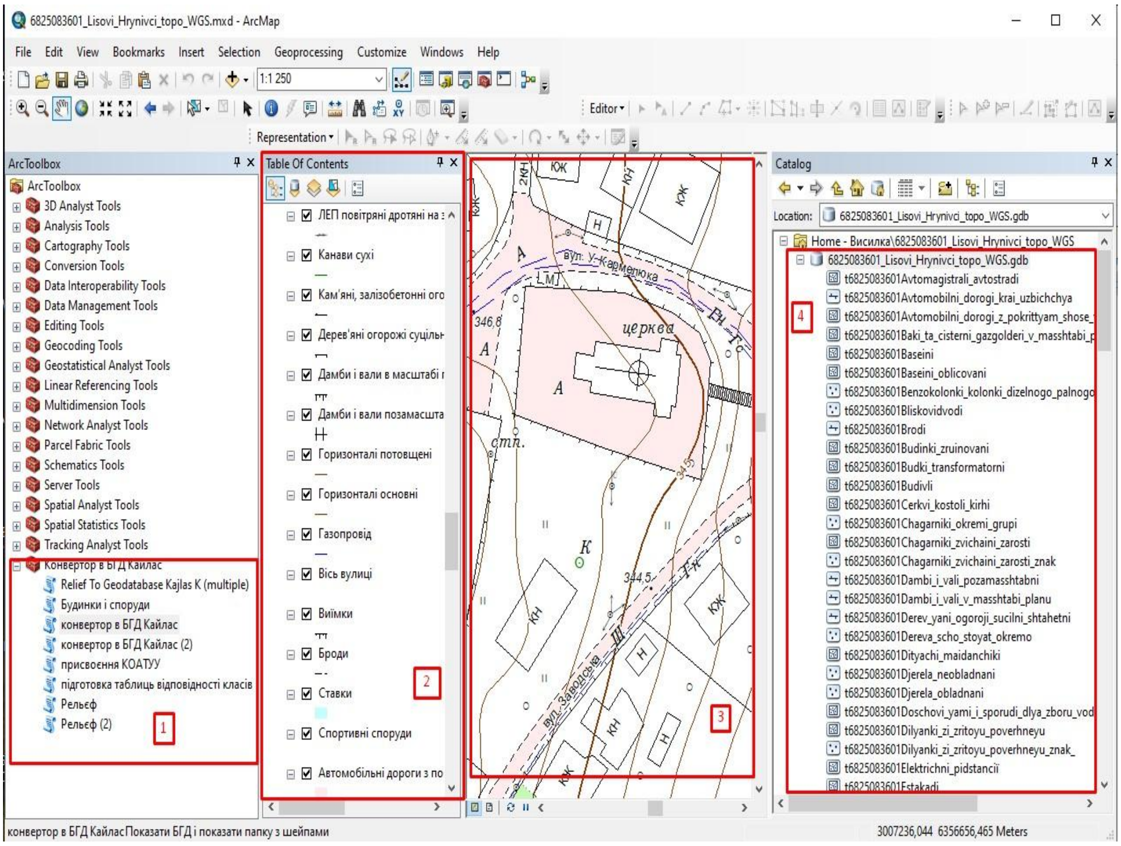

Fig. 5. Project of filling the geodatabase with topographic information in ArcMAP software

In Fig. 5, the numbers indicate: 1 – a group of geoprocessing tools developed by us on the panel ArcToolbox to perform vector data conversion; 2 – table of layered content of the electronic map document with symbols of objects; 3 – field for visualization of cartographic data from the geodatabase; 4 – ArcCatalog application window showing the structure of the filled geodatabase.

Actually scripts implement all the above manipulations with datafor polygonal, linear and point objects.

To control the operation of scripts, geoprocessing tools are equipped with appropriate interfaces with controls. Before running scripts, you need to select a database with classes for data sets with parallel conversion of attribute table fields. When starting the tools, we enter the required layers of input data and after execution we have combined tables and spatial data of the sum of layers of one type (Fig. 6).

