Development of Gis and Web Maps in Order to Extend Water Supply and Sewerage Infrastructure in Lechinţa Village, Iernut Town, Mureş County

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RESEARCH ARTICLE

Abstract

In Romania's most rural parts, the urban networks are not sufficiently developed. In order to improve the living standards of the inhabitants of Lechinta village, Iernut city, Mures county, it is necessary to extend water supply and sewerage infrastructure. For a better visualization and understanding of the interest area, a database was created in which the constructions, buildings, electrical and optical fiber networks, infrastructure and access ways were digitized. Considering the created database and the digital elevation model of the terrain, it was possible to easily design the water supply and sewerage infrastructure that allowed a better management of the field measurements. In order to ensure a higher degree of details, but also to complete and verify the measurements made with GPS receivers, photogrammetric and LiDAR data were obtained using a UAS equipped with the TopoDrone LiDAR 100 Lite sensor and the Zenmuse X4S DJI camera. The field data were imported into the ArcGIS application and analyzed in order to achieve the water supply and sewerage infrastructure. In order to visualize the digitization of the elements in the field, web maps were made using ArcGIS online application. The first map allows a 3D view of the area of interest and the second map includes 5 applications: database visualization, selection of desired layers, determination of distances and surfaces, use of different basemaps as well as sharing information through email, Facebook, etc. Database and webmaps that were created contribute to an easier design of urban networks and the visualization of the land in real time.

Keywords GIS, web map, water supply and sewerage infrastructure

INTRODUCTION

In most rural areas of Romania, the urban networks are not sufficiently developed. In order to improve the living standards of the inhabitants of Lechinta village, Iernut city, Mures county, it is necessary to extend water supply and sewerage infrastructure. In Romania, the urban areas have well-developed urban networks but in many rural areas, they are deficient. In recent years there are more and more concerns about the expansion of these networks in order to raise the standard of living of the inhabitants (Păunescu et al. 2017). The aim of the work is to design a water supply and sewerage infrastructure in Lechinţa village. Lechinţa is a village in Iernut town, Mures county located in the central part of the Transylvanian Plateau, on the middle course of the Mureş River between the towns of Târgu Mureş (30 km) and Luduş (14 km), at a north latitude of 46°27′13" and an eastern longitude of 24°14′0". The absolute altitude of 286 meters is located in the area of the Roman Catholic Church. The city's surface is 106 km² and occupies 1.5% - 2% of Mures County. The city of Iernut is located on the left bank of the

Mureş River, on the National Road DN15, respectively on the European Road E60, between Târgu Mureş, Turda and Cluj-Napoca (Figure 1).
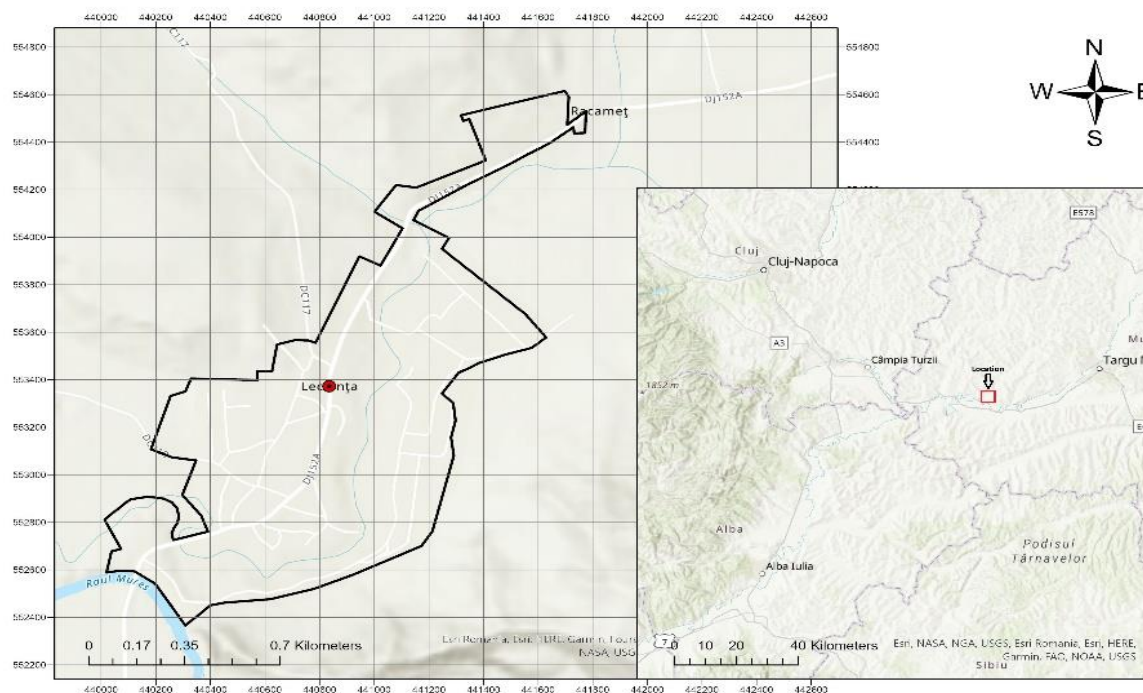

