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GIS APPLICATIONS IN ITALIAN ARCHAEOLOGY

1. Introduction

The adoption of Geographic Information Systems (GIS) in Italian archaeological research dates back to the end of the 1980s. As in other sectors of computer applications in archaeology, the use of GIS has been followed by a theoretical discussion on the new methodological developments that they propose. The widespread use of GIS, in fact, has shaped and evolved in an extremely particular moment of computerised archaeology; this is based on the necessity to deepen and resolve not only problems of data representation, encoding and standardisation, but also and above all issues related – from a technical point of view – to data and system integration, and – from an archaeological point of view – to the interpretation of archaeological processes.

The application of GIS, which was affirmed in Italy during the 1990s, has been particularly successful as it has fully answered the specific demands of archaeological research; in fact, in the sector of data computerisation the need to introduce spatial data was particularly felt when traditional methods of making archaeological data available were becoming increasingly inadequate for an overall analysis. Space-time data are of particular importance in topographic and urbanistic studies, as well as in classification and inventory procedures, because, as was recently stated (Arroyo-Bishop 1994), "archaeology is an object-space-time relationship". Spatial information, which presents no difficulty in data structuring and representation, offers a rather important element in referencing "objects" both in a spatial and chronological context.

The best technical solutions, therefore, seem to be the integration between a relational database, into which alphanumerical information concerning known archaeological evidence is fed, and a GIS. If the first reflects, more than any other model of data structuring, the inter-relational connections that occur in reality, GIS, prepared for a model of present reality, offer logical tools for the creation of a model of archaeological reality in which it is possible to process and retrieve spatial and thematic information as well as documentary data (Allen, Green, Zubrow 1990 for a general review; cf. lastly Lock, Stančič 1995; Gottarelli 1997; Johnson, North 1997). This can be obtained by following an investigative methodology aimed at creating dynamic models for the overall comprehension of ancient land and urban arrangement under geographic, topographic, economic, cultural and social points of view.

It is generally acknowledged that, in addition to rendering the problem of the use of international geographical standards more pressing, the

ever growing use of GIS and the consequent introduction of spatial information has modified the type of approach to the study of archaeological evidence, by the replacement of the basic information units. The attempt to overcome the traditional approach based on the concept of "site", "finds" and "features", by replacing them with the broader concepts of "landscape" and "spatial entities" is obvious, the latter being interpretable as analytical units that enclose occupational spaces with their own features.

The present article is an attempt to stress some methodological concerns and evolutionary trends that characterise the use of GIS in Italian archaeological research. The cognitive base to realise this synthesis was first offered by the analysis of answers to the questionnaire on "GIS and Archaeology", that was distributed in the framework of our "Caere Project" and that marked the basis for the publication of the present issue of this journal (cf. MOSCATI, in this volume). To render our data gathering more complete, it proved then necessary to collect further information from the most recent bibliography related to this topic. During this operation, the research activity promoted by the "Progetto Finalizzato Beni Culturali" of the Italian CNR (cf. GUARINO, in this volume; cf. also http://www.culturalheritage.cnr.it) emerged as a notable point of reference. In fact, right from the initial phases of this Project, co-ordination of different research units was indicated (cf. *infra*, paragraph 3), through the necessary promotion of a general co-operation, information exchange and data diffusion policy.

From a methodological point of view, it is interesting to see what sections contain research using GIS. Among the five subprojects that constitute the Project itself, these sections are essentially included in the first one, devoted to "Ancient resources: knowledge and dating". Within this subproject, GIS applications are found in the following two topics: "Survey of the territories and manufactures" (Objective 1.1) and "Geographical Information Systems" (Objective 1.3). There is still a further subdivision that pertains to specific research lines. In the first one GIS applications are recorded under "Remote Sensing" (Target 1.1.1), "Topography and cartography" (Target 1.1.2) and "Excavation computerised systems" (Target 1.1.3), while in the second they are under "Creation of multimedia banks" (Target 1.3.1).

2. GIS DEFINITION

Before proceeding in the analysis of the Italian situation in the sector of GIS application in archaeology, I think it convenient to dwell upon the important problem of a general definition of GIS, a term that is today over used; in fact, it describes a number of demands, computer technologies and applications, that share the necessity to record, process and retrieve different types of graphic "objects". According to the definition by F. Djindjian,

GIS are – in the strict sense – software that can process the overlay of thematic maps of "objects" – in the widest sense of this term – originating from different sources and recorded in different files (DJINDJIAN, in this volume). For this reason, the amplification of the term GIS to include other computer techniques can produce a misconception. Sometimes, in fact, they are considered, in a belittling manner, as a tool that only allows the integration between graphic results obtained through the application of CAD (Computer Aided Design) or CAM (Computer Aided Mapping) software packages and the alphanumerical database.

Thus, for a correct and useful application, a sound knowledge of their basic methodology is fundamental: if GIS are used exclusively for simple mapmaking tasks in order to produce a set of superimposed graphic maps, they are not being utilised to their full capabilities. The results produced in form of thematic maps must become a tool of improvement for research and not only of reproduction. GIS have many characteristics: map production, integration of different spatial scales, database management and data visualisation; substantially they integrate both attribute and location information to describe archaeological records within a single database environment. One of the main characteristics of GIS is the possibility they offer to accomplish some analytical functions. Through the introduction of the concept of spatial "relationships", these functions allow new stimulating approaches to the study of regional and urban space. They also constitute the distinctive element of GIS in comparison to CAD or CAM software and permit the overcoming of the restrictive concept that emphasises the purely geometric characteristics of GIS: mapping the results of any selections of the database and restituting thematic maps of distribution.

With respect to the definition of GIS, it is interesting to note the distinction recently proposed in Italian topographic and urbanistic studies between the two terms SIT ("Sistemi Informativi Territoriali", i.e. the Italian version of "Land Information Systems") and GIS (AZZENA 1997): in fact, it is not presented exclusively as a terminological distinction, but also as relating to the subject matter. According to this statement, SIT are systematised containers of information; through the numerical restitution of graphic data, they allow us to draw some inferences on the spatial association of archaeological phenomena and objects; their aim is to transform a topographical map into a number of thematic maps, depending on the number and type of information that describes the graphic "objects" recorded.

The "logical structure" of such a system, whose theoretical formulation must have precedence over the practical application, is independent of its "physical structure" inside the computer. Interface software – the GIS – acts as an interpreter between the two structures and it allows us to process, analyse and restitute information of a geographical character, revealing rela-

tionships and interactions. In this perspective, the establishment of an archaeological information system becomes an instrument of communication other than of data processing, in which the initial planning of research, the identification of geographical and archaeological phenomena, the definition of descriptive classes and finally the explanation of the aims pursued become a priority.

A deeper investigation of the central problems relative to archaeological cartography, a theme particularly dear to the Roman school of Ancient Topography, is therefore essential (Castagnoli 1974, 1978, 1985). In this school the principle of an operative computerised cartography, seen as a basic instrument for a policy of on-site intervention, safeguarding and improvement prevails (Sommella 1987, 1989, 1997; Sommella, Azzena, Tascio 1990; Azzena, Tascio 1996). This statement is evident in all the scientific works carried out and in particular in the institutional ones, like the *Forma Italiae* and the series "Città Antiche in Italia", as well as in the Italian part of the *Tabula Imperii Romani* project and in the new *Forma Urbis Romae*, promoted by various institutions (cf. http://web.tin.it/tabularium).

Mapmaking and mapreading are complex tasks that involve coding and decoding procedures aimed at the representation of spatial data. With this in mind, the need to accomplish numerical archaeological cartography, in particular through the aid of aerophotogrammetric restitution techniques, necessarily implies the realisation of specialised laboratories in which archaeologists must know how to use the instruments at their disposal (Guaitoli 1997; Piccarreta 1997). Technical staff may be employed for routine work, budget permitting, but for the analytical part the archaeologist himself must intervene, both in the laboratory and through the survey, which constitutes the necessary and unavoidable on-field data verification. In this perspective, there is also the necessity for a finalised practical education of new students and the subsequent training of specialised professionals.

3. The application sectors

One of the emerging issues in GIS applications in archaeology is the distinction between projects carried out by institutions dealing with the administration and safeguarding of the national cultural patrimony and those carried out by the academic and research institutes; this distinction concerns both methodologies of investigation and aims pursued. Generally, the first sector, listed under the CRM (Cultural Resource Management), refers to ministerial institutions and follows procedures and purposes of administrative character; the second, developed at Universities, Academies or other specific scientific centres, is aimed at a more analytical study, carried out in general on a more restrictive land scale.

This rather evident distinction has proved common to the various geographic areas examined in the survey we promoted. Unfortunately, there is sometimes a lack of communication and co-ordination between the two sectors, which would surely be productive from a methodological point of view, and, in any event, limit in many cases double spending. In fact, co-ordination between these two sectors should be interpreted not as a reciprocal limitation of imposition of places, times and methods with which to carry out projects, but rather as a mutual saving of energy and as a possibility to use, each with his own goals, specialistically differentiated data, in order to preserve archaeological records for the sake of knowledge and conservation.

As we said, a great possibility of dialogue is foreseen in Italy within the "Progetto Finalizzato Beni Culturali". Among the programmatic trends of this project, an interrelationship between the five subprojects, devoted to different topics, has been promoted with the purpose of collecting all the efforts towards the common aim of our national cultural patrimony preservation. Despite this indication, the first results of which are already available, in this article we still propose the classical subdivision between the two sectors, with the purpose of pointing out the methodological and technical choices adopted, which are not always the same.

