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GIS IN EASTERN EUROPE: NOTHING NEW IN THE EAST?

1. Introduction and Eastern European archaeology

At the end of the eighties GIS was hardly known amongst European archaeologists. There were several papers published, and some results were presented at specialized conferences (Harris 1986; Wansleeben 1988). A number of archaeological associations, especially the Computer Applications in Archaeology group and the Union International des Sciences Préhistorique et Protohistorique - Commission IV played an important role in dissemination of GIS awareness amongst archaeologists (Stančič 1994). Research institutes and universities were, however, the first to start using GIS in their work.

Many of the first applications were in research projects, mostly analyzing settlement patterns on the regional scale. The ease of advanced spatial analysis through GIS persuaded many research teams to acquire GIS technology and explore it using their own data. This occurred to the extent that spatial research without GIS was hardly feasible. In this phase of the "GIS bandwagon", GIS was a fashionable thing to do and the theory behind its application was not questioned (Wheatley 1993). However, soon GIS's capabilities for effective storage, manipulation, analysis and presentation of spatial data were realized and these technologies began to make an impression on funding agencies. It appears that these days are finally over. GIS applications in spatial archaeology have come to the point at which applying GIS in some stage of research is normal, almost like writing a report on a computer. Indeed soon we may say that GISs, like techniques of quantitative archaeology, are so much a part of the archaeological method that their uses need no longer appear in the literature as separate studies (Djindjian 1990).

However, this does not mean that GIS need not to be discussed among specialists. There are several topics which still need our attention: development of new techniques in spatial analysis, incorporating social phenomena in research, development of GIS interfaces to sites and monuments databases, 3D GIS applications in intra site analysis and last, but not least, raising GIS awareness and education.

In the project "Establishment of an Archaeological Information System model and its application to ancient Caere (Cerveteri)" (The Caere Project) I was responsible for evaluating the responses from the survey on GIS and archaeology projects carried out in Eastern Europe. Before going into detail on the evaluation of reports I would like to discuss some basic facts relating to the history of theoretical approaches and the stage of archaeological organization in the Eastern Europe.

The countries which compose Eastern Europe are most often understood as those which had socialist ("communist") governments in their most recent history. Although often perceived as a fairly uniform group, it should be stressed that they are very diverse. These differences are in cultural and historical background and are reflected in their political organization and economy. All these make an important impact on the level of archaeological practice and theory. While some Eastern European countries survive on the edge of poverty with national incomes comparable to the poorer Third World countries, some have standard of life close to Western European countries. Therefore, any attempt to discuss archaeological methodology in Eastern Europe can result in strong generalization and a loss of details. It seems, however, that most GIS oriented activities in Eastern European archaeology come from Central Europe. Before going into any detail on the results of GIS work I want to discuss some possible subdivisions of Eastern European archaeology. In this, I am aware that this is only one possible route and that probably every Eastern European archaeologist would produce a different division.

One group comprises the countries which are considered part of Central Europe. In his important book *Archaeology in Central Europe: the first 500 years*, Sklenar (1983) argues that archaeological methods and theories went through very similar or identical stages in most of Central Europe: this includes all Germany (except the Rhine basin), Poland, the Czech Republic, Slovakia, Hungary, Austria, Slovenia, Croatia and parts of Romania (Transylvania). Western parts of the former Soviet Union could also be added to these states. These countries were all part of the Austro-Hungarian empire and Germany, and therefore they have a common history of archaeology. All this is in many ways reflected in the stage of current archaeological work.

It would be wrong to claim that all the remaining countries form a homogeneous group of countries, and share a large part of the history of archeology. The second, partly homogeneous group, comprises the remaining states of south-eastern Europe. Another could be the countries or parts of countries in the European part of the Union of Independent States, Ukraine and Belarus. Finally the Baltic States could be a separate group or, possibly, fit in the Central European group (Sklenar 1983).

It is not my objective to discuss possible subdivisions of Eastern Europe since I am sure that anyone else attempting to divide and group them would have different perception of archaeological history and would produce an alternative division. However, it seems that Central European countries have been most active in archaeological GIS analysis. The reason for this might be the history of archaeological work or the tradition of archaeological co-operation and joint research projects with foreign archaeological schools. For example, early joint projects can be traced back in the nine-

teenth century and were continued throughout the twentieth century. All this lead to advancements in archaeological methods and theory, including numerous applications of information technology in archaeology (SUHAJDA 1992).

