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## USING SPATIAL DATA IN ARCHEOLOGICAL SURVEY

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**Abstract:** The field of archeology still relies on the traditional plans and section drawings as its primary form of graphic documentation, the standard “templates” that are used to represent the ancient past to the general public. Archeologists use many different methods (land surveying, remote sensing/satellite imaging, digital scanning, global positioning system, photogrammetric mapping and multimedia imaging) for capturing spatial data, which they use for a creation of an archeological information system. Geographical information systems (GIS) provide archeologists, particularly in landscape archeology, a powerful set of tools for management, analysis and research of cultural resources. The paper describes possibilities of using spatial data for different types of analyses, which are used for exploration potential archeological sites (settlements) and get information about the social and political complexity of the ancient people, size of domains and so on.

**Keywords:** archeological site, spatial data, georeferencing, digital elevation model, spatial analyses

### Introduction

The field of archeology has been changed by the massive use of powerful hardware and software for solving questions about ancient times. The most used tools are Geographical Information Systems (GIS) because they allow working with heterogeneous data and analyze them to draw conclusions.

### GIS and Archeology

The early GIS using “boom” diminished some years later. But, after the beginning of 1990’s, the interest in this field increased visibly again. From regional to small scales, GIS has demonstrated that it is an invaluable tool for data management, analysis and visualization. In Europe, use of GIS has been focused on the study of the relationships between archeological sites, and also between sites and their environment. In USA and Canada, the main utilization has been in regional data management and location probability modeling.

Managing all data (from many sources and stored in different formats) could be a very difficult process. It could affect the efficiency and practicality of attaining research results related to the archeological record. GIS are designed specifically to this purpose: managing and visualization of spatial data. We can say that GIS is the best data management tool available nowadays for archeological remains.

The main advantages of using GIS for archeological data management are (Tripcevich, 2004):

- rapid creation of maps to visualize the archeological record,
- the ability to query the database using spatial operators,
- the scale of GIS can range from individual excavation units to regional or national registries,

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- once data are in the GIS, it is possible to make many high quality maps in comparison with time needed to compose a single map using conventional methods,
- gives assistance to know more about recovered artifacts only clicking on a feature displayed on the map, showing attributes immediately.

GIS can be also used to visualize data in three dimensions. Starting on the two dimensional maps, and following some easy steps it is possible to obtain three dimensional models of archeological sites. This gives another perspective that could help archeologists to get different conclusions about archeological sites.

In last 10 years, some works are following the track of the temporal subject, very important in the archeology field. Temporal location of a feature is as important as its physical location. We can say that general mapping capabilities of GIS are a basic function and that it is generally more efficient than manual or computer assisted.

It is very useful using GIS to generate three-dimensional models (DEM or DTM). From them it is possible to made interpretations of many processes taken place in past, like an analysis of the most proper location to erect a settlement along of streams in mountains (they generally selected the driest territories) or the hottest or coldest part of a hillside based on an existing aspect of surfaces.

Using GIS allows displaying the distribution of historical artifacts in the excavation into the environmental context of the archeological site. An example of this kind of application could be the identification of architectural limits on different use areas.

The possibilities of computer graphic techniques (modeling, rendering and animation) that offer the last technological advances in informatics are increasing use of GIS as a tool of spatial data visualization. The creation of detailed *virtual reconstructions* (3D graphic models) of archeological sites is the most common and useful example of using this technology (Peterson et al. 1994).

### Spatial data and analyses in archeology

We could use different types of spatial data in archeological survey. Spatial data could be in many geodetic coordinate systems and formats.

We measured hill fortresses from Late Bronze Age from a territory of Nitra in Tribeč Mountains in co-operation with the Archeological Institute of the Slovak Academy of Sciences in Nitra. The toponym of first fortress is Cibajky situated near Vel'ký Tribeč hill (with a height of 829 m) and second one is Zobor located on the top of Zobor hill (588 m) in the northern part of Nitra. Measuring and processing GPS data of fortresses is described in a work (Vázquez 2006). Except original measured data we achieved spatial data from different sources, which are described in Table 1.