3.1 *GIS in the management and safeguarding of Cultural Heritage*

Cultural Resource Management in Italy is generally connected to the activities carried out by central and regional offices under the direction of the Ministero per i Beni Culturali e Ambientali and addressed to the problems of management, safeguarding, maintenance and exploitation of the national patrimony. We have not received many answers to our questionnaire from the scholars working in this sector of studies. So, to offer an exhaustive picture of computerised projects in which GIS are used or, in any case, in which their use is foreseen, we had to refer to papers presented during conferences (Amendolea 1997), to examples shown in exhibitions (AA.VV. 1997a), or finally to internal reports. As already mentioned, the major part of these projects is present in the "Progetto Finalizzato" of the CNR (AA.VV. 1997b).

A picture of reference of computer applications for the management of our cultural patrimony is to be gleaned from the activity carried out by the Ufficio Centrale per i Beni Architettonici, Archeologici e Storici in cooperation with the Istituto Centrale per il Catalogo e la Documentazione (ICCD; cf. also http://www.iccd.beniculturali.it). ICCD is an organ of methodological control; its activity pertains to the standardisation of the criteria with which to compile the file-cards and to the normalisation of descriptive

language, through the subsequent establishment of controlled thesauri and the publication of terminological dictionaries. ICCD also has the role of developing computer tools in order to operate a formal control on recorded data and to allow easy data transfer and online access to the information.

In fact, the central database of the Institute must gather the information coming from inventory procedures carried out by regional offices (i.e. the local Superintendences). Besides the project of an automated general catalogue of national cultural heritage, the realisation of a GIS is in progress, with the purpose of allowing the georeferencing of sites and monuments and their contextualisation within the national territory. This project has to face the technical and institutional problem of the production and circulation of cartographic information and to develop a co-ordination between the institutions producing cartography and those producing thematic information. A pilot study has been carried out in a sample area, along the axis of the Po River between the provinces of Lodi and Piacenza.

In the activities gathered under the CRMs, two other projects should be quoted; they are respectively promoted by the Ufficio Centrale per i Beni Ambientali e Paesaggistici and by the Istituto Centrale per il Restauro. The first one is aimed at the definition of reference criteria in order to determine the best technical and methodological solutions to adopt in the establishment of a georeferenced information system for the management and safeguarding of environmental and landscape heritage. The purpose of the second, aimed at the development of diagnostic and conservation techniques, is to standardise the systems of representation of danger factors inside different categories of works of art, in order to define a "Carta del Rischio del Patrimonio Culturale" (http://www.aec2000.it/aec2000/projects/riskmap).

Present in all the central CRM projects is the necessity to start with a first exploratory phase aimed at knowing and optimising already existing resources, through inspection, monitoring and testing procedures. The attempt at co-ordination among various ministerial offices involved in the recording of cultural heritage, and the necessary comparison with the research sector are generally developed in the common sector of the establishment and use of GIS. From a technical point of view, all efforts are intended to define, on a national basis, an organisational model to integrate data of different nature and place them in their original context. All this should be achieved within an information system, that privileges aspects of geographical and multimedial character. To this aim, and to facilitate the availability of data in the future, it is necessary to analyse and establish georeferencing standards for the recording of information and to define criteria for sharing and exchanging data in an integrated environment.

As for specific local activities within the CRM sector, a number of Italian Regions and local archaeological offices, often in collaboration, have

built up their own projects, in which data encoding and structuring must conform to the agreed central standards. Generally, they carry out, through the use of GIS, the georeferencing of sites, monuments, finds and features both on landscape and on different cartographic scales (AA.VV. 1997a, 20-37). The aims pursued are once more the identification of the immovable (containers) and movable (contained) evidence, their recording and their contextualisation. These projects, which will provide the basic repertory for detailed local archaeological information, are all in progress and deal particularly with administrative problems, also related to modern planning demands and intervention. Only rarely (cf. for example the C.A.R.T. project: Carta Archeologica del Rischio Territoriale of the Regione Emilia Romagna; GUERMANDI 1997) do they offer, starting with archaeological cartography, the prevision of danger factors, that should instead constitute one of the principal aims.

3.2 *The research sector*

The answers to our questionnaire regarding projects carried out by Italian academic and research institutes are numerous and permit us to show a rather detailed panorama of GIS applications. A reference point for strengthening Italian activity in this field of studies is also constituted by our journal «Archeologia e Calcolatori». From its beginning this journal has devoted wide coverage to problems concerning topographic and urbanistic studies, and in particular to the reconstruction of ancient landscape and city planning (cf. the subject index in our web page: http://cisadu2.let.uniroma1.it/iaei, which also contains papers on this topic presented during the III International Symposium on Computing and Archaeology, held in Rome in 1995 and published in the seventh issue of «Archeologia e Calcolatori»).

The results of our international survey give us the possibility to notice that GIS projects carried out in the framework of the research sector are often dedicated, especially in the Anglo-Saxon world, to the study of landscape and regional population. One of the characteristics of Italian studies seems to be the presence of two sectors of investigation: the first one pertains to regional studies, aimed at analysing large landscapes and at recording the presence of sites and features inside them; the second one is devoted to the study of ancient towns, either abandoned or obscured by modern evidence, and of their surrounding territory.

One of the principal aims of projects regarding the sector of regional studies is the reconstruction of land modifications during the centuries. This can be achieved through a number of strictly interrelated procedures: the geoenvironmental characterisation of the landscape, as a centre of anthropic pre-existence; the individualisation of laws that govern the relationship be-

tween archaeological sites and their context, and the selection of environmental parameters that contribute to better characterise it; the definition of nature and variability in space and time of the archaeological phenomenon under study and the prevision of its recurrence; the identification of archaeological remains, the evaluation of their condition, their computerised inventory and recording, their georeferencing and finally their restitution.

With regard to safeguard – and here we note the close relationship to the policy of CRM projects – such research projects, and the subsequent use of GIS, are aimed at estimating the degree of vulnerability, through the individualisation of geo-environmental risks, for instance seismic and hydrogeologic natural catastrophes (a problem particularly felt in Italy); at formulating new interpretative hypothesis of instability phenomena either in action or predictable; at proposing criteria for the prevention and the possible improvement of the study areas. From an operative point of view, there is a tendency to reconstruct, on the basis of the data recorded, the relationship among culture, population and landscape.

To achieve such goals it is necessary to establish a system based on the integrated use of different information and technical tools in order to implement the steps of acquisition, processing, enhancing and restitution of data. Among the principal products of these research projects are DTM (Digital Terrain Models) and DEM (Digital Elevation Models) established using information coming, for the most part, from remotely sensed and cartographic data sets (cf. for example Forte *et al*., in this volume). The integrated use of database allows the recording of the information gathered and the application of GIS permits us to associate physical parameters with archaeological records in order to evaluate their statistical relationship and to obtain thematic maps. Data restitution is often carried out through the use of scientific visualisation techniques. More unusual are the simulation of settlement processes and the investigation of the principles that regulate spatial distribution of archaeological features (cf. *infra*, paragraph 4.4).

As to the studies of ancient town planning, these appear particularly developed in Italy; the research methodology followed is based on the analysis and interpretation of the development of towns from the pre-urban phases up to the post-ancient transformations. Particular attention is also devoted to the analysis of the environmental factors (geographical position, geomorphology, climatic factors) that have contributed to the formation of each site. Wherever the study of the surrounding territory intervenes, the research is aimed at defining archaeological distributions and activity areas within a historically coherent context. In such a way, the analysis of archaeological data, punctually georeferenced, constitutes the basis for the urban study of ancient towns, as an example of an "integrated system" for the entire region under investigation.

In these research projects, the necessity for precise references, in order to analyse the reticular grids of urban plans, makes the acquisition of base cartography particularly demanding. This is carried out through the acquisition, processing and restitution in digital format of plans, generally coming from various sources and related to different conditions and chronological periods (cadastral maps, aerial photogrammetry, archaeological plans). The graphic documentation of detail is realised by acquiring, in vector format, plans of the archaeological features, subsequently georeferenced on the base cartography.

The gathering of published or unpublished information to be recorded in archaeological maps originates essentially from surveys and excavations, as well as obviously from research in archives and libraries and from the analysis of marks from air or satellite photographs. The cartographic representation of ancient remains, the definition of the logical structure of graphic entities, as well as the choice of descriptive data to be associated with topographical units relevant to each archaeological record are all inserted in the informative layers that constitute the land information system.

One of the principal purposes of these research projects is the definition of the urban form of ancient towns, for documentation and understanding, and therefore also for safeguard. Safeguard is not only intended in the sense of prevention from environmental and anthropic risks, but it is also devoted to the delineation, through archaeological analysis, of the possibilities to encounter archaeological remains. In practical terms, the goal pursued is to predict, with a high degree of probability, what will likely be found in the "white" spots on archaeological distribution maps (Bampton 1997), i.e. fill in the gaps in the existing archaeological record and make accurate predictions regarding the possible location of archaeological sites or features in unsampled areas.

4. The results of our survey

In the final examination of the results of our survey, our intent is to underline some of the questions posed in our questionnaire. In addition to a general outline of the ongoing projects and a specific survey of the situation in different countries, our initiative constituted the starting point for the investigation of specific topics. These have been identified through the specificity of our questions, which, notwithstanding their simplicity, have allowed us to limit our investigation within the projects already carried out or, in any case, in a progressive phase of realisation.

In the following part of this article, we always refer to the Italian answers received, included at the end of our text and arranged on the basis of the geographical area under study. Each project has also been numbered, so

in the course of this text the relevant numbers are marked in boldface.

4.1 *Archaeological and excavation areas*

Computerised archaeological projects in which GIS are used have interested nearly the entire national territory, from the Valle d'Aosta to Puglia and to the two principal islands. We have registered both CRM projects in which computer application assumes a mostly documentary character and deals with the inventory of archaeological records and projects relevant to the research sectors aimed, as we have seen, at regional analysis and the study of ancient towns, also covered by modern evidence (**nn. 6, 8, 19, 26, 28**). The major part of the territories examined have been chosen not so much on the basis of their modern geographical limits – e.g. for the restitution of regional or provincial archaeological maps (**nn. 7, 10-11, 25**) – but as regions that describe specific archaeological areas with uniform characteristics (**nn. 2-5, 9, 14-16, 18, 20-22, 27**). Only in a few cases, exploratory excavations of significant settlements within each region under study have been carried out.