Figure 1. Geographical location

MATERIALS AND METHODS

Field measurements were carried out with 2 Unistrong G10 GPS receivers, using the Base-Rover UHF communication method, the base point being determined using the rapid-static method, with the permanent station from Târgu Mureş as reference (Figure 2).
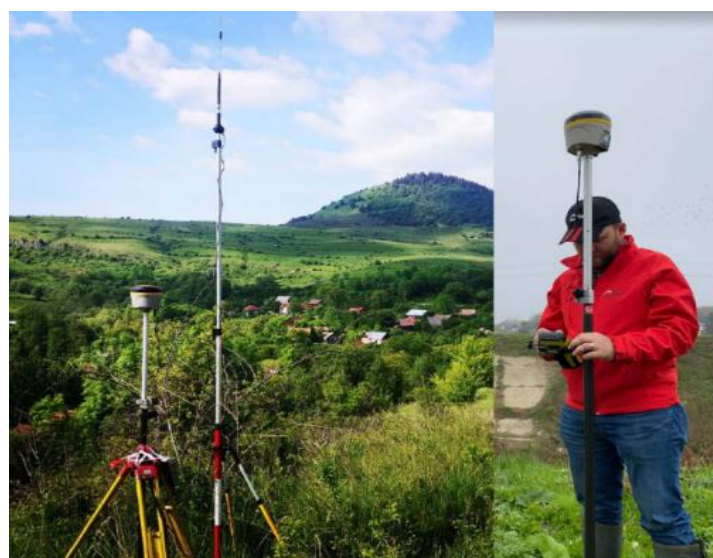

Figure 2. GNSS equipment in base-rover working mode, UHF transmission mode

In order to obtain as many details as possible from the field but also to verify the measurements made, photogrammetric and LiDAR data were collected with the help of an UAS equipped with the TopoDrone LiDAR 100 Lite sensor and the Zenmuse X4S DJI camera. The digital orthophotomap was obtained by processing photogrammetric images taken during the flight (Figure 3) (Chiţea, 2003; Şuba et al., 2017).
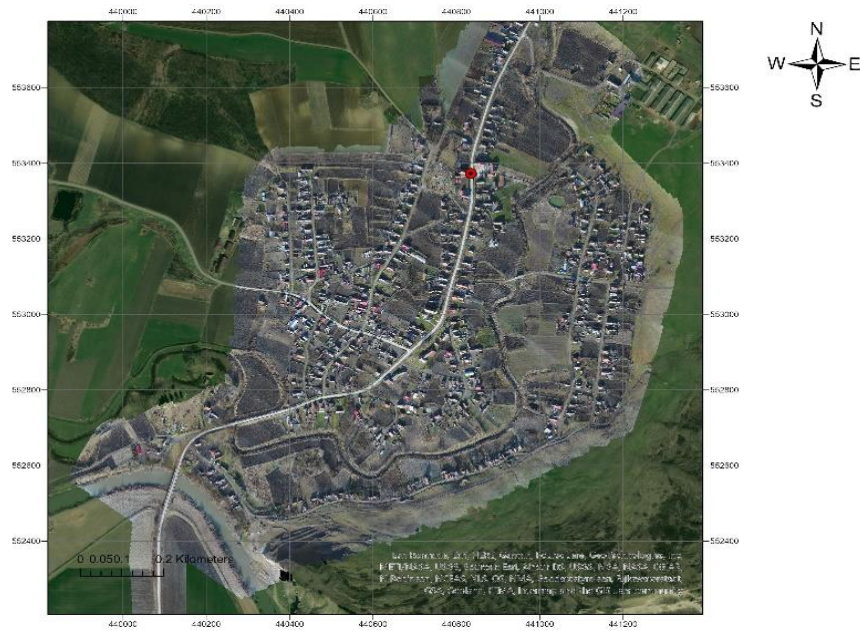
Figure 3. The ortophotomap of the study area