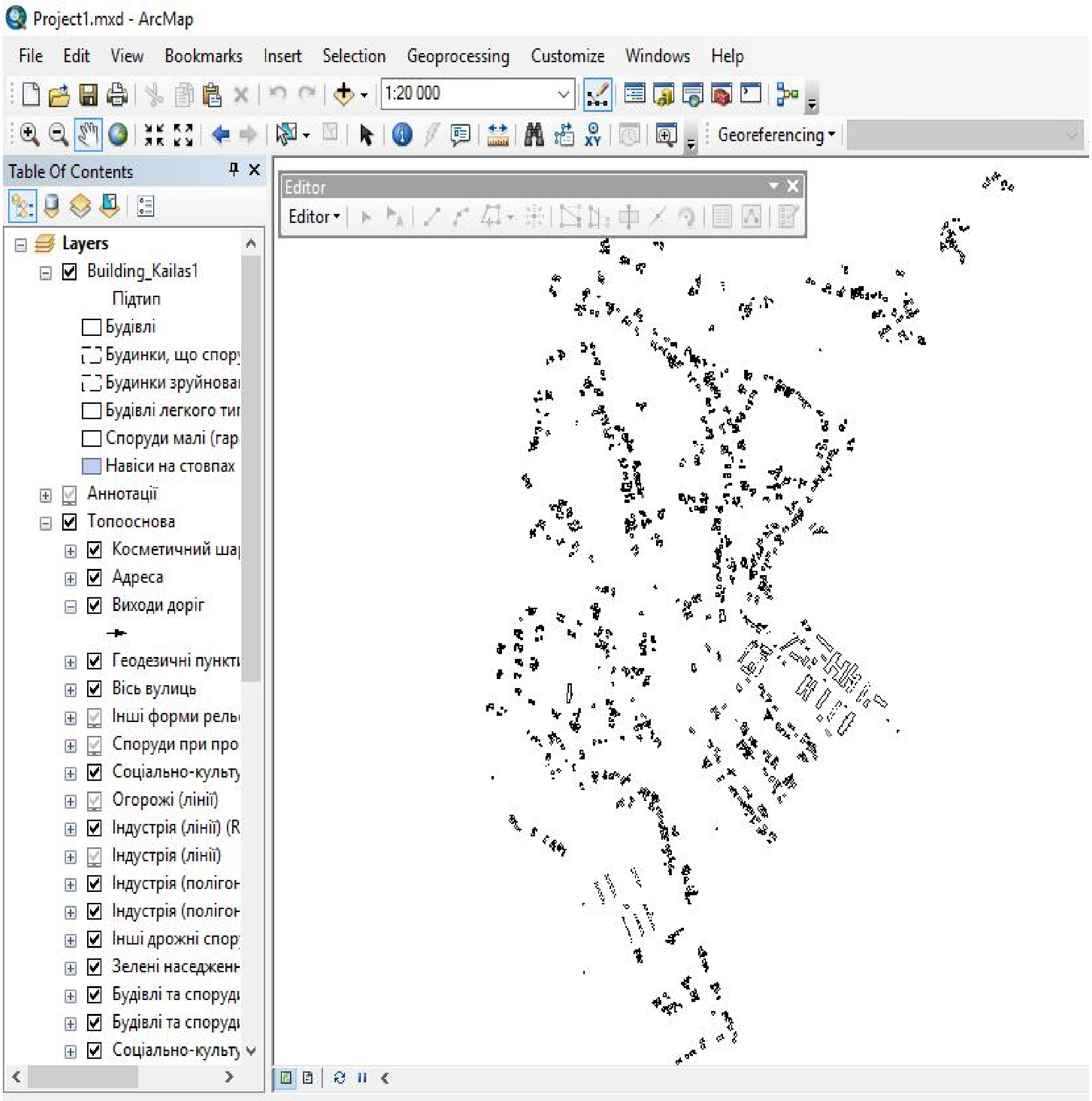

Fig. 6. The window of the converted layer of buildings to the geodatabase in ArcGIS

The structure of the geoportal was developed on the basis of ArcGIS Servers. And contained all the features that are available in ArcGIS. A map from the ArcGIS server was uploaded as the base layer of the geoport.