We have also recorded Italian projects that regard archaeological areas outside national limits, like those carried out in the Iberian territory (**n. 29**), in Northern Africa (**n. 30**), in Greece (**n. 28**), in the Near East (**n. 31**) and in Asia (**n. 32**). Only one project, devoted to the study of necropolis areas and the relevant graves, is present (**n. 23**); this surprises us since this is a traditional topic often present in computer applications in archaeology and in particular in the quantitative approach, through the use of seriation techniques, automatic classification methods, factor and spatial analyses.

In general there is also a rather limited use of GIS in the management of archaeological excavations (**nn. 12-13, 17, 24**). In fact, the use of CAD software is more diffused; like GIS, they offer facilities for the graphic management, the support layers and the production of output easily referable to different scales. Once more, however, we must remember that GIS potentials do not only consist of the management of graphic and cartographic data. In CAD software packages, in fact, the analytical abilities of GIS are lacking, particularly those for carrying on spatial analyses and the interactive management of the georeferenced database.

As a ten-year experiment on the use of information systems in archaeological excavations, we can quote the ODOS project, promoted by the University of Lecce together with the CNR (**n. 24**). It concerns the Southern Puglia, through the computerisation of excavations carried out in settlements relevant to ancient Messapia (D'Andria 1997; Semeraro 1996, 1997). The system, that foresees the integration between three different databaseses (alphanumeric, cartographic and images), has been recently inserted on a GIS

platform, in order to increase the use of spatial analysis techniques. In other projects (**nn. 12-13**), promoted by the University of Siena and concerning medieval settlements in Tuscany (cf. VALENTI, in this volume), GIS constitutes only a modulus within a more complex system of multimedia management of excavations, that facilitates the integrated processing and visual restitution of different archaeological data.

4.2 *Hardware and software*

As far as technical aspects are concerned, hardware tools used are both Unix stations and for the major part PCs (the use of Apple Macintosh seems to be limited to specific academic projects). These choices respect current market tendencies with the growing use of increasingly powerful PC workstations. As far as software is concerned, there is a wide panorama of solutions, and this underlines the primary necessity, within an archaeological information system, to confront the problems connected with the integration of various packages. Workstations generally comprise a GIS, to which a relational database and CAD or CAM software are connected.

The choice of software packages appears strictly linked to the distinction of the two above-mentioned sectors. CRM projects are usually lengthier projects with permanent personnel and sound financial budgets. In these cases the most used solutions are ArcInfo for GIS and Oracle as a database, running on a Unix workstation. The projects carried out in the framework of research institutions are usually of a shorter duration, in strict connection with the available budget, and are managed by a restricted group of researchers. In these projects, generally run on PCs, the most used systems are ArcView and MapInfo for GIS or other university software available to the public and therefore not too expensive, and as a database Access, which is rapidly substituting the preceding products such as D-Base, Filemaker, etc. Lastly, for CAD and CAM products, AutoCAD and Microstation seem to be the most popular.

4.3 *Descriptive standards*

Interest in the use of standards, as a tool for the systematisation of filing criteria and data description procedures, is mostly felt in those projects that operate at a central administrative level, strictly connected to activities delegated to central and local bodies under the direction of the Ministero per i Beni Culturali e Ambientali. In the projects carried out by research institutions, however, scholars are more likely to adapt the ICCD cards to suit their problems or create their own criteria, related to the goal of the research itself.

This is due mostly to the set up followed in the inventory of national

cultural heritage, which has given rise in general to criteria aimed at knowledge in the sense of documentation of cultural patrimony, rather than to its diagnostic analysis, a fundamental step for the improvement of heritage. As for methodologies used for the definition of centralised standards, there have often been objections to their too general set up, which has penalised several study trends; we can quote, for example, the typological and chronological analysis of specific classes of artefacts or the topographical analysis of ancient landscapes and sites. In fact, when facing the necessity to index the entire national patrimony, the greatest efforts are directed towards a system which will safeguard the correlation existing between objects of a different nature relative to a single cultural context, rather than towards the characterisation of specific features and the demands of each branch of archaeological research.

In any case, the problems of uniformity and standardisation of descriptive language that have filled so many pages in the history of computer applications in archaeology seem to assume different features today. The evolution of computer tools, in fact, causes the problem of the definition of controlled thesauri or dictionaries to assume a different role. In GIS applications the interest is generally focused rather than on the establishment of descriptive standards above all on the integration of different modules, concerning data acquisition procedures, image processing techniques, statistical analysis and predictive models.

Speaking about standards, we cannot proceed without mentioning the recording of textual data using SGML (Standard Generalized Markup Language); this system provides the rules for the definition of a descriptive, flexible model suitable for the structuring of each document under study. Data encoding is independent of hardware and software and therefore guarantees easy transfer of files in different systems; it also allows for information retrieval inside the document, as if it were an archive. This kind of procedure, and more in general the use of hypertexts, by now diffused for example in philological studies, is not very used in archaeology, above all within information systems devoted to regional and urban studies (cf. instead Moscati, in this volume, and more in general Orlandi 1996; Bonincontro 1997).

4.4 *Spatial Analysis*

As far as the use of Spatial Analysis techniques are concerned, both inter- and intra-site, they constitute a tool that improves the investigation and above all the understanding of the criteria and processes that are at the basis of archaeological spatial distributions. The research is therefore aimed at stressing the presence of a programmatic choice in the criteria followed in

land and site occupation; in the meantime, the central problem is to ascertain if changes caused by post-depositional phenomena and external factors, both geomorphologic and more specifically economic-cultural, have influenced the settlement structure.

Spatial Analyses are still considered the necessary completion of research using GIS (cf. for example FOTHERINGHAM, ROGERSON 1994; BARCELÓ, PALLARÉS 1996 and in this volume; KVAMME 1997). In fact, spatial elements constitute the very innovation produced by these tools, together with their capabilities to visualise archaeological spatial patterns, generate new spatial variables, promote the quantitative analysis of archaeological distributions. Notwithstanding this, there are in general few projects that reach this phase of experimentation – in which the ability of GIS to manipulate spatial data permits us to extract additional meanings as a result – and that, in any case, show the necessity to investigate topics connected both to the modelling of the distribution of archaeological records and to the simulation of settlement processes. This last step is fundamental to the aims of heritage safeguarding and planning purposes as well, through the identification of variables that characterise the choice of place and the distributive parameters of archaeological records, in correlation also with time.

In Italy, we have registered only a few projects in which Spatial Analysis is usually applied. In general, they make use of functions present within existing commercial GIS, such as those for deterministic location/allocation modelling and gridding (for a meaningful distinction between "spatial analysis" in general and "statistical spatial analysis" in particular, cf. BAILEY 1994). Realisation of distribution maps of archaeological sites and objects and visualisation of density distribution are the most common applications. In some cases, the use of distribution predictive models has furnished important results, as for example in the study of the Sabina area (**n. 18**) in the Tiber Valley (ESPA *et al.* 1997) and of specific archaeological areas in the Veneto Region (**nn. 3-5**; DE GUIO 1991). In any case, attention should be focused on the improvement of a set of existing statistical spatial analysis techniques and on their implementation as modules in a GIS platform.

Two topics, on the contrary, are practically absent: probabilistic sampling techniques for the improvement of the management of survey and excavations, and the reconstructive analysis of ancient socio-cultural systems. In the first case, the cause of this absence should be connected, in my opinion, with a problem of methodological character: spatial distribution of archaeological records responds in general to aggregation and concentration criteria; therefore, it cannot be submitted to a series of tests supposing the randomness of the distribution of the sample.

In the second case, the reproduction of processes that contribute, in space and time, to the formation, development and subsequent disappear-

ance of specific societies, has found a more fertile application within the Anglo-Saxon tradition of studies devoted to the so-called "Social Archaeology" (Gilbert, Doran 1994; Doran 1995, 1996). Mathematical models and simulation techniques become in this case a methodological tool; they allow us to underline the relationships between archaeological data, with their static nature, and human behaviour, whose characterisation is substantially dynamic: a compenetration therefore between the more traditional archaeological problems and the more distinctly anthropological ones.

4.5 *Information diffusion*

In the Italian projects under study, Internet is not a very frequent tool for on-line data diffusion. We can quote some web pages devoted to the general presentation of archaeological activity carried out by each institution, with some links to more detailed information on computerised projects. Only in some cases are web pages specifically dedicated to the presentation of research teams working on computer applications, in which goals pursued, methods used and results obtained are expressly described. As an example of an interdisciplinary research centre, we can quote the CeSTer of the University of Rome "Tor Vergata" (**n. 19**), where different expertise is used for the general purpose of analysing the South-West Roman hinterland (http://www.cester.utovrm.it).

It is of note that we have not recorded any diffusion in Internet of data gathered (such as for example databases), with the possibility, therefore, to consult or query them. In this respect, I would like to quote another Italian project, again promoted by CNR and still in progress, which will constitute the basis for deepening the problem of scientific data availability on-line: the "BIBLOS. Biblioteca Umanistica Virtuale degli Organi di ricerca del CNR" project. Its primary aim is the establishment of a telematic page within the more general Internet web site of the CNR (http://soi.cnr.it/~biblos). In this electronic environment, bibliographic and archivistic information, as well as linguistic, textual, historic and archaeological data gathered by each research Institute operating in the humanities, will be available and searchable.