Archaeology in the Union of the Independent States, on the other hand, remained isolated. In the Union of the Independent States some 5000 archaeological reports are published annually and one can have no doubt on real advances in archaeological theory (TRIGGER 1989, 207-243). However, the role of information technology in the Union of Independent States is more problematic. The desire to control archaeological information and not disseminate it is still very common and it often leads to a refusal to implement information technology (TRIFONOV, DOLUKHANOV 1992), therefore it seems that the work of archaeologists in the Union of Independent States remains isolated from most of the international archaeological community.

Before discussing the results of the questionnaire and stages of GIS practice in Eastern Europe it is worth at least mentioning the organization of archaeology in Eastern European countries. Despite some variation, archaeological work is generally performed by four types of organization. The oldest organizations involved with archaeology in most Eastern European countries were the National Museums: archaeological work was carried out here from the second part of the nineteenth century. Archaeology was established as a university discipline by the end of the nineteenth century and the beginning of the twentieth century (SKLENAR 1983, 137). While museums and universities were the focus of archaeological research, protection and management of archaeological heritage was implemented much later through different schemes of regional or state organizations for protection of cultural heritage. While paralleled in most or all other countries of Europe and the World, the Central and Eastern European Institutes or Academies of Sciences and Arts seems to be rather peculiar and therefore worth mentioning here.

Eastern and Central European Academies of Sciences and Arts have officially incorporated archaeological research as a research topics since the second half of the nineteenth century, when many of them set up Prehistoric Committees. While some of these committees were founded by groups of enthusiasts, some become important professional organizations. Only later did most of these Committees become full scale research institutes doing actual research. They are usually financially dependent on individual Academies of Sciences and Arts. Therefore in most Central and Eastern European Academies of Sciences and Arts one can find a number of institutes for different disciplines, most often humanities and some natural sciences. In some countries these institutes contain the largest and most active full time archaeological research groups.

2. Current GIS activities in Eastern Europe

Despite this diversity, data was solicited from most countries where individuals or groups were doing some GIS work. A questionnaire on GIS and archaeology was sent to all participants on major discussion lists covering GIS in archaeology or quantitative methods in archaeology. Also, a number of individuals known to be carrying out GIS work were individually contacted. However, the amount of answers to the questionnaire was rather disappointing. Only one answer on the questionnaire originally sent by The Caere Project was received, while wider dissemination of the questionnaire on discussion lists produced only a few additional replies. Therefore, the overview and evaluation of the GIS activities in Eastern European archaeology was based on three sources: results of the questionnaire, previously established individual contacts and published work. It is very clear that wide areas where some GIS work might have been performed was not been reached. Most evident is the luck of information from the Union of Independent States. However, it might be claimed that the results of the questionnaire are representative of the stage of GIS applications within the Eastern Europe.

The institutions conducting substantial GIS research are in most cases either research institutes of national Academies of Sciences and Arts or archaeological departments within universities. Lack of interest in GIS by organizations for protection and management of cultural heritage is evident. In most cases research organizations are involved in projects lasting several years. This probably means that their financial situation is relatively good. Most projects last three up to five years. It is worth stressing here that most of the research in Eastern Europe was funded in different way to the situation today. Several years ago research funding in many Eastern European countries was replaced by project-based funding. This can be compared to the prior situation when funding was limited but constant and stable. This has meant that research organizations have stopped receiving governments funding apart from project-based resources.

Most of the data on GIS research come from Croatia, Czech Republic, Hungary, Slovenia and Yugoslavia, with some information received from the Union of the Independent States. It would be very wrong to claim that all the archaeological GIS activities were covered with the survey, but one would expect that most active and innovative institutions were represented.

We should start the overview of the results information on hardware and software. Research teams usually have no major problems in acquiring powerful hardware. Most of the research projects were utilizing IBM compatible computers running under one of the Windows environment. Very few of them were using PCS with 486 processors, most of them have powerful and fast Pentium processors. Lack of Macintoshes and Unix based work-

stations is also evident. A bit more problematic is the software these groups are using. While some have access to full scale professional GIS products like Arc/Info, large number are using IDRISI or ArcView. Some groups are also doing small scale GIS work with non GIS products, which can do some GIS-like procedures. Surfer would be a representative product of this kind, which if innovatively used can do many GIS-like routines. It is also worth stressing here that some groups have access to powerful statistical packages like SPSS and SAS and that most research projects are using some kind of relational database management tools.

While these generalizations are possible for hardware and software used in the projects, it is much more difficult to draw meaningful generalizations when considering the objectives of the projects. Therefore I would like to briefly mention a few projects which might be of interest to the wider archaeological community. In this presentation I will try to group projects according to research objectives.