The latest professional desktop application from Esri is ArcGIS Pro. This application allows the creation of a database on which different analysis and filters can be applied and also permits the creation of 2D and 3D maps as well as the sharing of the database in ArcGIS online so that it can be accessed from any device. ArcGIS online offers the possibility of viewing and editing layers in real time (Badea, 2013; ArcGis Online, 2022).

The field measurements were incorporated into the ArcGIS application and a database was created by digitizing the constructions, buildings, electrical and fiber optic networks, infrastructure and access roads. In this way, a better visualization and understanding of the entire area of interest is allowed (Figure 4 (a) and (b)) (Almagro, 1999; Droj et al., 2016).
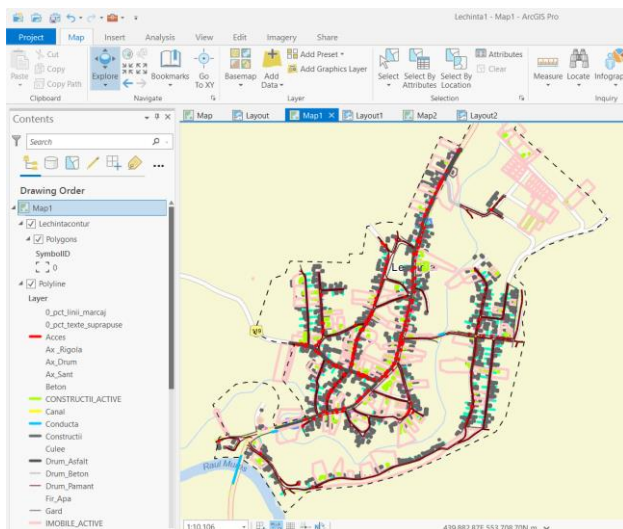
(a) Data base in ArcGIS Pro, basemap: Streets
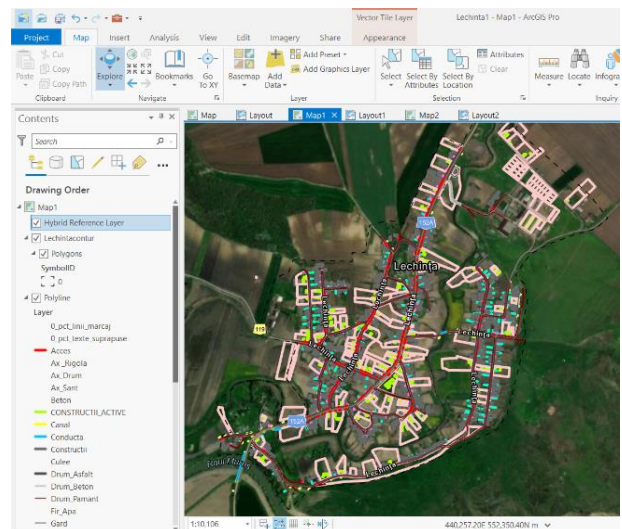
(b) Data base in ArcGIS Pro, basemap: Imagery Hybrid