5. Conclusions

On the basis of the aforesaid and in this perspective, new methodological and practical trends in the use of GIS can be recognised in the following aims: co-operation among different institutions, to preserve the archaeological record for the general sake of science and of cultural heritage safeguarding; formalisation and computerisation of scientific procedures; joint use of geographical, geophysical, topographical and archaeological data; integration of data and technical tools; data restitution in different formats

and with different purposes; data analysis and visualisation; data diffusion also through the use of multimedia systems.

As computer tools are subject to continuous improvement, which is of course much more rapid than the actual research, the problem of basing a computerised project only on the choice of specific hardware and software arises. From a methodological point of view, it is therefore essential to strengthen the relationship, which links computers to the humanities and, in our case, to archaeology. This can be carried out through a series of procedures, both technical and theoretical; they culminate in the identification of the formalisable logical parts of each discipline, and in the explanation of the relationship which binds them to the application of a computerised approach (Orlandi 1997; Moscati 1997).

As to the formalisation of the initial stages of each project, the phase of research formulation, too often underestimated or in any case rarely notified, is the most important. This phase can be carried out through the following steps: syntactic description, encoding procedures (i.e. data representation), data structuring and recording, data restitution. The "encoding" of gathered data, i.e. the formalisation of their representation and their integration within a logical model of data structuring, is the most important step.

In this operative stage, the relationship between computer tools and the demands of archaeological research becomes particularly delicate. In fact, once the methodological parameters of research are determined, all efforts should be aimed at the realisation of a "global" archaeological information system, independent in its theoretical form of the choice of hardware and software. This system should be created and should operate in a unitarian environment and should be able to process, integrate and transfer data of different nature, also originating from different sources.

A reliable information system must also foresee the computerisation not only of data, but also of all methodological procedures, such as those of gathering, management and interpretation of archaeological information. In this respect, the application of GIS within this archaeological information system is of great importance, for its capabilities of data handling and its practical ability to record, cross-reference and analyse large amounts of different data. The relationship, in a unitarian conceptual framework, of all this information will constitute a real basis for data understanding, interpretation, representation, safeguard and improvement. Only in this perspective can the use of computers in archaeology be considered, as it should be, an epistemological revolution rather than only a technological one.

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RESULTS OF THE QUESTIONNAIRE GIS AND ARCHAEOLOGY*

Project 1:

Title of the project: Carta Archeologica d'Italia – *Forma Italiae*.

Promoting Institution: Università degli Studi di Roma "La Sapienza" – Dipartimento

* At the end of the list of the Italian projects, we have inserted also the single answer (**n. 33**) coming from Israel, as a country that overlooks the Mediterranean Basin.

di Scienze Storiche, Archeologiche, Antropologiche dell'Antichità – Laboratorio di Cartografia Archeologica Sperimentale – Cattedra di Topografia dell'Italia antica, I; CNR – Comitato 08; CNR – Comitato 15; CNR – "Progetti Strategici Sud".

Year of beginning: The "Carta Archeologica d'Italia" project began in 1875.

Foreseen term:

Geographic area: Italy in general. Current applications: Northern Basilicata, central and coastal Abruzzo, North-Western Sardinia.

Excavation area: No proper excavations, with respect to single projects.

Short description of the project: The Carta Archeologica d'Italia and the editorial series *Forma Italiae* (now at its 37th volume) are based on methodological assumptions which date back one hundred years. During the last few years new applications, which can be considered in the fare-front also in an international perspective, have been developed. The purpose of *Forma Italiae* to publish an archaeological land register, useful for historical research but essential also for Cultural Heritage safeguard, has never changed. This aim provides a solid and, at the same time, unusual tool for approaching archaeological discipline; in fact it is not based properly on excavation but on high intensity regional surveys. According to these assumptions, an integrated system of analysis and field recording methods was implemented and then developed for the definition and upgrading of a GIS. This system can manage a large amount of data: numerically considerable, with respect to the land "presence" of ancient records and qualitatively extraordinary, with respect to the possibility of a differentiated access within a database able to manage a wide range of information, from the whole context to single archaeological excavation areas.

Hardware: Workstation InterPro 2020; PC HP MT P166 (monitor 20"); Plotter Graphtec GP1002; Digitizer Calcomp 91480; Scanner HPScanJet CX.

Software: Operating system: Windows 95, Windows NT, Unix. Bentley Microstation 95 (with GeoGraphics and Descartes), for numeric cartography and computer graphics management. Personalised software for data integration. Various software packages for topography. Software for Intergraph GIS: Microstation 32; MGE; MGA; I/RASC; MSM; Oracle.

Application of descriptive standards: Recording cards and descriptive procedures used in *Formae Italiae*, that can be managed both on Oracle for Unix, Access and Apple Systems. Vector data format: DGN; exchange format for vector graphic data: DXF; raster: COT, Tiff, JPEG etc., also for Apple Systems.

Application of Spatial Analysis: All those that can be managed by means of MGA/MGE module for Intergraph and GeoGraphics functions on PC Bentley System.

Other important information: The project makes use of various collaborations in order to unify methodologies and exchange results obtained; relationships with the following institutions were in particular officialised: Soprintendenza Archeologica della Basilicata; Soprintendenza Archeologica dell'Abruzzo; Università degli Studi di Lecce; Università degli Studi di Sassari; Istituto Beni Artistici Culturali Naturali della Regione Emilia Romagna.

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Project 2:
Title of the project: Image Processing technique optimisation in an integrated approach to the analysis of remotely sensed data and cartographic information for archaeological research in the Po basin area.
Promoting Institution: Special Project for Cultural Heritage – CNR – Italy.
Year of beginning: 1996.
Foreseen term: 1999.
Geographic area: Lake Como, Lake Iseo.
Excavation area: Gera Lario (Como).
Short description of the project: The aim is to develop a methodology based on the integration of different historical and technological domains expertise to be applied to the study of Cultural Heritage in the different geomorphologic environments of the Po basin. The remote sensing approach is aimed at defining its potential and limitations concerning both spatial (Airborne/Spaceborne Sensors) and spectral (Hyperspectral) resolution aspects.
Hardware: Sun – Sparcstation 10.
Software: PC – EASI/PASE; ArcInfo.
Application of descriptive standards:
Application of Spatial Analysis: The integrated analysis of multisource (cartographic, geophysical, remotely sensed) data by means of GIS tools will allow the assessment of paleoenvironments conditioning the human settlement, and will allow the detection of physical/environmental parameters derivable from remote sensing and related to archaeological sites.
Other important information:
Address: P.A. Brivio, CNR, Istituto di Ricerca per il Rischio Sismico, Via Ampere 56, 20131 Milano.
Tel. 0039-2-70643651-2-7; Fax 0039-2-70643660.
E-mail: sensing@tel-irrs.mi.cnr.it
www address: http://www.tel-irrs.mi.cnr.it

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Project 3:
Title of the project: Alto-Medio Polesine – Basso Veronese.
Promoting Institution: Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova; CISAS (Centro Internazionale di Studi di Archeologia di Superficie), c/o Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova.

Year of beginning: 1986.

Foreseen term: 2000.

Geographic area: Eastern Po Plain (Veneto, provinces of Verona and Rovigo).

Excavation area: No proper excavations: basically high to low intensity field-survey and "stratigraphic windows" (exposed stratigraphy) analysis.

Short description of the project: Themes: the "reconstruction" of the multidimensional evolution of a critical area subject to dramatic cyclical shifts in a number of natural and (eco)cultural "landscapes" (from a geomorphologic landscape to a landscape of power and a landscape of the mind). Two major periods of interest: the Bronze Age (particularly: the morphogenesis of a landscape of power, Aegean connections and long-distance trade, "off-site archaeology" and hydraulic agrarian management, ritual landscape, "survival analysis": "birth, life and death" analytical demography, from the wetland-oriented occupation of the Early Bronze Age to the demographic explosion of the Late Bronze Age banked settlements and their highly differential collapse in the Final Bronze Age, 14C), and Roman (particularly: centuriation-agrarian management, communication networks, archaeology of death, survival analysis).

Direction: A. De Guio (Univ. Padova and C.I.S.A.S.), R. Whitehouse and J. Wilkins (Univ. London and Accordia Research Centre).

Hardware: MAC 9600; MAC 6200; MAC 6100; MAC FX; MAC II; MAC PLUS; PC PENTIUM PRO 200 (coming soon); 2 PC PENTIUM 100 4 (in course of upgrade).

Software: MAC:

Topography: ContoursPro; CumTerra; CAD. Photo-realistic rendering and VR: StrataStudio; Bryce2; PhotoVista. Image Processing: Optilab; Enhance. Hypermedia: Macromedia Studio; Premiere. Statistics: Systat. Programming: Future Basics; Lingo.

PC:

GIS: IDRISI. Hypermedia: Macromedia Director.

Application of descriptive standards: Image processing and pattern recognition of remote sensing and aerial images; descriptive, inferential and multivariate statistics; database management; hypermedia; WWW.

Application of Spatial Analysis: GIS (IDRISI, in general); DEM; aspect; locational analysis; view-shed and the like; risk assessment; Landscape of Power simulation; survival analysis (applied to various archaeological units); trend-surface analysis; Percolation Analysis (original algorithm for multi-modal cluster detection: cfr. De Guio A., Secco G., Archaeological applications of the "Percolation Method" for data analysis and pattern recognition, in Rahtz S.P.Q. (ed.), Computer and Quantitative Methods in Archaeology 1988, B.A.R. International Series, Oxford 1988, 446 (ii), pp. 63-93).

Other important information: Key references: De Guio A., Alto-Medio Polesine – Basso Veronese: from a "landscape archaeology" to an "archaeology of the mind", in Christie N. (ed.), Settlement and economy in Italy 1500 BC to AD 1500, Oxford 1995, Oxbow, pp. 13-24.