There are a number of GIS research projects dealing with larger regions. The research objectives of these projects are usually rather diverse and range from simple location analysis to advanced predictive modeling. Most of these regional projects are organized by strong research teams having substantial financial support and are often lasting five years and more. Hardware used often involves different geophysical survey equipment, global positioning system (GPS) and in the case of the Department of Spatial Archaeology of the Archeologický Ustav from Prague, Czech Republic even an aircraft (Kuna, pers. comm.; KUNA, ADELSBERGEROVÁ 1995). Objectives of this long term project are to analyze settlement patterns in some parts of Bohemia. Similar projects are just finished or are still ongoing in Hungary (CSÁKI *et al.* 1995), Croatia and Slovenia (DULAR *et al.* 1995; GAFFNEY *et al.* 1996).

The number of projects involved in the application of GIS in excavations or similar intra site analysis is rather small. Several years ago BIRÓ *et al.* (1995) published results from a simple but effective GIS intra site analysis in Hungary. More innovative is the work of MUŠIČ (1995) on the hillfort Rodik in southwestern Slovenia. Mušič is trying to combine different sorts of data from the hillfort including the magnetometry data, georesistivity, geochemical data, microrelief elevation data, surface collection and limited excavation to observe and predict activity loci. Although he started the analysis with specialized geophysical software, integration of different information was made possible by using raster based GIS. Raster based GIS provided enough flexibility to integrate all data from different sources and strong analytical capabilities for extensive analysis and finally effective results presentation.

Although most of research teams have powerful GIS software, it is worth mentioning here that some teams manage to conduct interesting spatial research with rather simple non GIS dedicated software products. For

example Ivana Radovanović (pers. comm.) from the Centre for Archaeological Research at the Faculty of Philosophy in Belgrade, Yugoslavia is trying to analyze excavation data from the Paleolithic cave and rock shelter dwellings in the canyon of Cehotina. Given the fact that they do not have access to powerful GIS programs they are using Surfer. Although Surfer is not a GIS dedicated software it can carry out some GIS like procedures. Of course some statistical procedures and presentation capabilities of Surfer are rather limited, therefore the Belgrade research team is trying to improve its capabilities with some processing of data in Excell and image finalization with AutoCAD. This approach seems to be very effective and rather usual amongst groups which do not have access to powerful full scale GIS products.

In Central Europe there are a number of ongoing archaeological research projects involving extensive GIS applications. Most of the projects are regional projects covering areas ranging from several square kilometers to very large regions. These teams have access to extensive funds providing long term engagement in research. However, the lack of intra site GIS applications is evident. Most cases of intrasite research GIS relate to prehistoric sites only or where GIS is used for the integration of different sources of data like geophysics, and surface artefact data. It is worth stressing here the lack of GIS intra site projects involved in the research of Greek or Roman archaeology. It really seems that GIS is mostly used in regional research in prehistory.

The reasons for this were, in the past, the predominant use of raster based GIS which were suitable for analyzing prehistoric settlement patterns over larger regions. For the intra site analysis of Roman settlements for example, one would need to invest large amount of time in preparation and data input. Since the data were usually gathered by several teams using different recording techniques and even coordinate systems, data integration would be an extensive task involving large amount of manual work and digitizing. This work would be even larger when the urban data would be input into the computer. To my knowledge there is only one team in Eastern Europe (comprised of scholars from several European states and Canada) which planned a project of this kind and which would involve intra site analysis of the town of Salona and its hinterland (Gaffney, pers. comm.).

It is important to notice that in most GIS projects the management and protection of archaeological heritage is not a primary issue. Very often local centers for protection of cultural heritage are not involved in these projects. This often means that the data standards are not interchangeable and the database produced is not compatible with international or even national standards if they exist. Every project should provide possibilities for exchange of data with other national and international databases.

3. General conclusions and recommendations

In Central Europe there are a number of research projects using GIS. Most of research projects last three to five years. It is worth stressing that they usually have access to advanced computer technology, including powerful hardware and software. The applications cover wide range of different objectives: from intra site analysis to regional settlement pattern analysis. Most of the research teams have fewer possibilities to exchange information within their nation or state due to the small number of research teams with similar objectives. However, they usually have strong international links through which they can evaluate their ideas and research approaches. One should also notice that their results are often published first in their national language and are very soon followed by extensive publication in some foreign language, usually German or English. The results of their work is regularly presented at international scientific conferences.