Tab.1 Different types of spatial data

Data	Source	Format	Scale	Size (approx.)	Coordinate system
Topographic maps	Geodetic and Cartographic Institute in Bratislava	*.tiff	1:25 000	4MB	S-JTSK
Digital Elevation Model	Archeological Institute in Nitra	*.shp *.dbf *.sbn *.shx *.sbx	-----	4,9MB	S-JTSK
GPS files	measured GPS data (Trimble GeoExplorer, Leica GS20)	*.txt *.shp	-----	1MB	WGS 84 or S-JTSK

These data are basic sources for visualization and spatial analyses and with the others archeological data are used for a creation of special archeological analyses using GIS. An important step within the creation of spatial analyses is georeferencing spatial data to a unified local geodetic co-

ordinate system (S-JTSK). We used ArcGIS software and its extension 3D Analyst (Fig. 1). This extension allows many tasks if we have already generated a three-dimensional model of a landscape (e. g. create contours, lines of sight, steepest path or interpolate features).

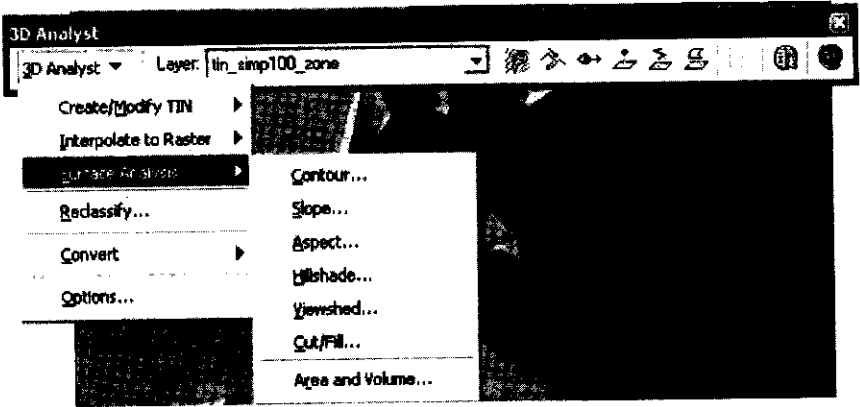


Fig. 1 ArcGIS 3D Analyst toolbar

We did a few basic analyses (Velasco 2006): slope analysis, buffer zone and analysis of visibility. We created a map with the slope ranges of CIBAJKY fortress (Fig. 2) and four profiles to show the slope in Northern, Eastern, Southern and Western part of the fortress (Fig. 3). Another important thing is the creation of buffer zones, which are used for spatial queries. We did buffer zones around the fortress with different distances (Fig. 4). A very useful analysis from the point of view archeologists is analysis of visibility. We created the map of visibility between two fortresses (Fig. 5).