De Guio A., Surface and subsurface: Deep ploughing into complexity, in Hensel W., Tabaczynski, Urbanczyk P. (eds.), Theory and practice of archaeological research , II, Institute of Archaeology and Ethnology, Commitee of Pre- and Protohistoric Sciences, Polish Academy of Sciences, Warszawa 1995, pp. 329-414.
De Guio A., Whitehouse R.D., Wilkins J. (eds.), Progetto Alto-Medio Polesine – Basso Veronese: nono rapporto, «Quaderni di Archeologia del Veneto», 13, 1997, pp. 154-168.

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Project 4:

Title of the project: Monti Berici.

Promoting Institution: Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova; CISAS (Centro Internazionale di Studi di Archeologia di Superficie), c/o Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova.

Year of beginning: 1993.

Foreseen term: 2003.

Geographic area: Pre-alpine hill/mountain system (Veneto, province of Vicenza).

Excavation area: Soastene: hill-slope multi-stratified site (Neolithic to present). In the Neolithic sequence we have found what seems at present the most ancient "road" in the world (cal. radiocarbon date: 4935-4695 BC (2s) (Beta-107672); see: De Guio A., Cattaneo P., "Dirt roads to Brendola": le strade preistoriche di Soastene-Brendola (VI), «Quaderni di Archeologia del Veneto», 13, 1997, pp. 168-182; De Guio A., in press.

Short description of the project: Themes: past human adaptation to an area characterised by two distinctive features: a) a basically "ecotonal" environment (i.e. a territory that concentrates in a relatively small area a wide range of ecological niches and related transitional belts, from wetlands of the plain to a low altitude Karst-plateau); b) a "creodic" status in North-Eastern Italian communication systems, in that the Monti Berici constitute the Southern wall of a narrow funnel across the high plain, which acted as a highly channelling constraint through time. Major periods of interest: Neolithic (see above, under "excavation area" about the most ancient "road" in the world), Copper Age, Bronze Age, Roman, Medieval (particularly: adaptations of different sociocultural systems in terms of survival strategies aimed at actively manipulating the specific degrees of freedom and constraints offered by local environment). Because of the above-described peculiarities and its extraordinarily rich archaeological record, the area has been chosen for a regional pilot project to make a "hyper-medial" (computer-interactive) archaeological map.

Date: 1993, in progress. Direction: A. De Guio (Univ. Padova and C.I.S.A.S.).

Hardware: Mac 9600; MAC 6200; MAC 6100; MAC FX; MAC II; MAC PLUS; PC PENTIUM PRO 200 (coming soon); 2 PC PENTIUM 100 4 (in course of upgrade).

Software: MAC:

Topography: ContoursPro; CumTerra; CAD. Photo-realistic rendering and VR: StrataStudio; Bryce2; PhotoVista. Image Processing: Optilab; Enhance. Hypermedia: Macromedia Studio; Premiere. Statistics: Systat. Programming: Future Basics; Lingo.

PC:

GIS: IDRISI. Hypermedia: Macromedia Director.

Application of descriptive standards: Image processing and pattern recognition of remote sensing and aerial images; descriptive, inferential and multivariate statistics; database management; hypermedia; WWW.

Application of Spatial Analysis: GIS (IDRISI, in general); DEM; aspect; locational analysis; view-shed and the like; risk assessment; Landscape of Power simulation; survival analysis (applied to various archaeological units); trend-surface analysis; Percolation Analysis (original algorithm for multi-modal cluster detection: cfr. De Guio A., Secco G., Archaeological applications of the "Percolation Method" for data analysis and pattern recognition, in Rahtz S.P.Q. (ed.), Computer and Quantitative Methods in Archaeology 1988, B.A.R. International Series, Oxford 1988, 446 (ii), pp. 63-93).

Other important information: Key references: De Guio A., Il "Progetto Brendola": linee di un Eco-cultural Resource Management" per il terzo millennio, «Quaderni di Archeologia del Veneto», 10, 1994, pp. 203-206.

De Guio A., Cattaneo P., "Dirt roads to Brendola": le strade preistoriche di Soastene-Brendola (VI), «Quaderni di Archeologia del Veneto», 13, 1997, pp. 168-182.

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Project 5:

Title of the project: Altopiano dei Sette Comuni.

Promoting Institution: Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova; CISAS (Centro Internazionale di Studi di Archeologia di Superficie), c/o Dipartimento di Scienze dell'Antichità, Università degli Studi di Padova.

Year of beginning: 1993.

Foreseen term: 2005.

Geographic area: Pre-alpine upland (Veneto, province of Vicenza).

Excavation area: Bostel site at Rotzo (Vicenza): multi-stratified settlement (Late

Bronze Age – 2nd Iron Age).

Short description of the project: Themes: the adaptation of past sociocultural systems to the local upland environment (often acting through time as a highly dynamic and metastable unit between different natural and socio-political entities), strategies for the exploitation of local resources (mainly: pasture, woodland, mineral ores), pastoralism and seasonal movements, local to long-distance trade, "survival analysis", "archaeology of the mind", ethno-historical archaeology, "archaeology of war", frontiers and boundaries. Major periods of interest: Bronze Age, Iron Age, Medieval to contemporary.

Three major local sub-projects:

a) Rotzo – Bronze Age occupation, Iron Age hillfort, ethno-historical archaeology and "archaeology of war", public archaeology;

b) M. Corgnon – Lusiana: Bronze to Iron Age hillfort;

c) Lusiana – Ethno-historical archaeology and public archaeology in the Lusiana area: e.g. research into charcoal burning, lime kilns, pastoralism, tobacco smuggling, the design and construction of theme-parks and archaeological trails for the general public, "archéologie événementielle": ethno-history as a key to re-evaluating the role of short-term processes in imprinting the taphonomy of the archaeological record.

Hardware: MAC 9600; MAC 6200; MAC 6100; MAC FX; MAC II; MAC PLUS PC PENTIUM PRO 200 (coming soon); 2 PC PENTIUM 100 4 (in course of upgrade).

Software: MAC:

Topography: ContoursPro; CumTerra; CAD. Photo-realistic rendering and VR: StrataStudio; Bryce2; PhotoVista. Image Processing: Optilab; Enhance. Hypermedia: Macromedia Studio; Premiere. Statistics: Systat. Programming: Future Basics; Lingo.

PC:

GIS: IDRISI. Hypermedia: Macromedia Director.

Application of descriptive standards: Image processing and pattern recognition of remote sensing and aerial images; descriptive, inferential and multivariate statistics; database management; hypermedia; WWW.

Application of Spatial Analysis: GIS (IDRISI, in general); DEM; aspect; locational analysis; view-shed and the like; risk assessment; Landscape of Power simulation; survival analysis (applied to various archaeological units); trend-surface analysis; Percolation Analysis (original algorithm for multi-modal cluster detection: cfr. De Guio A., Secco G., Archaeological applications of the "Percolation Method" for data analysis and pattern recognition, in Rahtz S.P.Q. (ed.), Computer and Quantitative Methods in Archaeology 1988, B.A.R. International Series, Oxford 1988, 446 (ii), pp. 63-93).

Other important information: Key references: De Guio A., Dal Bronzo Medio all'inizio dell'Età del Ferro, in AA.VV., Storia dell'Altipiano dei Sette Comuni. I. Territorio e istituzioni, Vicenza 1994, Neri Pozza, pp. 157-178.

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Project 6:

Title of the project: Sistema Informativo Territoriale-Archeologia (SITAr) di Padova.

Promoting Institution: Università di Padova, Comune di Padova, Soprintendenza Archeologica per il Veneto.

Year of beginning: 1992.

Foreseen term: 1998.

Geographic area: Padova and its municipal territory.

Excavation area: Historical town center and municipal territory.

Short description of the project: Realization of an archaeological thematic analysis (from Prehistory to Early Middle Age) within the Geographic Information System of Padova.

Hardware: Siemens.

Software: Unix.

Application of descriptive standards:

Application of Spatial Analysis:

Other important information: The information elements of the SITAr are the following: numeric cartography, alphanumeric database, image database.

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Project 7:

Title of the project: C.A.R.T.: Carta Archeologica di Rischio Territoriale dell'Emilia Romagna.

Promoting Institution: Istituto Beni Artistici, Culturali, Naturali della Regione Emilia Romagna; Soprintendenza Archeologica dell'Emilia Romagna.

Year of beginning: 1995.

Foreseen term: 1998 (first module: Faenza).

Geographic area: Emilia Romagna.

Excavation area:

Short description of the project: The C.A.R.T. project aims at the realisation of archaeological cartography on an urban scale in Emilia Romagna region as a tool for land planning (the first urban center will be Faenza). From a technological point of view, our purpose is the implementation of specific software, which has information retrieval system characteristics and GIS software capacity.

Hardware: PC Pentium tipology.

Software: Odysseus system (Highway as IRS; ArcView as GIS).

Application of descriptive standards: Istituto Centrale per il Catalogo e la Documentazione (ICCD) archaeological descriptive standards.

Application of Spatial Analysis: Distance calculation; linear regression statistical analysis; Poligon processing.

Other important information: Odysseus system also manages on line thesauri and it has a specific gateway to read database information via Internet.

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Project 8:

Title of the project: "Mutina". Carta archeologica informatizzata del territorio modenese. Tutela archeologica e pianificazione territoriale.

Promoting Institution: Museo Archeologico Etnologico di Modena together with Comune di Modena, Assessorato alla Cultura e Beni Culturali, Assessorato alla Programmazione e Pianificazione Territoriale, Centro Elaborazione Dati; Ministero per i Beni Culturali e Ambientali, Soprintendenza Archeologica dell'Emilia Romagna; Regione Emilia Romagna, Istituto per i Beni Artistici, Culturali e Naturali; Provincia di Modena, Assessorato alla Programmazione e Pianificazione Territoriale.

Year of beginning: 1994.

Foreseen term:

Geographic area: Province of Modena.