However, while these comments stand for most parts of Central Europe, there are many Eastern European countries where the situation is not so bright. Archaeologists there work with very limited resources and have few opportunities to exchange information with the international archaeological community. The lack of international contacts is reflected by the limited application of new approaches and advanced technology, including GIS. This is despite the activity of international associations, most notably Computer Applications in Archaeology group, Association of European Archaeologists and International Union of Prehistoric and Protohistoric Sciences, which are trying to establish new international links with Eastern Europe and strengthen the existing ones. Most archaeologists in Eastern Europe (excluding those in Central Europe) have very few chances to exchange information with the international community. From this perspective, the Internet might be the easiest technological solution for integration of isolated research teams and to spread advances in spatial archaeology. Computer supported discussion lists, the exchange of electronic messages and electronically published scientific journals are an important step in this direction. One should be aware that all parties would benefit from the integration of Eastern European archaeologists.

Finally, I would like to note a number of major concerns related to the advancement and application of GIS in Eastern Europe in general. First, one can anticipate that economic recession in most of these countries will result in significant cuts to archaeological funding. This might result in the abandonment of applications of advanced techniques in archaeological research. One should also note the lack of educational courses in Eastern Europe on spatial archaeology and GIS. While GIS is a part of many graduate and postgraduate courses in Western Europe, the number of similar courses in

Eastern Europe is very small. This problem might be solved through extensive support of exchange programs for students and university lecturers.

Last but not least, the lack of GIS based cultural resource management programmes is particularly problematic. The countries in Eastern Europe have undergone extensive economic, social and political changes. These all have an impact on the environment and cultural heritage. The cultural heritage, including archaeological sites and monuments, can be effectively managed and protected only with the application of advanced computer technology, powerful databases management systems and GIS. In some Eastern European countries, notably Hungary (Suhajda 1992), Poland (Jaskanis 1992; Prinke 1992) and Slovenia (Dular *et al.* 1992), extensive field survey projects provide large amounts of data which is input into powerful database management systems. These databases are not yet integrated into GIS. However, the quality of the archaeological data gathered and application of advanced computer technology for data storage and manipulation will provide basis for future GIS applications in research, cultural heritage management and protection.

The state of GIS applications in Eastern Europe in research is not inferior to that in the rest of Europe. Many research groups are carrying out highly innovative research into spatial archaeology and are no less advanced either in methodology or applied technology. However, even in the countries where GIS is common among researchers, it still has not been established as a tool in cultural resource management. Finally, there are a number of Eastern European countries with very limited scientific contacts with foreign archaeologists and little knowledge on the current stage of archaeological science. Despite geographical proximity, the long term political isolation of these countries and limited available resources makes it seems that we are worlds apart.

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RESULTS OF THE QUESTIONNAIRE GIS AND ARCHAEOLOGY

CROATIA

Title of the project: Adriatic Islands Project.

Promoting institution: Archaeological Museum Split.

Year of beginning: 1991.

Foreseen term: To be completed in 1999.

Geographic area: Central Adriatic Islands.

Short description of the project: Regional spatial analysis of the Central Adriatic Islands and area arround Salona. Testing a variety of archaeological hypothesis from the earlies prehistory to Roman Age.

Hardware: PCs.

Software: Arc/Info, IDRISI.

Application of descriptive standards: Manufacturers standards and local database.

Application of Spatial Analysis: SPSS, SAS.

Address: Branko Kirigin, Zrinsko Frankopanska 25, 21000 Split, Croatia.

E-mail: bkirigin@public.srce.hr

www address:

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CZECH REPUBLIC

Title of the project: Archaeology of Central Bohemia.

Promoting institution: Department of Spatial Archaeology, Institute of Archaeology.

Year of beginning: 1986.

Foreseen term: 1998.

Geographic area: Central Bohemia.

Excavation area: Numerous smaller excavations.

Short description of the project: Application of airborne remote sensing and numerous spatial analysis in Central Bohemia, Czech Republic.

Hardware: PCs.

Software: Arc/Info, ArcView, IDRISI.

Application of descriptive standards: Local standards, manufacturers standards.

Application of Spatial Analysis: Various spatial analysis.

Address: Martin Kuna, Letenska 4, 118 01 Praha 1, Czech Republic.

E-mail:

www address:

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HUNGARY

Title of the project: GIS at the Department of Information and Conservation of the Hungarian National Museum.

Promoting institution: Department of Information and Conservation of the Hungarian National Museum.

Year of beginning: 1993.

Foreseen term:

Geographic area: Various locations and entire Hungary.

Excavation area: From several hundred square metres to 14,600 square metres.

Short description of the project: Applications are focused on three main areas: first, the interpretation of archaeological recording of fieldwork and find material at the lithic workshop; second, the elaboration of large multi-period excavation; third, the wider possibilities of using GIS as a tool for distribution studies.

Hardware: PCs.

Software: IDRISI, and various databases.