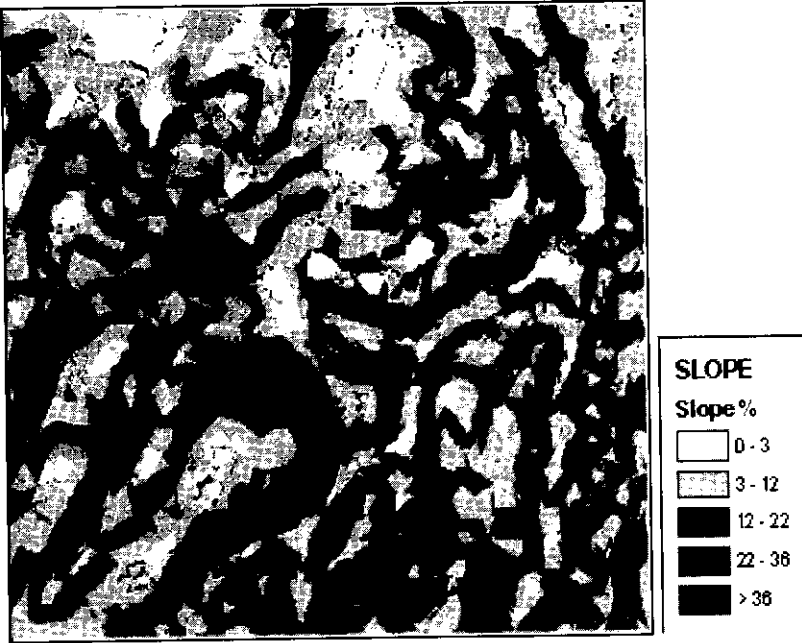


Fig. 2 The map of slopes

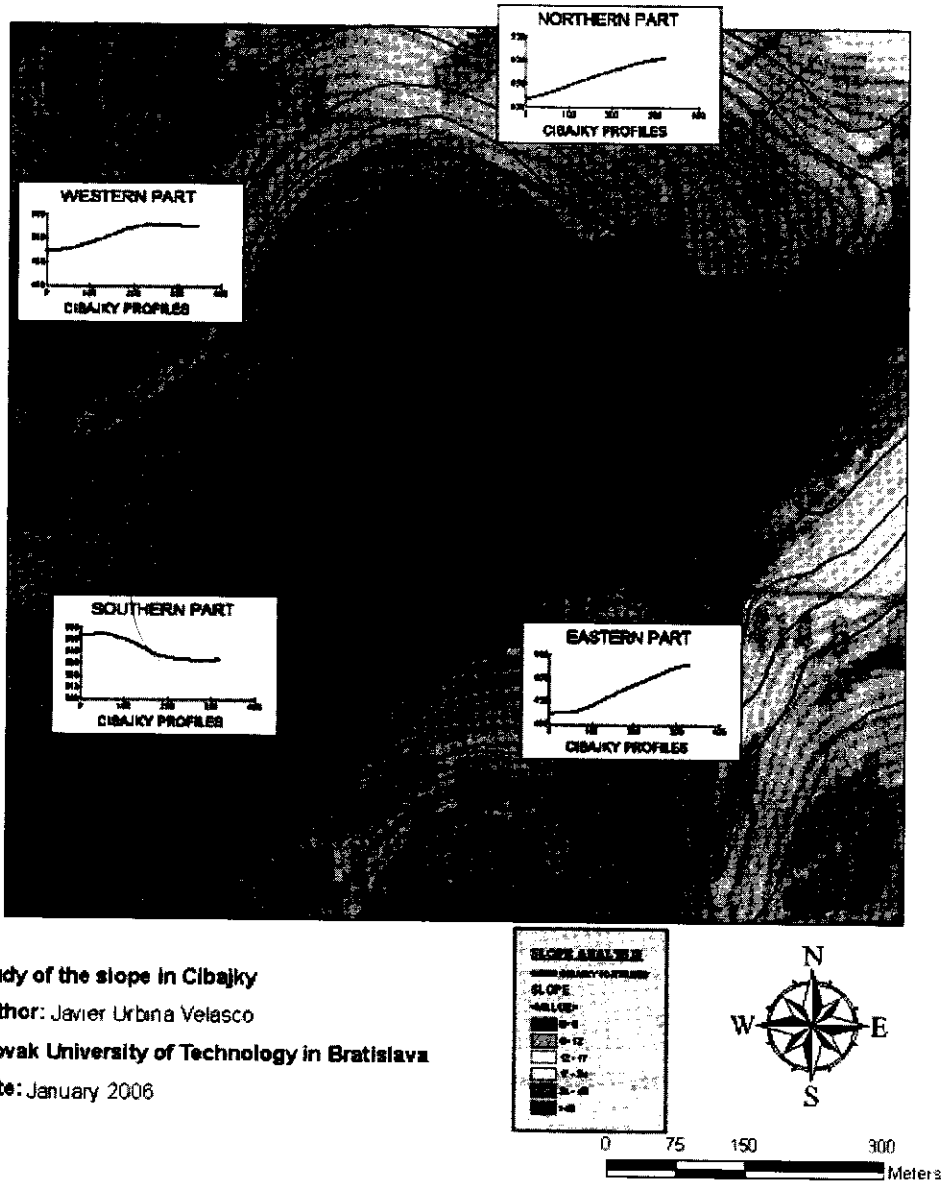


Fig. 3 The map of slopes from Cibajky fortress



**Buffer applications in Cibajky**

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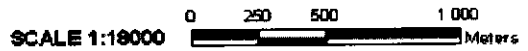
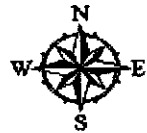
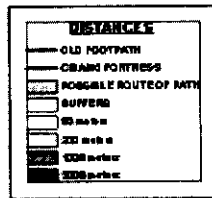
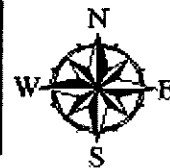
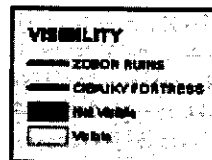


Fig. 4 The map of buffer zones of Cibajky fortress



**Analysis of the visibility from Zobor**  
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**SCALE 1:160000**



Fig. 5 The map of visibility from Zobor fortress

### Conclusion

GIS provides archeologists a powerful set of tools for management, analysis and research of cultural resources. GIS links objects on the map to the database, combining the graphical display of data with database query and analysis functionality. This kind of software has been used in the field of archeology since the 1980s but it has only been within the last decade when this technology has grown up substantially for archaeological applications.