Excavation area:

Short description of the project: Census of all information useful to: reconstructing ancient landscape, managing archaeological finds and museum activities, defining rules for the safeguard of the archaeological patrimony. Information is recorded in a database within a GIS platform.

Hardware: Client-Server System; Server: Pentium 166, 64 MB RAM; Client: Pentium 133, 32 MB RAM, PC 486 dx 33, 32 MB RAM.

Software: Highway Client-Server (Windows NT platform). Highway is an informa-

tion retrieval software, linked to modules for carthograpic and image data management. This software can manage different kinds of data with flexibility (structured text, natural language, *thesauri*) and, by means of information retrieval technology, can structure them in conformity with a reticular model.

Application of descriptive standards: Most of the information has been recorded using ICCD descriptive standards ("Scheda di Sito" and "Scheda RA").

Application of Spatial Analysis: Thematic Maps based on any kind of query, to be shaped through the choice of different symbols and colours.

Other important information: Data visualisation on georeferenced cartography, both vector or raster. Capability to overlay raster images on vector cartography. Image visualisation of sites and/or finds. Bibliographic controlled database.

Address: Museo Archeologico Etnologico di Modena, Piazza S. Agostino 5, 41100 Modena.

Tel. 0039-59-243263; Fax 0039-59-224795.

E-mail: museoarc@comune.modena.it

www address:

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Project 9:

Title of the project: Atlante delle terramare emiliane.

Promoting Institution: Centro di Studio per la Geodinamica alpina e quaternaria, CNR (Progetto Finalizzato CNR – Beni Culturali); Dipartimento di Scienze della Terra, Università di Milano; CINECA, Bologna.

Year of beginning: 1997.

Foreseen term: 1999.

Geographic area: Central and Western Emilia.

Excavation area: S. Rosa di Poviglio (Reggio Emilia).

Short description of the project: Establishment of a GIS of terramare; multimedial data publication (multimedial Atlas) on CD-ROM.

Hardware: SGI O2, SGI INDY, PC Pentium, Workstation HP.

Software: ER MAPPER, GRASS, GRASSLAND, AutoCAD, Toolbook, Director, IDRISI, Surfer, Quickgrid.

Application of descriptive standards: All GIS and remote sensing application oriented techniques; on-field creation of DEM by means of laser stations; advanced micromapping analysis; multimedial products; applications of non full immersion Virtual Reality.

Application of Spatial Analysis: Yes.

Other important information:

Address: Maurizio Forte, International Association of Computing in Archaeology, Via Magnanelli 6/3, 40033 – Casalecchio di Reno (Bologna).

E-mail: aiace@sirio.cineca.it maurizio.forte@bo.nettuno.it

www address: http://www.cineca.it/projects/aiace/

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Project 10:

Title of the project: Carta Archeologica della Regione Toscana.

Promoting Institution: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Sezione Archeologica, Cattedra di Archeologia medievale.

Year of beginning: Survey of the province of Siena: 1989; inventory of hill sites: 1995; GIS platform: 1997.

Foreseen term:

Geographic area: Tuscany.

Excavation area:

Short description of the project: Data management, by means of a GIS platform, of archaeological records produced by our Department in Tuscany (Archaeological Map of the province of Siena, inventory of hill sites, excavations), in order to establish an analytic tool for archaeologists and land operators.

Hardware: Apple Power Macintosh G3 Minitower (266 MHz, 160 MB RAM).

Software: GIS: ArcView 3.0 (ESRI); DBMS: FilemakerPro 3.0 (Claris).

Application of descriptive standards:

Application of Spatial Analysis: Thiessen Polygons, Central Place Theory.

Other important information: Our GIS platform is only a module within a multimedial system which, through the realisation of a programmed user interface ("OpenArcheo"), allows us to manage all archaeological data in an integrated environment.

Address: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Via Roma 56, 53100 Siena.

E-mail: VALENMAR@unisi.it

www address: www. archeo.unisi.it

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Project 11:

Title of the project: Carta Archeologica della Provincia di Siena.

Promoting Institution: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Sezione Archeologica, Cattedra di Archeologia medievale.

Year of beginning: Survey: 1989; GIS platform: 1994.

Foreseen term:

Geographic area: Province of Siena (Tuscany).

Excavation area:

Short description of the project: Data management, by means of a GIS platform, of the results obtained through the implementation of the Archaeological Map (survey, archive research, excavations), in order to establish an analytic tool for archaeologists and land operators.

Hardware: Apple PowerMac 8500/180 (180 MB RAM).

Software: GIS: MapGraphix 3.5.5. (Comgrafix Inc.); ArchView 3.0 (ESRI) (in course of upgrade). DBMS: FilemakerPro 3.0.

Application of descriptive standards:
Application of Spatial Analysis: Thiessen Polygons; Central Place Theory.
Other important information: Our GIS platform is only a module within a multimedial system which, through the realisation of a programmed user interface ("OpenArcheo"), allows us to manage all archaeological data in an integrated environment.
Address: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Via Roma 56, 53100 Siena.
E-mail: VALENMAR@unisi.it
www address: www. archeo.unisi.it

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Project 12:
Title of the project: Poggio Imperiale a Poggibonsi.
Promoting Institution: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Sezione Archeologica, Cattedra di Archeologia medievale.
Year of beginning: Excavation: 1993; GIS platform: 1996.
Foreseen term: Excavation currently in progress.
Geographic area: Val d'Elsa, Poggibonsi (Siena).
Excavation area: Poggio Imperiale fortress.
Short description of the project: Integrated multimedial management of archaeological excavation.
Hardware: Apple PowerMac 8500/180 (180 MB RAM).
Software: Geo Concept/ MacMap.
Application of descriptive standards:
Application of Spatial Analysis: Cost – Surface Analysis, descriptive statistical analysis of excavation findings (frequency analysis, means, standard deviation); the application of simulation models and the projection of excavation models on the excavation area under study are in progress.
Other important information: Our GIS platform is only a module within a multimedial system which, through the realisation of a programmed user interface ("OpenArcheo"), allows us to manage all archaeological data in an integrated environment.
Address: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Via Roma 56, 53100 Siena.
E-mail: VALENMAR@unisi.it
www address: www. archeo.unisi.it

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Project 13:
Title of the project: Rocca San Silvestro.
Promoting Institution: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Sezione Archeologica, Cattedra di Archeologia medievale.
Year of beginning: Excavation: 1984; GIS platform: 1997.

Foreseen term: 1998.

Geographic area: Val di Cornia.

Excavation area: Rocca San Silvestro, Campiglia Marittima (Livorno).

Short description of the project: Integrated multimedial management of archaeological excavation.

Hardware: Apple PowerMac 8500/180 (180 MB RAM).

Software: Geo Concept / MacMap.

Application of descriptive standards:

Application of Spatial Analysis: Cost – Surface Analysis, descriptive statistical analysis of excavation findings (frequency analysis, means, standard deviation).

Other important information: Our GIS platform is only a module within a multimedial system which, through the realisation of an user programmed interface ("OpenArcheo"), allows us to manage all archaeological data in an integrated environment.

Address: Università degli Studi di Siena, Dipartimento di Archeologia e Storia delle Arti, Via Roma 56, 53100 Siena.

E-mail: VALENMAR@unisi.it

www address: www. archeo.unisi.it

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Project 14:

Title of the project: Tecniche multimediali per la valorizzazione e la fruizione dei beni culturali sul territorio: l'esempio dell'Etruria meridionale.

Promoting Institution: Ceaprelda srl (Napoli) – Divisione Beni Culturali.

Year of beginning: 1993.

Foreseen term: Work in progress.

Geographic area: Southern Etruria (Veio, Caere, Pyrgi, Tarquinia, Vulci).

Excavation area:

Short description of the project: The aim of our project is the setting up of a multimedial system for the improvement and fruition of archaeological resources. Our first goal is to realise a scientific/popular product, which can be used both by scholars – for study and research – and more in general by people interested in this subject. Modern GIS methodologies, combined with the use of relational databases, were applied not only to implement detailed "intelligent" land maps, but also to gain access to a large amount of data (texts, photographs, 3D rendering). The subsequent application of specific *ad hoc* software gives the opportunity to produce the so-called "Programmi Multimediali", which allow the user to freely navigate through the various information at disposal. This possibility makes the product suitable to every user. Greatest care is devoted to image processing: the search for photos and the possibility of enlarging details make the photographical section of our product a valid work-tool. The use of GIS makes available all data necessary for a 3D reconstruction of lost archaeological contexts, both partial (a single structure, a grave, etc.) and total (a whole archaeological area). In the phase of development, the use of detailed cartography gives considerable importance to the product also from a

topographical perspective: salient features in the area under study are linked together (by close interrelations to the supporting database) and they allow a visualisation of data relevant to each of them; for each co-ordinate cards, photos, reconstructions, etc. are at disposal. Systems which allow the visualisation at different levels of all data, both environmental and archaeological, are now in progress. This peculiarity permits the visualisation of data, according to typologies and chronological periods, and to steer the product towards a properly scientific approach. As we can see, the first goal of our research is not to realise new GIS, but to develop software able to interface any kind of existing GIS.

Hardware: Programme development: Pentium 166 (48 MB RAM, HD 1,3 GB, Super VGA 16 bit true colours). Running: PC 486 DX2 66 (8 MB RAM, VGA 640x480 65000 colours, sound blaster, CD-ROM, 15 MB free on HD).

Software: Cartography: AutoCAD. Graphic reconstruction: 3D studio, Video for Windows, Adobe Premiere. Image processing and enhancing: Photo Shop. Database: Microsoft Access. Software development: Visual Basic, Multimedia ToolBook.

Application of descriptive standards:

Application of Spatial Analysis:

Other important information: The results of our research team represent the operating and methodological basis for multimedial products (CD-ROM) on archaeological subject, such as "Gli Etruschi – Etruria meridionale", "Paestum", "Napoli", "Campi Flegrei", "Amalfi".

