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THE USE OF GEOGRAPHICAL INFORMATION SYSTEMS AND LIDAR TECHNOLOGY IN THE FIELD OF ARCHAEOLOGY

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Abstract

The paper aims to present the early stages in the implementation of a Geographic Information System in the field of archaeology and its advantages. This field uses the spatial information in the required activities, whether in research or management. The chosen area of study is located in the West part of Galaţi City. We used as support data the orthophotoplans of that area, produced by National Agency for Cadastre and Land Registration, a topographical map produced by D.T.M, sets of photographs of archaeological sites in the area, taken from the helicopter and a LiDAR dataset for the archaeological site from "Bărboşi".I wanted to highlight the placement of these objectives in the area of study and to present the potential that LiDAR technology has in archaeology. For this I drew up a situation plan based on the digitised data, I realised a Digital Terrain Model using contours and points of known elevation from the topographic map. I generated a Digital Terrain Model based on LiDAR data, for archaeological site from "Bărboşi" and I showed a few of the analysis possibilities on the basis of this model.

Keywords: *LiDAR, Bărboşi, GIS, Galaţi, archaeology*

INTRODUCTION

This paper aims to present the possibilities and benefits of using a Geographic Information System in archeology. This domain necessarily uses spatial information in its research or management activities.

Although we can view and create maps with a GIS application we should not confuse this technology with digital cartography. The main difference lies in the fact that a GIS application offers the possibility to manage and analyse data. Therefore any research project that includes spatial information, such as archaeological research projects, needs GIS

In a GIS we can integrate different types of data from different sources in a single computer environment, which brings a huge benefit and contributes to the data protection, management and planning. We can overlay the information in a database with other types of information (maps, plans, photographs, etc.). Thus, a GIS database populated with comprehensive and accurate information, represents the basis for decisions regarding the objectives. Decisions must be fair and prompt, especially since these objectives require protection against destruction.

In our country, the National Archaeological Record of Romania (which is based on GIS technology) was founded for the clear need to locate archaeological sites and to protect them.

GIS also offers the possibility of completing and updating the data during the accumulation of new information.

You can work with 3D data, with 3D models of archaeological sites, thus introducing the

concept of virtual archaeology. You can produce videos through the virtual flights for the presentation and promotion of national tourism.
Fo instance, geomorphological analysis may be carried out on the basis of the accurate and detailed data sets provided by LiDAR technique. You can monitor changes of the objectives over a certain period of time.
Another advantage of building a GIS is the fact that in Romania you can find affordable hardware platforms that can run GIS applications.
Similarly, in the software, there are free solutions and representations of world famous GIS software companies.
For institutions whose business requires such spatial information GIS is beneficial. In our country, though some institutions already use this technology, we have not reached the point where we have a unified system covering all the data.
So, we present the basics of this technology and the first steps in implementing a GIS to be a starting point for further development, serving different purposes.

MATERIAL AND METHOD

The Software used for building the database is ArcGIS, version 9.3.
For the representation of archaeological sites in West side of Galaţi City and their integration into a GIS, I have realized a Digital Terrain Model based on the contours on the topographic map, at 1:25 000 scale and for shaping the site from Barboşi, I used the cloud of points obtained through laser scanning.
In the area there are 19 archaeological sites that will be integrated into database.
In order to cover that area, 12 trapezoid maps were georeferenced and unified at 1:25 000 scale.
The maps were made in 1981 using the Gauss-Krüger projection system. The georeferencing was performed using geographical coordinates of the corners. These coordinates were transformed into a Stereo 70 projection system using the *NEGO* software.
Contours were digitized using assisted method and together with the known elevation points, were the input data for the generation of digital terrain model. The DTM was obtained using Topo to Raster method in ArcGIS.
After generating the digital terrain model, the next step was tracing the areas containing archaeological sites. We're talking about archaeological sites that are difficult to identify on the orthophoto. Therefore tracing has been carried out using the support of photos taken from a helicopter. I created a polygon-type shape file, I digitized every goal and then I attached the appropriate photo, to highlight very well these mounds, using Hyperlink option.
Also, the outlined archaeological areas were highlighted on the photos.
The resulting data was overlapped over the DTM with the help of ArcScene application.
I was also tracing hydrography elements, items that belong to the agricultural, building and road areas.
The archaeological site of Bărboşi was scanned with the Leica ScanStation 2 laser scanner, that retrieves points using the time of flight measurement technique. The data was taken from three positions of the scanner and then were unified into a single cloud of points using the targets placed on the ground. The cloud of points was filtered to use in processing only the points which belong to the ground. Filtering was conducted using *ALDPAT* software (Airborne LiDAR Data Processing and Analysis Tools) with *ETEW* method (Elevation Threshold with Expand Window).
This method filters data, transforming it into a surface consisting of square cells. All points in each cell are removed, except the ones with the smallest share. For the next stage, the cell size is increased and, thus, in each cell there will be another minimum share. This stage is repeated, in order to eliminate the points of a higher share than a threshold situated above the new minimum share.
This entire process is repeated by increasing cell size and threshold share until no other point is removed from one iteration to another.