The first vector layer that we uploaded for testing in the geoportal was the boundary layer of the Forest-Hrynivtsi community of Khmelnytsky region (Fig. 7).

The next step was to download raster data, namely raster layers of master plans of settlements and raster layers of orthophotos created based on aerial images from UAVs (Figs. 8, 9).

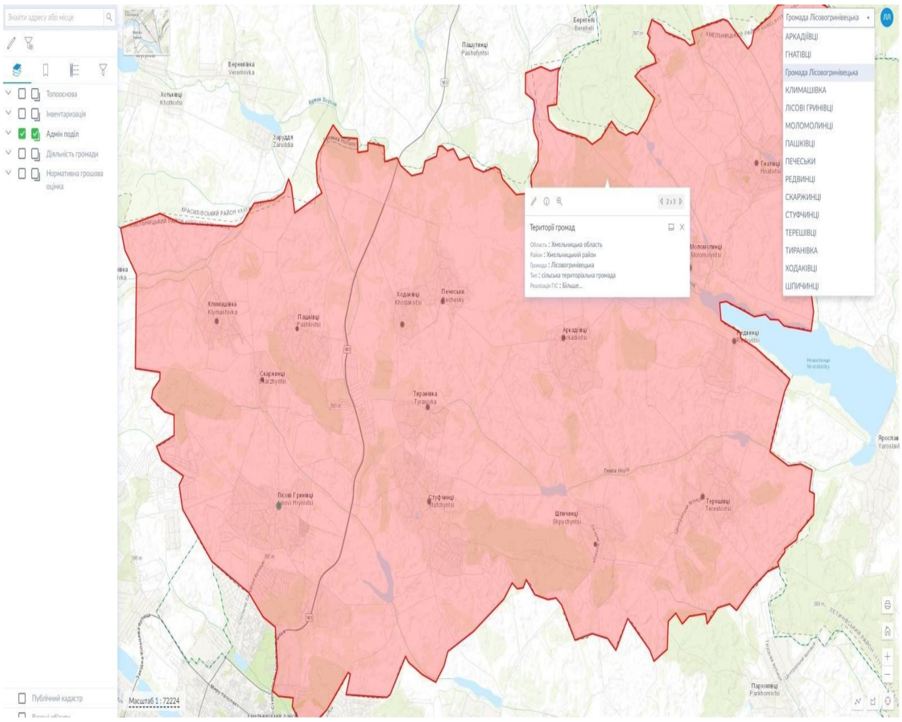

Fig. 7. Administrative map posted on the geoportal of the Lisovohrynivets community