Figure 4. Database management

RESULTS AND DISCUSSIONS

An ArcGIS web map is an interactive display of geographic information that can be analyzed (ArcGis Online, Web maps, 2022). A Web map contains a basemap that can be chosen (such as: imagery, strets, navigatin and so on), a set of data layers (each layer includes information about the data: name, length, area etc.) and navigation tools to pan and zoom (ArcGis Online, Web maps, 2022). The web maps offer different options such us to add layers, to draw,

measure directly to the map (ArcGis Online, Web maps , 2022). In order to view and analyze the digitized elements in ArcGIS in real time from any device, web maps were created to help the teams on the ground.

A web map (in 3D format) that highlights constructions, roads, sidewalks and grooves was created to easily determine the possible route of the water and sewage network. This web map allows users to study the area from different angles such us the top view (Figure 5 (a)) or front view (Figure 5 (b)).

(a) Top view

(b) Front view

Figure 5: 3D web map with constructions, roads

An important facility offered by ArcGIS Online is the possibility to create maps that allow the analysis of data from different devices directly on the field. To exemplify this facility, a webmap was created in which different options were used to make the work easier for the teams in the field (Figure 6).

In this sense, the following options were chosen: Measurement, Layer List, Legend, Basemap Gallery and Share.
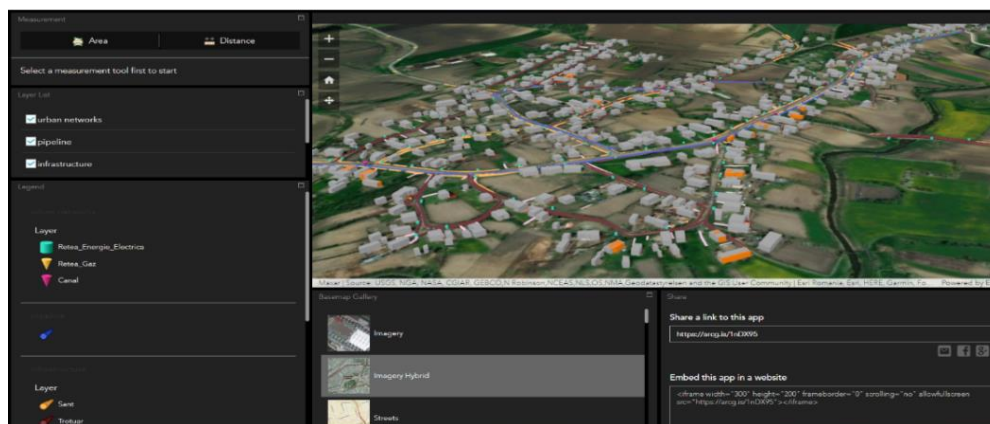

Figure 6. Web Map

The Measure widget allows users to measure the area and the perimeter of a polygon and the length of a line. This tool can be useful to find easily and quickly the distance between two points or the area of a polygon in the field. In Figure 7, the distance between two manholes was measured.

Figure 7. Measurement

The Layer List widget provides a list of layers and their symbols, and allows users to turn individual layers on and off. Each layer has a check box that allows the control of the visibility and of the order of the layers in each widget. For a better visualization of the pipeline, the enabled layers that can be seen in Figure 8 are: urban networks and pipeline and the disabled ones are: infrastructure and shape.
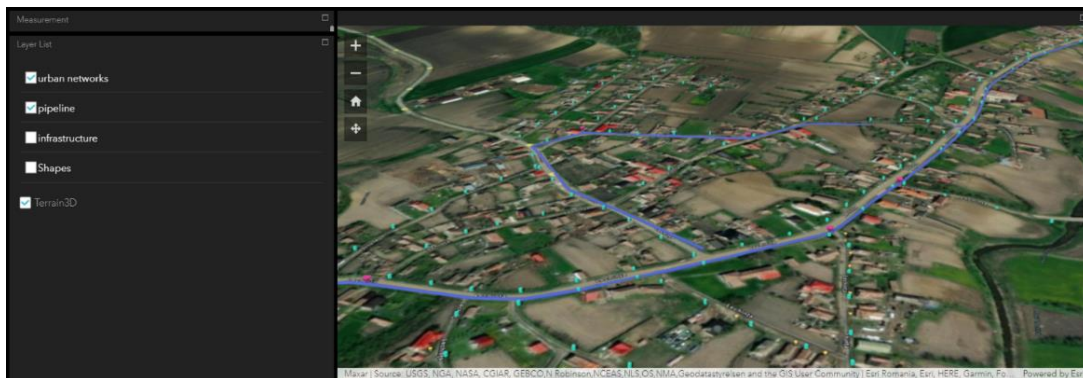