Then, I imported filtered points file in *Cyclone* and on their basis, I shaped the site (Fig. 1).

Based on the obtained DTM, we can make calculations and complex analysis using functions from the *Cyclone*.

Fig. 1. Digital Terrain Model realized using Cyclone

RESULTS AND DISCUSSIONS

Vector data were overlapped on the digital terrain model using ArcScene application. I also overlapped the orthophotoplan in order to generate a layout as close to reality as possible (Fig. 2).
Secondly, I made the situation plan of the area, based on the vector data (Fig. 3).

For volume calculation, I set a reference plane Using *Cyclone*, obtaining an approximate value of 60,500 m^3 (Fig. 4).
I also created sections for intersecting the model with a vertical plane (Fig. 5) or for establishing an alignment and creating sections perpendicular to it (Fig. 6).

Fig. 2. The result of overlapping

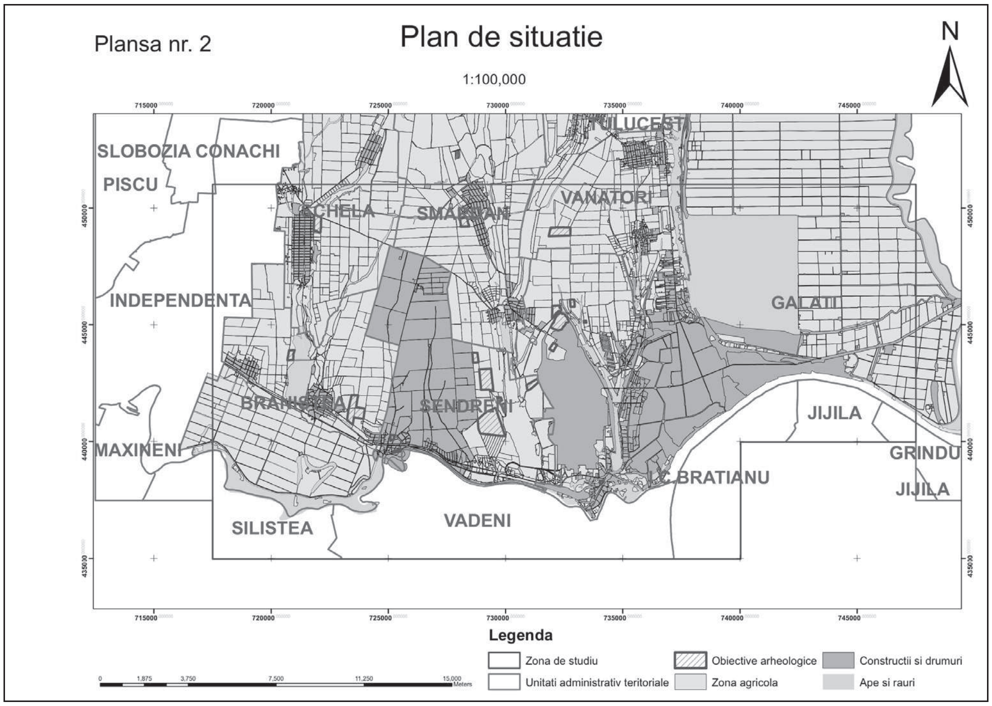

Fig. 3. Situation plan

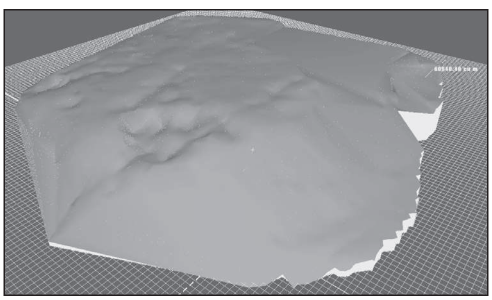
Fig. 4. Volume calculation using Cyclone

Furthermore, I generated contours with equidistance of 2 m, referring to a plane chosen arbitrarily, located at 25 m under the Digital Terrain Model (Fig. 7).

CONCLUSIONS

Geographic Information Systems evolved rapidly and will soon become indispensable in the completion of projects that use spatial information.
LiDAR technology also represents a great potential in archaeology due to data acquisition speed and due to the fact that the cloud of points can be georeferenced directly in the take-over process, if the scanner is placed on a known-coordinates point. Laser scanning offers the possibility of acquisition of an immense amount of data in a short time.
Such a 3D scan can be performed for each archaeological site and so may a database can be out together with very high accuracy information.