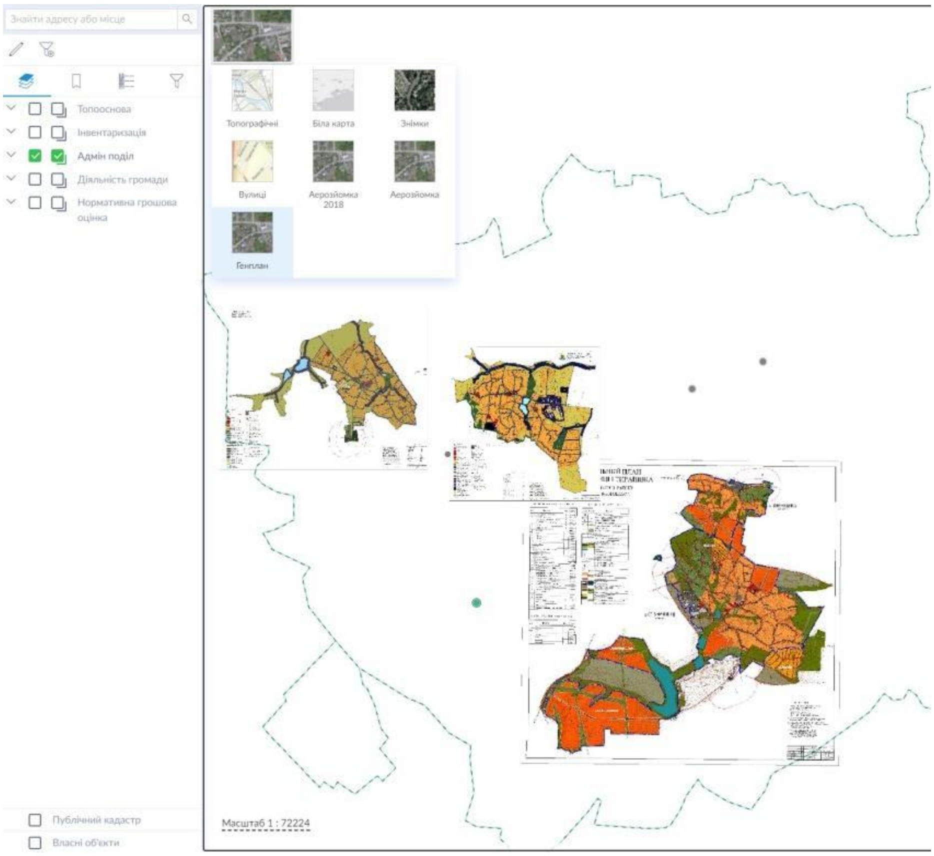

Fig. 8. Master plans of settlements are uploaded to the geoportal

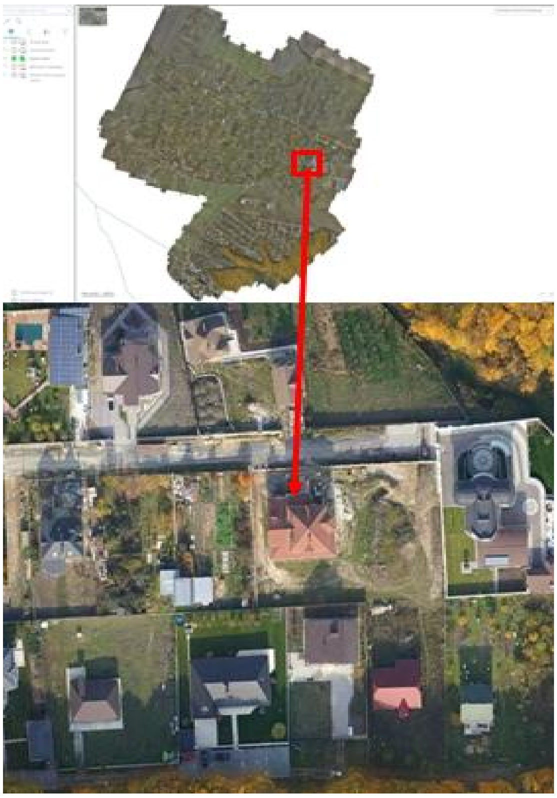

Fig. 9. Orthophotos uploaded to the geoportal based on the results of aerial imagery from UAVs in 2018. Magnified fragment below

Then the vector layers of topographic plans of settlements were uploaded to the geoportal, namely:

- power grid (Fig. 10);
- road network (Fig. 11);
- hydrography (Fig. 12);
- forest plantations (Fig. 13);
- buildings;
- network;
- relief;
- etc.

In addition, for the convenience of economic planning by the administrative bodies of UTC, the geoportal provides a quick transition to the website of the Public Cadastral Map of Ukraine.

Scientific novelty and practical significance

The scientific novelty is to develop the concept of accumulation of heterogeneous vector and raster geospatial data in one geodatabase, by converting themin a specific format.

The technological scheme of creation of geographic information online resource for the management of the united territorial community is offered. Additional modules have been written in ArcPy to unify the database structure. Implemented geographic information system is located on the geoportal and is designed for management decisions of community leaders. In addition, the created GIS can be used for land management and surveying work on community sites.