Figure 8. Layer list

The Legend widget displays labels and symbols for layers in the map and can be set to automatically update when the visibility of a layer or sublayer changes. In Figure 9 the three types of the urban networks, the pipeline, the infrastructure (different types of roads, grooves and sidewalks) and buildings are presented, with different symbols and colors.

Figure 9. Legend

The Basemap Gallery widget presents a gallery of basemaps: imagery, imagery hybrid, streets, topographic etc. and allows users to select one from the gallery as the basemap for their app. In Figure 9, the Imagery Hybrid basemap was used to visualize all the details on the field while in the Figure 10 the Streets basemap was chosen for a better visualization of the pipeline network.
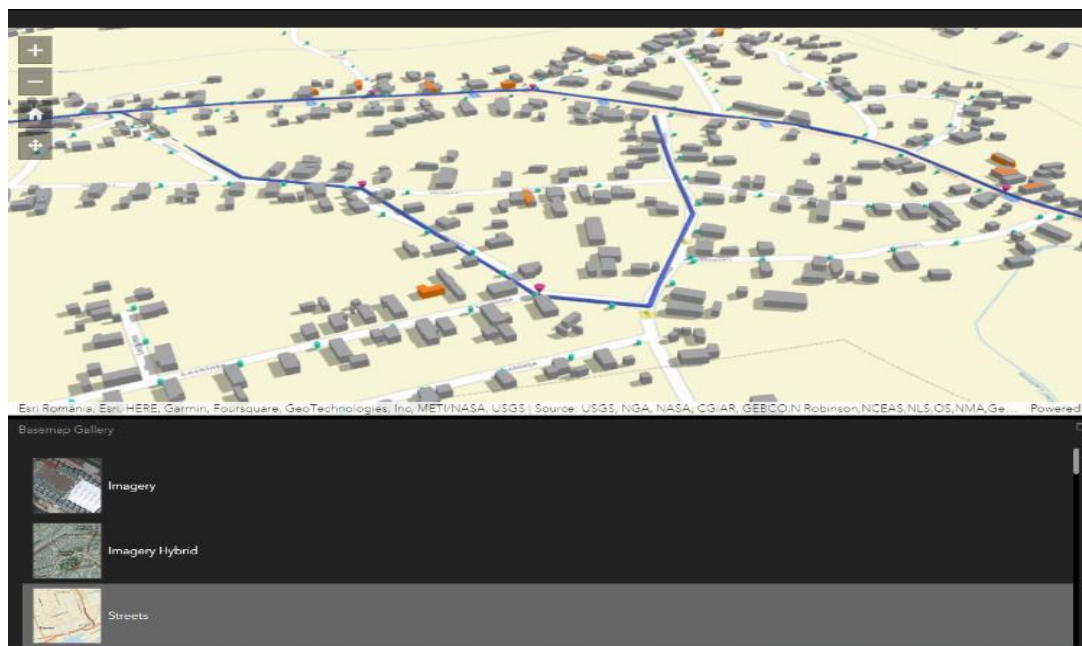