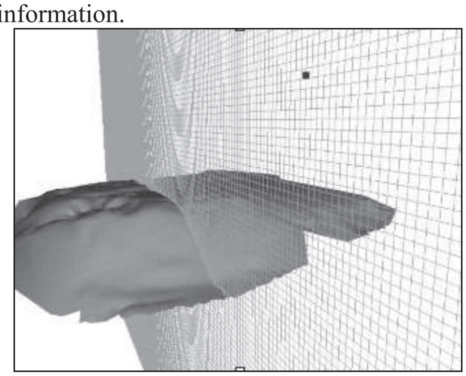
Fig. 5. Intersection with a vertical plane

GIS can also be used to manage the current activities including archaeological excavations. The database may contain information concerning the types of discoveries from the excavations, it may draw up maps which show the distribution of harvested materials, create complex analysis and so on.

With GIS, materials can be produced for helping people in the field of research but also for the general public.

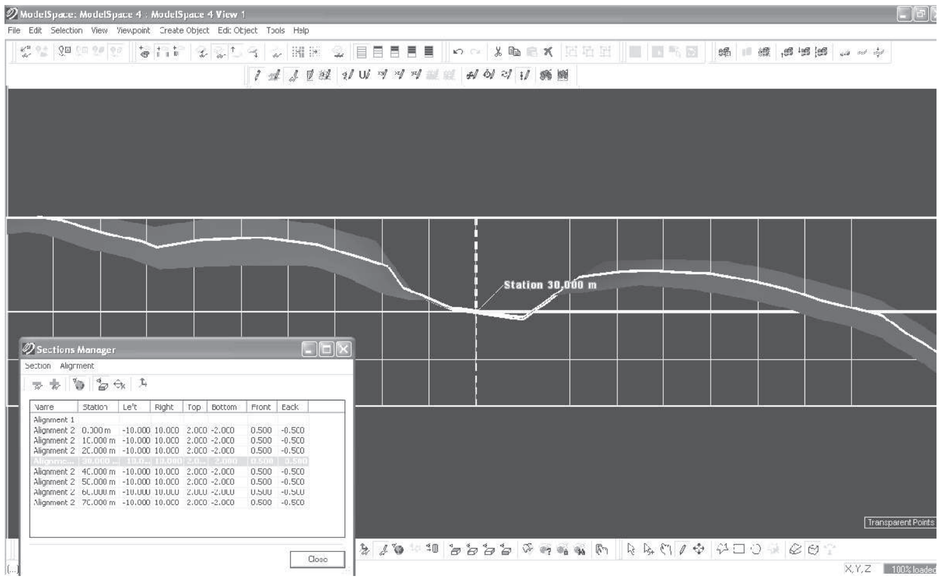

Fig. 6. Section at 30 m from the beginning point of alignment

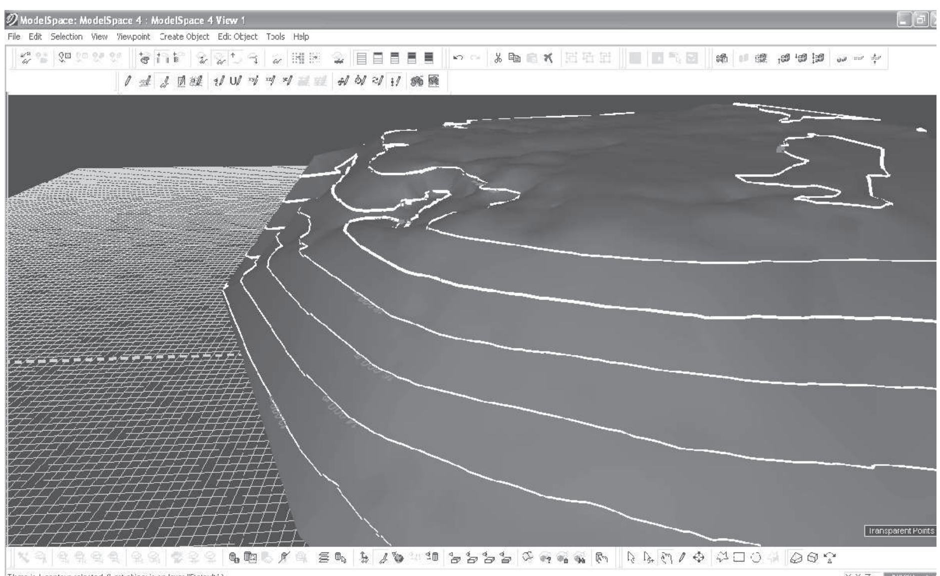

Fig. 7. Contours generated using Cyclone

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