Fig. 10. The selected layer of the power grid is uploaded to the geoportal (as a basis used a space image from the ArcGIS server)

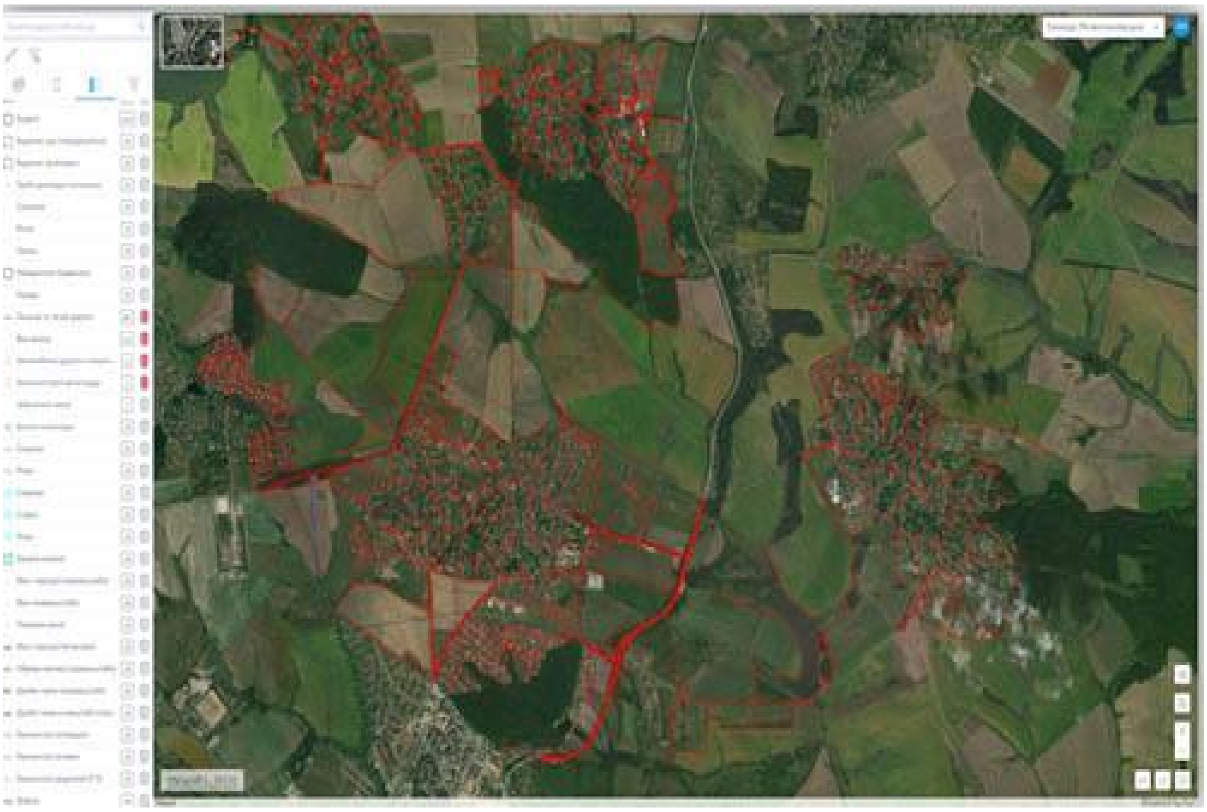

Fig. 11. The selected layer of the road network is uploaded to the geoportal (as a basis used a space image from the ArcGIS server)

Fig. 12. The selected layer of hydrographic objects is uploaded to the geoportal (as a basis used a space image from the ArcGIS server)

