

Mon-21-061 Web mapping of Boguslav forestry as an example of visualization of forest cadastre data

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Introduction

All forests on the territory of Ukraine, regardless of the categories of lands on which they grow for the main purpose, and regardless of the right of ownership, constitute the forest fund of Ukraine and are under state protection. (Lisovi kodeks Ukrainy, 1994). Despite the relatively small wooded area (15.9%), Ukraine ranks ninth place in Europe in terms of forest area and sixth place in timber reserves. Conditions for afforestation in Ukraine are heterogeneous, so forests are distributed throughout the country unevenly. (Publichnyi zvit derzhavnoho ahentstva lisovykh resursiv Ukrainy, 2019). The Forest Cadastre began its existence in Ukraine in 1926, but the State Forest Cadastre was legally established only in 1977. Currently, there are two types of forest management in Ukraine: economic (traditional basic forest management) - carried out once every 10 years and operational (continuous forest management) - during which formed the current forest management plans. Both types of forest management require forest inventory, protection, combating unauthorized deforestation, environmental violations, and require up-to-date and objective information. This is exactly the information that the National Spatial Data Infrastructure can provide (NSDI). The creation of which is enshrined in law (Zakon Ukrainy «Pro natsionalnu infrastrukturu heoprosorovykh danykh», 2020) and provides the transfer of all geospatial data into electronic format for further accounting and updating according to common standards and rules, namely: the integration of all data into a single information system and providing open access to it through the geoportal. The NSDI also provides for the possibility of combining different layers of information: cartographic and geodesic bases, land plots, soils and their quality, relief, forests, water, geology; information about the results of agricultural production, buildings and structures, utilities, statistics, etc. The implementation of forest cadastre data in the NSDI will provide an opportunity to update the databases of forests and hunting grounds, increase the level of protection and conservation of forests, control the use of forest resources, effective planning of forest roads, etc.

Method and Theory

To create a web application, the state enterprise "Boguslav Forestry" was chosen, which began its activities in 1936. Currently, the forestry consists of seven forestry agencies: Boguslavsk, Potashnyanske, Medvynske, Tarashchanske, Ulashivske, Bushivske, Olshanytske, as well as Boguslavsky and Olshanytsky lower warehouses, Boguslav transport department and Tarashchansky wood processing department. The total area of the forestry, according to 2014 year's data, is 30,164.5 hectares, under the forest - 28,177.6 hectares. Forests of SE "Boguslav Forestry" are referred to the following forest categories: forests for environmental, scientific, historical and cultural purposes - 697.0 hectares; recreational and health forests - 2383.0 hectares; protective forests - 2709.2 hectares; operational forests - 24,440.8 hectares. The main activity of the SE "Boguslav Forestry" is the timely implementation of measures for the restoration of forests with a focus on the main forest-forming species, preservation and improvement of environmental, preventive, sanitary, aesthetic, and other economic functions of forests, security and protection of forest plantations from illegal logging, fires, diseases and pests, meet the needs of local timber companies, organizations and the population, use of forest resources without harming the environment.

The first stage of the work was to find and prepare the source materials: the plan of the territory of Boguslav forestry, the plans of the plantations of the All-Ukrainian Association «Ukrderzhlisproekt», statistical data on forests and individual areas. Downloading a raster image of the plan of the territory of Boguslav forestry and its georeferencing were performed in QGIS program, free and open GIS program, which allows to create, edit, visualize, analyze and publish geospatial information. The forest area consists of four divided forest arrays, which, as it became known in the process of geotagging, were spatially shifted relative to each other with a certain margin, due to which each forest array was tied separately. During the spatial binding of scanned sheets, a basic map of World Imagery from WMTS server ArcGIS Online in the coordinate system WGS 1984 projection Pseudo Mercator was used, which corresponds to the spatial binding of the tile system of base maps of such popular mapping web services as Google Maps, OpenStreetMap and so on. The reference points for binding the raster were selected according to the characteristic contours of the area, which can be recognized in the space image: the boundaries of forest quarters, turning and crossing points of roads, power lines, etc. In the process of preparing the materials there were some difficulties.

For example, when creating a web application, there was used a scanned raster image of a paper plan of forest plantations of Boguslav forestry with a significant number of colors and their shades, which are difficult to perceive and distinguish by a human eye. In addition, plans for such forest plantations were made at different times, by various units of the All-Ukrainian Association «Ukrderzhlisproekt», so there is no single legend for all plans. As a result, the maps differ in the tone of the colors which are used to mark those or others species.