Figure 10. Basemap Gallery

The Share widget offers the possibility to share an app by posting it to social media, sending an email with a link, or embedding it in a website or blog. It also provides an easy way to define URL parameters for the app (Figure 11). This option is very useful because everything that is edited in the web map from the field can be transmitted to other people who can see the changes made in real time.
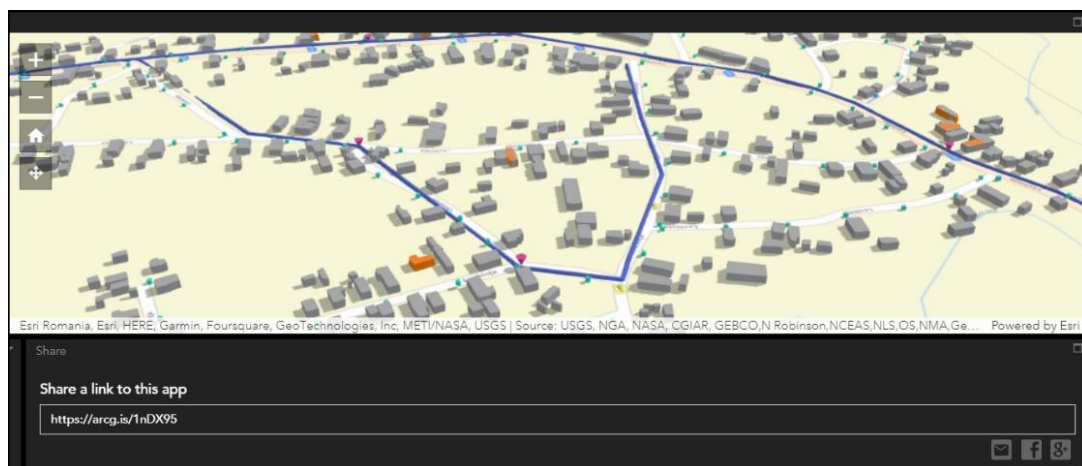

Figure 11. Share

CONCLUSIONS

The development of urban networks brings a contribution to the inhabitants for a better life. The measurements made with the GPS can be supplemented by photogrammetric measurements made with a drone equipped with cameras and Lidar sensors. As a result, the orthophotomap of the land was obtained.

The best solution to visualize and analyze all the elements in the field is to create a database with geographic information. Incorporating the measurements made in the ArcGIS application, a data set that includes layers for each feature class type was created. Using this database, interactive web maps were created. Those maps can be accessed from any device in real time. The advantage of those maps is that a web map can be viewed at the same

time by several users on different devices.

REFERENCES

1. Almagro A. Photogrammetry for everybody, International Archives of Photogrammetry and Remote Sensing, vol. XXXII, CIPA Symposium, Olinda, Brazilia. 1999;
2. Badea AC. Cadastre. Databases and GIS applications in urban areas, Conspress Publishing House, Bucharest, Romania. 2013;
3. Chiţea G, Kiss A, Vorovencii I. Fotogrammetrie şi teledetecţie, Editura Universităţii Transilvania, Braşov. 2003;
4. Droj G, Droj L. GIS based automated valuation models – A Genuine Solution for Real Estate Valuation in Romania, RevCAD Journal, 2016; 20: 45-52.
5. ArcGIS Online, Webmaps, 2022; https://doc.arcgis.com/en/arcgis-online/reference/what-is-web-map.htm
6. ArcGIS Online, 2022; https://www.arcgis.com/index.html
7. Matei F, Aldea N. Sisteme informatice geografice ARCGIS. RisoPrint, Cluj-Napoca, 2014.
8. Păunescu V, Călin M, Manea R, Moscovici A, Sălăgean T. GIS in Active Monitoring of Green Spaces, Modern Technologies for the 3rd Millenium: 2017; 73-78.
9. Şuba EE, Sălăgean T, Pop I, Matei F, Deak J, Coroian I, Ficior D. Using Photogrammetric UAV Measurements as Support for Classical Topographical Measurements in Order to Obtain the Topographic Plan for Urban Areas, Bulletin UASVM Horticulture, Cluj-Napoca, 2017.