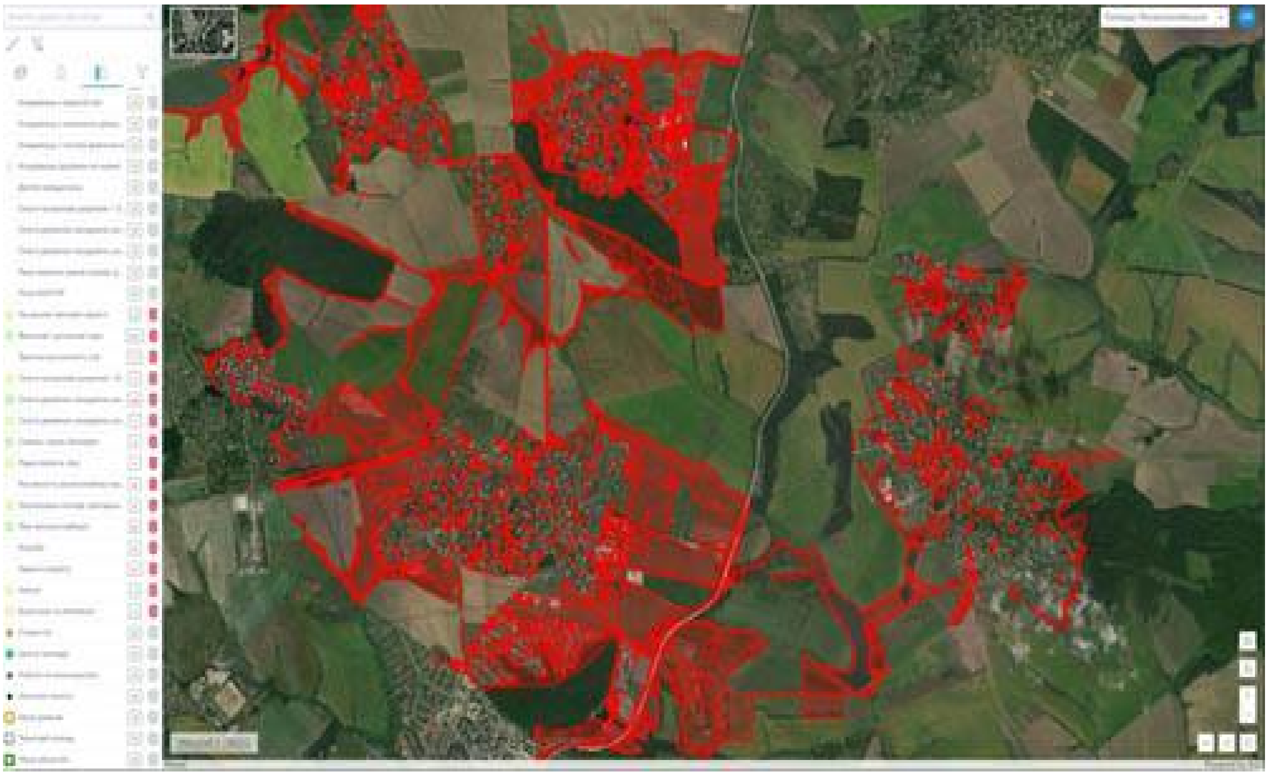

Fig. 13. The selected layer of forest plantations of settlements is loaded into the geoportal (as a basis the space image from the ArcGIS server is used)

Conclusions

As a result of realization of the set purpose the technological scheme of creation of the geoinformation online resource for management of the united territorial community which includes 9 stages, from the analysis of input materials to approbation of the created system is offered.

The method of creating a geographic information online resource for the management of a united territorial community is proposed and described. During the implementation of the method the data of 24 disparate vector layers for the Lisohrynivtsi community of Khmelnytsky region were processed and converted. Raster cartographic materials for UTC were collected and processed. The geodatabase according to the classifier for scale 1: 2000 is created. The structure of the geoportal based on the ArcGIS-online kernel with a connected map-base based on the online resource GoogleMaps, where all processed materials are downloaded, has been developed.