The second stage involved vectorizing objects and filling the database with attribute information. Each object on the electronic map has a set of attributive information that can be used to visualize data, object captions, or simply to provide / output / save additional information. The attribute information is stored in the form of a spreadsheet. Each column has its own data type (text, integer, floating point number, etc.). Based on the georeferenced image, the thematic layer "Forests" was created, with the following attribute information: quarter number, selection number, tree type, age characteristics of trees, area, category and subcategory of forests. In total, the table of attributes includes information about 1157 forest sections with the photos of typical trees for each of the sections. **Figure 1.**



Quarter number	Selection number	Tree type	Age characteristics	Area	Category	Subcategory
1	1	Oak	10-15	100	Operational	High-stemmed oak-rod oak
1	2	Pine	10-15	100	Operational	Pine, larch
1	3	Birch	10-15	100	Operational	Others
1	4	Maple	10-15	100	Operational	Others
1	5	Alder	10-15	100	Operational	Others

Figure 1 Fragment of the attribute data table (layer "Forests")

The third stage was actually creating a web application, customizing images, captions, etc. The ArcGIS Online platform was chosen to create the web application. It allows you to distribute data and has the access to maps from any device to perform spatial analysis. Through the built-in map viewer, a gallery of basic maps and tools for adding your own data or layers are available. You can add shapefiles, spreadsheets, KML files, cached mapping services, GeoRSS and GPS files, and you can also easily combine data and maps provided by other users. Esri regularly updates the gallery of basic maps, so such important features like having a free subscription, handy interface and sufficiently wide range of visualization tools have led to choose this platform.

At the fourth stage, changes in forestry condition were analyzed. Space images from Landsat 5 and 8 satellites for August 1985 and 2021 were included for input. As a result of image processing, thematic rasters were obtained in natural, artificial colors and the vegetation index (NDVI) was calculated. **Figure 2.**

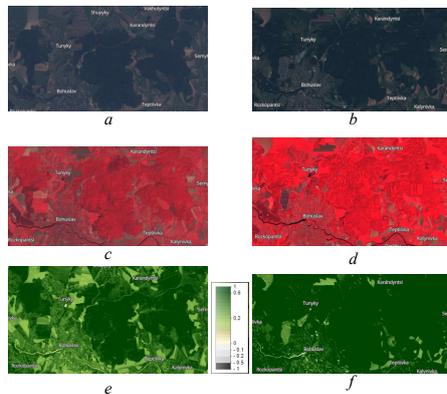


Figure 2. Fragments of thematic rasters of space images Landsat 5 (25.08.1985 - a, c, i) and Landsat 8 (25.08.2021 - b, d, f): a, b - images in natural colors (combination of channels 3,2,1 and 4,3,2); c, d - images in artificial colours (combination of channels 4,2,2 and 5,4,3); e, f - vegetation index NDVI (above 0.5 corresponds to good vegetation).

The analysis of processed space images revealed the following: the boundaries of the forestry have not changed in 36 years, the vast majority of forest stands are deciduous species, but conifers in 1985 year were more (area in the northern part of the forestry, which corresponds to the dark red color in the picture artificial colors), in the picture of the year of 2021 there are significant areas of felling, which are planted with young forest. Calculated NDVI shows that in August 2021 the general condition of vegetation is better than in 1985. The result is, in particular, more favorable weather conditions, the presence of sufficient heat and humidity.

The created cartographic web application contains information about the borders of forest districts of Boguslav forestry, forest categories (operational, recreational, health, protective), the main element of the forest (areas with predominant tree species). When displaying data on the map, the principle of spatial generalization of the map is used - the information capacity varies depending on the selected scale - from forest districts on a small scale (1:75 000) to areas with predominant species on a scale of 1:15 000 and larger. In setting up the map layers, it is possible to connect data from the Public cadastral map of Ukraine - the layer of cadastral areas and the layer "Forest cadastre" (boundaries of forest lands). For a more detailed familiarization with the territory of forestry, you can use any basic maps that are available in the gallery ArcGis Online (topographic, OpenStreetMap, relief (Terrain) and others). Built-in tools (widgets) for a cartographic web application allow you to measure line lengths and areas using different units of measurement. It is possible to determine the coordinates of both the selected point on the map and its location in the forest. The color design of the web application is made in green color, which corresponds to both the content of the map and the associative perception of the target audience. **Figure 3.** The finished web map is published on the Internet as a web application using built-in electronic map display templates. <https://arcgis.com/arcgis>



Figure 3 Web application of forest cadastre data of Boguslav forestry

Conclusions

The sources of information about the environmental, economic condition and legal regime of using the forest fund of Ukraine are the State Forest Cadastre, which is maintained on the basis of the State Land Cadastre. Updated forest cadastre data will be included as part of a single cadastre system to the NSDI, which allow to systematize information about the geospatial data and metadata and to receive quality analysis. The law provides that all information will be open and free of charge and will be updated in real time. Geospatial data will be under state control. The created web map of Boguslav forestry is an example of improving the display of information of the state forest cadastre in the NSDI. The following electronic map of forest plantations in free access can be useful for scientific purposes for collecting and processing data related to the dissemination of certain species of trees, as well as for designing new protected areas, for navigation in the forest and checking suspicious deforestation for their legality, avoid the deficiencies of paper plans for afforestation. The developed web application can be interactively supplemented with additional data, such as space images, thematic rasters and maps, charts. **Figure 4.**

Species composition of the forest

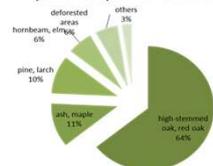


Figure 4 Diagram of the forest species composition. Among other species - white acacia, black alder, birch, poplar, willow, linden, walnut, fruit.

References

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