Using computers and GIS archeologists can deduce some aspects about the social and political complexity of the ancient people, size of domains and so on. In these aspects, GIS can be used as a database management tool with great flexibility and generate new information. They offer the

possibility of analysis for the purpose of discovering trails of potential archaeological sites and deduce which ones are interesting or not.

Archaeologists can analyze data within a single layer or the relationship between multiple layers to study how a natural environment affects a site location. There can be done visual analyses or more complex ones. Using spatial data opens possibilities of building archeological information systems that satisfy most, if not all, of requirements of a modern archeological research.

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### **References**

- PETERSON, P., HAYDEN, B., DAVID, F. (1994). *Integrating Spatial Data Display with Virtual Reconstruction*. USA, Simon Fraser University.
- TRIPCEVICH, N. (2004). Mobile GIS in Archeology Survey. *The SAA Archeological Record*, 17 p.
- VÁZQUEZ, G.S. (2006). *Spatial Data for the Purpose of Archeological Survey in ArcGIS Environmen*. Diplomová práca. Bratislava (Slovenská technická univerzita, Stavebná fakulta).
- VELASCO, J.U. (2006). *Analysis of Heterogeneous Data in the Archeological Information System*. Bachelor thesis. Bratislava (Department of Mapping and Land Consolidation, Slovak University of Technology).

### **Resumé**

#### **Použitie priestorových dát v archeologickom výskume**

Geografické informačné systémy predstavujú nový prístup získavania a analýzy údajov vo všetkých vedných a spoločenských disciplínach pracujúcich s priestorovými dátami. Zaraďujeme k nim aj archeológiu, ktorá spája poznatky z dávnej minulosti so súčasťou tvárou krajiny. Archeológia sa v minulosti venovala takmer výlučne štúdiu artefaktov. V poslednom desaťročí sa stále viac sústreďuje na doplnenie tohto štúdia výskumom ekofaktov a priestorového rozloženia archeologických prameňov. Priestorové vzťahy jednotlivých zložiek archeologických prameňov sú vedľa formálnych vlastností ich jedinou pozorovateľnou vlastnosťou. Obsahujú obrovské množstvo informácií o minulosti.

Z pohľadu archeológie je dôležitý poznatok, že GIS umožňuje:

- Analýzu priestorového usporiadania (napr. plošný rozsah, hustota, vzájomná vzdialenosť) celkov zistených terénnym výskumom, alebo formálnou analýzou a z toho novú definíciu priestorových celkov.
- Zisťovanie vlastností o priestore, ktoré sú významné z hľadiska správania sa minulých populácií, ale ktoré nemôžeme zistiť v bežne dostupných mapách.
- Prístup k priestorovým dátam ako súvislému povrchu spojitosti sa meniacich vlastností.
- Vizualizáciu priestorových dát a jej využitie pre archeologickú analýzu a interpretáciu.

Príspevok popisuje možnosti použitia GIS a rôznorodých typov dostupných priestorových dát (merané dáta GPS, topografické mapy, digitálny model reliéfu a pod.) v archeologickom výskume.

V prostredí ArcGIS sme na základe dostupných priestorových dát vytvorili niekoľko tematických máp (obr. 2, 3, 4, 5), resp. priestorových analýz, ktoré v kombinácii s ďalšími archeologickými dátami slúžia na tvorbu špeciálnych archeologických analýz. Na základe priestorových analýz sme schopní overiť niektoré archeologické hypotézy o vzájomných vzťahoch medzi náleziskami, skúmať a sledovať pravdepodobné správanie sa človeka v minulosti a približne rekonštruovať už zničené archeologické lokality. Používanie priestorových dát v archeologickom výskume poskytuje nový, komplexnejší pohľad na jednotlivé archeologické lokality a ich vzťah ku krajine.

Tab. 1 Typy priestorových dát

Obr. 1 Základné funkcie ArcGIS 3D Analyst

Obr. 2 Mapa sklonov

Obr. 3 Mapa sklonov pevnosti Cibajky

Obr. 4 Mapa nárazníkových zón v okolí pevnosti Cibajky

Obr. 5 Mapa viditeľnosti z pevnosti Zobor

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