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Андрій ГАЛАЙДА[1], Борис ЧЕТВЕРІКОВ[2], Ігор КОЛБ[3]

[1] Департамент розвитку національної інфраструктури геопросторових даних Державної служби України з питань геодезії, картографії та кадастру, вул. Народного ополчення, 3, Київ, 03040, Україна
[2] Кафедра фотограмметрії та геоінформатики, Національний університет "Львівська політехніка", вул. С. Бандери, 12, Львів, 79013, Україна, тел. +38(063)1671585, ел. пошта: chetverikov@email.ua, https://orcid.org/*0000-0002-0992-5582*
[3] Кафедра фотограмметрії та геоінформатики, Національний університет "Львівська політехніка", вул. С. Бандери, 12, Львів, 79013, Україна, тел. +38(063)1671585, ел. пошта: ihor.z.kolb@lpnu.ua, https://orcid.org/*0000-0002-1370-6235*

МЕТОДИКА СТВОРЕННЯ ГЕОІНФОРМАЦІЙНОГО ОНЛАЙН-РЕСУРСУ ДЛЯ УПРАВЛІННЯ ОБ'ЄДНАНОЮ ТЕРИТОРІАЛЬНОЮ ГРОМАДОЮ

Мета роботи – запропонувати методику створення геоінформаційного онлайн-ресурсу для управління Лісовогринівецькою ОТГ. Для реалізації поставлених завдань розроблено технологічну схему, що складалася з 9 етапів роботи. Перший етап передбачав збір та аналіз різнорідних даних як векторного, так і растрового форматів на територію Лісовогренівецької об'єднаної територіальної громади. На другому етапі, за допомогою програмного забезпечення Global Mapper, всі файли векторних даних у форматах *.dxf та *.dmf, що були раніше отримні, конвертовано у формат *.shp для подальшого їх опрацювання в ПП ArcGIS. Внаслідок конвертації, отримано графічні і атрибутивні дані в потрібному форматі і згідно шарів, які вони містять, відредаговано базу геоданих з умовними позначеннями згідно класифікатору для створення планів масштабу 1:2000. На наступному етапі постало завдання уніфікації бази даних конвертованих файлів, так як векторні дані створено з різною побудовою атрибутивних таблиць. Окрім цього, виникла необхідність внесення векторних даних у відредаговану базу геопросторових даних. Для цього написано скрипт на мові Python, що перебудовує атрибутивні таблиці та вносить дані в базу геоданих. Проведено корегування і наповнення атрибутивної бази даних векторних об'єктів для тих стовпців, де була відсутня інформація. Передостаннім кроком була розробка структури геопорталу на основі ArcGIS-online для завантаження бази геоданих на Лісовогринівецьку ОТГ на сервер, для можливості їх зовнішнього використання за допомогою унікальних логіну і паролю. Останнім кроком, після створення структури геопорталу, було завантаження векторних і растрових геоданих, підготовлених у ПП ArcGIS на геопортал. В результаті реалізації поставленої мети розроблено і описано методику створення геоінформаційного онлайн-ресурсу для управління об'єднаною територіальною громадою. В ході реалізації методики опрацьовано та конвертовано дані 24 картографічних векторних шарів для Лісогринівецької громади Хмельницької області. Зібрано та опрацьовано растрові картографічні матеріали для ОТГ. Створено базу геоданих згідно класифікатора для масштабу 1:2000. Розроблено структуру геопорталу на базі ядра ArcGIS-онлайн з під'єднаною картою-основою на базі онлайн ресурсу GoogleMaps, куди завантажено всі опрацьовані матеріали. Наукова новизна полягає у розробці концепції нагромадження різнорідних векторних і растрових геопросторових даних в одній базі геоданих, шляхом конвертації їх у визначений формат. Написано додаткові модулі на мові ArcPy для уніфікації структури бази даних. Реалізована геоінформаційна системи розміщена на геопорталі та призначена для управлінських рішень голів громад. Окрім цього, створену ГІС можна використовувати для землевпорядних та геодезичних робіт на об'єктах громади.

Ключові слова: WEB-картографія, геопортал, конвертація даних, ArcGIS, база геоданих.

Received 23.04.2022