Address: Ceaprelda srl – Divisione Beni Culturali – Via Ferrante Imparato, 495 – 80143 Napoli.

Tel./Fax: 0039-81-5846470.

E-mail:

www address:

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Project 15:

Title of the project: Scuola Cantiere Archeologica nel territorio di Vulci e Montalto di Castro.

Promoting Institution: Ministero del Lavoro e della Pubblica Sicurezza – Ministero dei Beni Culturali; Concessionaire (financial support L. 160/88): Arethusa Consorzio di Ricerca e Sviluppo.

Year of beginning: 1993.

Foreseen term: 1996.

Geographic area: Municipal territory of Montalto di Castro.

Excavation area: Etruscan and Roman town of Vulci.

Short description of the project: The project aims at setting up: a module for an Archaeological Park; a restoration laboratory of analysis and diagnosis; a meeting hall; an E.D.P. Center; a GIS concerning archaeological data from Vulci and its surrounding territory; 24 publications (also in a multimedial format); other activities for Cultural Heritage improvement.

Hardware: Server: 2 IBM RISC 6000, 14 Client Olivetti PC Pentium, LaserJet printers, plotter, scanner.

Software: Oracle DBMS, ArcInfo, MS Office; CorelDraw, Aldus Pagemaker.

Application of descriptive standards: Descriptive standards of the Istituto Centrale per il Catalogo e la Documentazione (ICCD) for database recording; development on Oracle/MS Access on Client/Server system.

Application of Spatial Analysis: GIS integrated "Asia"; Client/Server system developed on ArcInfo/ArchView and integrated with Oracle database.

Other important information:

Address: Susanna Bianchi, Arethusa Consorzio di Ricerca e Sviluppo S.r.l., Via Garibaldi 1/a, 01014 Montalto di Castro (VT).

Tel. 0039-55-576944 576959; Fax 0039-55-576938

E-mail:

www address:

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Project 16:

Title of the project: Conoscenza e tutela del territorio di Cerveteri.

Promoting Institution: Soprintendenza Archeologica per l'Etruria meridionale; ISMES Bergamo (with the financial support of ENEL).

Year of beginning: 1995.

Foreseen term:

Geographic area: Territory of ancient Cerveteri (Rome).

Excavation area:

Short description of the project: The project aims at setting up: 1) a tool for the study and the analysis of cultural patrimony, through a cartographic georeferenced database of Cerveteri municipal territory; 2) a tool for managing, by means of an alphanumerical database, all the institutional activities with respect to acts, expropriation orders and all the administrative procedures pertaining to the Soprintendenza per l'Etruria meridionale and all other territorial authorities.

Hardware: PC Pentium 133 MHz (256 K cache, 32 MB RAM, HD EIDE 1.6 GB).

Software: MapInfo Professional; Access 7 (for database).

Application of descriptive standards:

Application of Spatial Analysis:

Other important information:

Address: Soprintendenza Archeologica per l'Etruria meridionale – P.le di Villa Giulia, 9 – 00196 Roma.

Tel. 0039-6-3226571; Fax: 0039-6-3202010.

E-mail:

www address:

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Project 17:

Title of the project: Creazione di un modello di sistema informativo archeologico e sua applicazione all'antica Caere ("The Caere Project").

Promoting Institution: CNR – Istituto per l'archeologia etrusco-italica; CNR – Progetto Finalizzato "Beni Culturali".

Year of beginning: 1996.

Foreseen term: 2000.

Geographic area: Etruscan town of Cerveteri (Rome).

Excavation area: Excavations in the urban area.

Short description of the project: The main purpose of the "Caere Project" is to use an archaeological information system in the study of the ancient Etruscan town of Caere, where our Institute had been carrying out surveys and excavations since 1982. Through an international census of the research projects carried out in this sector of studies, our initial aim was the definition of some methodological and technical problems: 1) data representation and encoding; 2) data structuring and formalisation of the procedures; 3) use of descriptive standards; 4) alphanumerical, graphical and cartographic data analysis and image processing; 5) application of inter- and intra-site Spatial Analysis; 6) definition and testing of new software; 7) application of our model to Caeretan data; 8) establishment of a parallel multimedia product for data diffusion and conservation.

Our information system model foresees the computerisation of different archaeological issues: from survey to excavations, laboratory analyses, documentary research, information diffusion and safeguarding of archaeological heritage. Subsequent operating stages are therefore aimed at developing the following points: integration of different systems, normalisation of descriptive language, standardisation of technical and methodological tools. First of all, an *ad hoc* low altitude flight over the area of the ancient settlement and the necropolis on the overlooking hills has been planned. A successive phase envisages the aerophotogrammetric restitution of the data in digital format on the scale of 1:1000. The two areas under excavation, which have led to the discovery of the remains of temples and structures of the ancient urban area, will be positioned on this cartographic basis. This will allow us to test the potentiality of GIS in the field of archaeological excavations.

Hardware: Client-Server System, Windows NT 4.0. Server: PC Pentium (133 MHz, 98 MB RAM, HD 4 GB, 256 KB cache, net card Etherlink III). Clients: PCs. Scanner HP 4C, scanner 35 mm. Minolta QuickScan 35, scanner CALCOMP ScanPlus III A0 format. Plotter ENCAD Nova Jet pro, A0 format. Laser Writer QMS 1660 A3, InkJet Canon BJC 620. CD writer Yamacha SCSI, CDR400TI.

Software: PC ArcView 3.0 and ArcCAD for GIS management; AutoCAD 14 and Microstation 5.0 for computer graphics and 3D restitutions; Adobe Photoshop 4.0 and CorelDraw 7.0 for image processing; Access for database management; FrontPage 98 as web designer; SoftQuad for SGML data encoding; SPSS and SPAD for statistical analyses.

Application of descriptive standards: With regard to the alphanumerical databases, we are following two distinct procedures. In the excavation at St. Antonio, a relational database using Access is being set up: the central nucleus comprises Strati-

graphic Units, recorded according as far as possible to the Istituto Centrale per il Catalogo e la Documentazione (ICCD) descriptive standards. However, in the excavation at Vigna Parrochiale the yearly excavation diaries are now being recorded in hypertext form, using SGML.

Application of Spatial Analysis:

Other important information: The archaeological information system model, which will constitute the scientific product of our research, will have a double aim: it will be used as a research tool, but it will also be supported by a multimedia version for a wider public. Our purpose is to favour widespread information and at the same time to safeguard the Caeretan archaeological patrimony.

Address: Istituto per l'archeologia etrusco-italica del CNR, Viale di Villa Massimo 29, 00161 Roma.

Tel. 0039-6-44239470 44239696; Fax 0039-6-44239379.

E-mail: moscati@iaei.rm.cnr.it

www address: http://soi.cnr.it/~iaei http://cisadu2.let.uniroma1.it/iaei

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Project 18:

Title of the project: Geographical Information System and database for thematic mapping and data comparison (Geology, Geography, Archaeology).

Promoting Institution: Istituto per le tecnologie applicate ai Beni Culturali – CNR; Istituto per l'archeologia etrusco-italica – CNR; Progetto Finalizzato Beni Culturali – CNR.

Year of beginning: 1993.

Foreseen term: 1999.

Geographic area: Sabina Tiberina (Latium).

Excavation area:

Short description of the project: Establishment of a GIS. Organisation and statistical analysis of spatial data. Archaeological and territorial data have been collected in order to provide information on the evolution of the population settlement in a selected area concerning the Tiber Valley during the orientalising and archaic periods and in the Republican age.

Hardware: Workstation Alpha Digital 250, PC Pentium, Plotter Calcomp A0, Scanner H.R.

Software: PC ArcInfo, PC Erdas, PC ArcView, Doris, Geo, AutoCAD 13, A.V.S.

Application of descriptive standards:

Application of Spatial Analysis: Point Pattern Analysis; predictive modelling in archaeology.

Other important information:

Address: Salvatore Espa, Istituto per le Tecnologie applicate ai Beni Culturali – CNR, Via Salaria Km. 29.300. C.P. 10, 00016 Monterotondo Scalo (Roma).

Tel. 0039-6-90672363 90672370; Fax 0039-6-90672373.

E-mail: espa@nserv.iemat.mlib.cnr.it
www address:

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Project 19:
Title of the project: Cartografia Informatizzata (GIS) dei Beni archeologici e architettonici del suburbio S-O di Roma.
Promoting Institution: CeSTer – Università di Roma "Tor Vergata".
Year of beginning: 1986.
Foreseen term: 2000.
Geographic area: South Western Roman hinterland delimited by the ancient Via Appia and Casilina, between the Aurelian walls and the Colli Albani slopes.
Excavation area: Villa dei Quintili, Tor Vergata territory (Carcaricola, Boccone del Povero, Passolombardo).
Short description of the project: Reconstruction of land environmental conditions and modifications, from the archaic period to contemporary age.
Hardware:
Software: MapInfo, ArcInfo, ArchView, various software for database integration.
Application of descriptive standards:
Application of Spatial Analysis:
Other important information: Data acquisition and recording are aimed at urban planning and analysis of archaeological risks, to be used in the projects of land modifications.
Address: Centro per lo Studio delle Trasformazioni del territorio, beni culturali, ambientali e risorse informatiche (CeSTer), Università di Roma "Tor Vergata", Via A. Cavaglieri 6 – 00133 Roma.
Tel./Fax 0039-6-72595001.
E-mail:
www address: http://www.cester.utovrm.it