Application of descriptive standards:

Application of Spatial Analysis: Various spatial analysis.

Address: Katalin Biró, PO Box 124, Konyves Kalman krt. 40, 1450 Budapest, Hungary.

E-mail: birok@helka.iif.hu

www address:

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Title of the project: Archaeological Topography of Hungary.

Promoting institution: Archaeological Institute of the Hungarian Academy of Sciences.

Year of beginning: 1991.

Foreseen term:

Geographic area: Various locations and entire Hungary.

Excavation area: Extensive excavations on individual sites.

Short description of the project: The project is comprised of the intra-site spatial analysis of numerous archaeological sites and various regional analysis in selected regions.

Hardware: PCs.

Software: Arc/Info, ArcView.

Application of descriptive standards: Local standards and manufacturers standards.

Application of Spatial Analysis: Various spatial analysis.

Address: Ferenc Redö and Elizabeth Jerem, Uri Utca 49, 1250 Budapest, Hungary.

E-mail:

www address:

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SLOVENIA

Title of the project: Survey and excavations at Rodik hillfort.

Promoting institution: Department of Archaeology, University of Ljubljana.
Year of beginning: 1992.
Foreseen term: Completed 1996.
Geographic area: Hillfort at southwestern Slovenia.
Excavation area: 100 square meters.
Short description of the project: Integration of various remotely sensed data of the hillfort Rodik and its vicinity and spatial analysis of features recorded.
Hardware: PCs.
Software: IDRISI, Arc/View, specialised software for remote sensing.
Application of descriptive standards:
Application of Spatial Analysis: Various spatial analysis.
Address: Branko Mušič, Zavetiska 5, 1000 Ljubljana, Slovenia.
E-mail: BRANKO.music@uni-lj.si
www address:

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Title of the project: Site and monument database of Slovenia.
Promoting institution: Institute of Archaeology, Centre for Scientific Research of the Slovenian Academy of Sciences and Arts.
Year of beginning: 1980.
Foreseen term: 2000.
Geographic area: Slovenia.
Excavation area: Limited excavations on individual sites.
Short description of the project: Creation of site and monument database of all archaeological sites in Slovenia and spatial analysis on regional scale with the special emphasis on the Dolenjska region.
Hardware: PCs, Vax mainframe and Vax workstation.
Software: TRIP database, IDRISI.
Application of descriptive standards: Local standards.
Application of Spatial Analysis: Various spatial analysis and predictive modeling.
Address: Janez Dular, Gosposka 13, 1000 Ljubljana, Slovenia.
E-mail: Dular@zrc-sazu.si
www address:

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Title of the project : Application of GIS in archaeology.
Promoting institution: Centre for Scientific Research of the Slovenian Academy of Sciences and Arts.
Year of beginning: 1992.
Foreseen term: 1998.
Geographic area: Slovenia and Croatia.

Excavation area:
Short description of the project: Application of various spatial analysis and remote sensing in archaeology. Project is comprised of a number of case studies ranging from the applications in cultural resource management, predictive modeling to detecting new sites using remotely sensed images.
Hardware: PCs, Vax mainframe and Vax workstation.
Software: Arc/Info, ArcView, IDRISI, ERDAS Imagine.
Application of descriptive standards: Local standards and manufacturers standards.
Application of Spatial Analysis: Various spatial analysis and predictive modeling.
Address: Zoran Stančič, Gosposka 13, 1000 Ljubljana, Slovenia.
E-mail: zoran@zrc-sazu.si
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Yugoslavia
Title of the project: Cave and rock-shelter dwellings in the canyon of Cehotina.
Promoting institution: Centre for Archaeological Research at the Faculty of Philosophy, Belgrade.
Year of beginning: 1981-1987.
Foreseen term: To be completed in 1997.
Geographic area: Northern Montenegro, canyon of Cehotina.
Excavation area: 43 square meters.
Short description of the project: Research of the Palaeolithic site in the rockshelter of Malisina Stijena. Analyses of artifacts and faunal remains are in course as well as the spatial analysis of all data recorded.
Hardware: PC 486.
Software: Surfer 4.0 Golden software.
Application of descriptive standards:
Application of Spatial Analysis: Various intra-site analysis.
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ABSTRACT

This paper is an attempt of the overview of recent GIS activities in Eastern Europe. The paper is composed of three parts. In the first section organisational characteristics and historical background of the Eastern European archaeology are briefly presented. The second section focuses on current GIS activities in mostly Central European countries. In the next section general trends in archaeological GIS research and practice are summarised. In this section some suggestions for improvements through international co-operation are drawn. The paper is followed by the abbreviated results of the replies on the Caere Project questionnaire.