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Project 20:
Title of the project: Computer applications in Lower Sangro Valley Survey.
Promoting Institution: Dipartimento di Scienze Archeologiche e Storiche dell'Antichità, Macerata.
Year of beginning: 1996.
Foreseen term: 2000.
Geographic area: Lower Sangro Valley (Abruzzo).
Excavation area:
Short description of the project: Sub-project of LUDS survey. Aim: evaluation of survey data reliability; analysis of the spatial distribution of archaeological remains.
Hardware: Pentium MMX 200 (512 KB cache, 64 MB RAM, HD 2GB); digitizer

A0; printer Epson Stykus colour 1520.
Software: Idrisi for Windows 2.0; AutoCAD R14.
Application of descriptive standards: ICCD (Istituto Centrale per il Catalogo e la Documentazione) descriptive standards.
Application of Spatial Analysis: At present, Idrisi modules.
Other important information:
Address: Umberto Moscatelli, Facoltà di Lettere, Via Don Minzoni 2, 62100 Macerata.
E-mail: umoscatelli@mercurio.it
www address:

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Project 21:
Title of the project: La linea di costa fra Posillipo e Pozzuoli (Napoli).
Promoting Institution: GEOMARE Sud – CNR; TEKNOMAR srl.
Year of beginning: 1997.
Foreseen term: 1999.
Geographic area: Naples (Campania).
Excavation area:
Short description of the project: Geophysical prospecting of the coastline; mapping and recording of undersea archaeological evidence.
Hardware:
Software: CARIS (Universal System Ltd.).
Application of descriptive standards:
Application of Spatial Analysis:
Other important information:
Address: Umberto Pappalardo, Via Quisisana 35, 80050 – Castellammare di Stabia (Napoli).
E-mail: umbpappa@unina.it
www address:

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Project 22:
Title of the project: A GIS for the Vesuvian area.
Promoting Institution: CNR – Centro di studio per la Geologia Strutturale e Dinamica dell'Appennino; CNR – Istituto Nazionale di Coordinamento dei Beni Culturali.
Year of beginning: 1996.
Foreseen term: 1998.
Geographic area: Circumvesuvian area (including Pompei, Ercolano, etc.).
Excavation area:
Short description of the project: The goal of the project is the creation of a GIS for the archaeological sites of the Circumvesuvian area. The GIS will include:

– Actual information on the Circumvesuvian area (17 council districts with a total area coverage of about 240 sq. km). The digital information regards roads, buildings, railways, elevation quotes etc. The scale is 1:2000.

– Archaeological evidence. The "layers" considered are elevation points at 79 AD, aqueduct, amphitheatre, honorary arch, canalisation, ancient urban centre, votive deposit, productive commercial building, generic public building, forum, sporadic material, funerary monument, necropolis, fountain, sanctuary, buildings, uncertain interpretation structures, harbour structures, theatre, temple, thermae, tomb, agrarian division traces, installation traces, preserved road, villa etc.

– Archaeological buried evidence.

– Archaeological restraints.

Each single object of the archaeological database is characterised by descriptive alphanumeric data (characteristics, history, etc.), attributes (actual status, vulnerability, etc.) and digital images.

Hardware: Digitiser CALCOMP 9500/A0 – PC; Station IBM RISC 6000, model 540, 128 MB RAM, 6G; Plotter IBM 6186/2 colour, A0 format, Inkjet colour, 720 dpi. 16 MB; Station HP/400, 16 MB RAM, 1G; Station IBM RISC 6000, model 7011 220, 32 MB RAM 2G; 2 Laser Writer Macintosh; 3 PC Macintosh, 2 PC Pentium 180 MHz.

Software: Software (Galaxy, XV, Erdas, ENVI, etc.) for visualisation and management of digital images and DEMs; software GEOMAX-XM and ArcView 3.0 for GIS management; software DIGIT to store geographical data in the GIS.

Application of descriptive standards:

Application of Spatial Analysis:

Other important information:

Address: Maria Teresa Pareschi (Geophysicist), Centro per lo Studio della Geologia Dinamica e Strutturale dell'Appennino (CSGSDA) – CNR, Via Santa Maria 53, 56100 Pisa.

Tel. 0039-50-847267; Fax 0039-50-500675.

Working Group: Piero Manetti (Geologist), DST, Università di Firenze; A. Varone (Archaeologist); G. Stefani (Archaeologist); Luciano Cavarra (Geologist), CSGSDA-CNR, Pisa; Francesco Mazzarini (Geologist), CSGSDA-CNR, Pisa.

External Partners: Soprintendenza Archeologica di Pompei; Dipartimento Scienze della Terra, Università di Pisa; Dipartimento Scienze della Terra, Università di Firenze; Osservatorio Vesuviano, Napoli.

E-mail: pareschi@dst.unipi.it

www address:

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Project 23:

Title of the project: Il progetto Eurialo: un GIS vettoriale per la gestione integrata dei dati archeologici di Pontecagnano / The Eurialo Project: a vector GIS for the integrated management of the archaeological data from Pontecagnano (Italy).

Promoting Institution: Istituto Universitario Orientale together with Università degli

Studi di Salerno, Soprintendenza Archeologica di Salerno, Avellino e Benevento, Comune di Pontecagnano, IRSIP CNR area di ricerca di Napoli.

Year of beginning: 1996.

Foreseen term: 1998.

Geographic area: Pontecagnano (Salerno).

Excavation area: Over 100 cemeteries, which contain more then 8000 graves.

Short description of the project: In more than thirty years of investigation in Pontecagnano, a substantial archaeological documentation has emerged, comprising an extensive settlement and a vast necropolis. While the exploration of the ancient town has been limited to part of its center, the necropolis, having been overrun by the urban expansion of the modern town of Pontecagnano, has been investigated more thoroughly. To face this rapid urban expansion, since the Sixties a systematic excavation of the funerary evidence has been going on. Up to now, over 8000 burials from the Iron Age (9th century BC) to the 4th century BC have been brought to light. This impressive archaeological sample spanning six centuries is documented by a wealth of plans, drawings and photographs. The need to record, analyse and visualise this abundant and diverse material was the stimulus for the creation of the Eurialo project, involving the application of a vector GIS for the integrated management of funerary archaeological data. Eurialo is based on the development of a cartographic database containing the spatial and topological information concerning the burials, associated with the description of the individual funerary contexts. The system has been adjusted to the needs of different users: on the one hand, scientists interested in the reconstruction of the social, economic and cultural organisation of the ancient community, on the other, operators involved in the preservation of our cultural heritage through the promotion of a careful policy of development integrating the archaeological patrimony into urban planning.

Hardware: HPVectra VT 48/150pro Windows NT 4.

Software: MapInfo, AutoCAD, Access.

Application of descriptive standards: Until a few years ago, the connection between spatial data and alphanumerical attributes was performed by software tailored by expert programmers to the needs of specific research projects, and hence structured on the base of exclusive final objectives. This precluded the possibility of using them in another research context. Furthermore, due to their experimental nature, these programs had a serious limitation: it was impossible to export their archives, without considerable additional costs, to more modern and simple operative environments. With time, in spite of the inevitable multiplication of computer applications, an increasing need has been felt to establish common methods for the normalisation and formalisation of data. An especially innovative role is being taken on by computer techniques favouring the diffusion and exchange of information through the definition of standard formats for the storing of archaeological records. Moving from these considerations, the Eurialo project provides some synthetical operative and methodological guidelines for the development of data model applied, in this specific case, to the analysis of funerary contexts.

The first stage of our work was the planning of the archives. This phase required a

long period of analysis and evaluation of the problems connected to the formalisation of the data. Working from the premise that the information should be organised to meet the needs of different types of users, we chose to employ a relational architecture comprising three archives connected by tomb number. The first archive contains general information on the tomb; in the second one are registered the osteological remains and other organic material; in the third, every single gravegood is recorded.

After creating the new reference map with AutoCAD, we proceeded to attribute a numerical code to each vector object to provide a connection with the databases. More specifically, we marked the polygons defining the perimeter of each burial with the tomb number. For this specific phase of the work, we preferred to use market software, instead of developing a custom application. Our choice was MapInfo, a vector GIS widely used for the management of infrastructure networks. This software integrates in a transparent fashion both the alphanumerical data on the necropolis of Pontecagnano recorded in Access and the graphical objects elaborated with AutoCAD, creating tables which geo-codify database records on the basis of the tomb number assigned to the vector polygons. Through a simple procedure, it is possible to create new archives combining database information with the maps. Any database query can be visualised in a new table or a new map highlighting the chosen theme. The data can then be processed or exported for more in-depth statistical analyses.

Application of Spatial Analysis:

Other important information: The future development of the project will probably involve the creation of a CD-ROM containing the graphical and alphanumeric information stocked in the archives. This medium could be easily distributed with a short accompanying text, allowing the scientific community to check the accuracy of the data and the validity of the recording procedures.

Address: Istituto Universitario Orientale – Centro Interdipartimentale di Servizio di Archeologia, V.tto I, S. Maria ad Agnone, 8, Napoli.

Tel./Fax 0039-81-293501

E-mail: dandrea@iuo.it

www address: http://www.iuo.it (web pages relevant to our project are in preparation).

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Project 24:

Title of the project: ODOS. Sistema integrato per la gestione dei dati di scavo.

Promoting Institution: CNR – Progetto Strategico n. 251100 "Metodologie di Catalogazione Beni Artistici e Culturali del Mezzogiorno"; CNR – Progetto Finalizzato "Beni Culturali"; Università di Lecce.

Year of beginning: 1991.

Foreseen term:

Geographic area: Southern Italy, with particular reference to Southern Puglia Region.

Excavation area: Otranto (Lecce); Vaste (Lecce); Oria (Brindisi); S.Vito dei Normanni (Brindisi); Montescaglioso (Matera).

Short description of the project: I phase (1991-1996). Realisation of a system for data management of archaeological excavations, carried out at archaeological site (settlement) level. The system integrates three databases: alphanumeric (for excavation recording cards), graphic (for drawings), image (for excavation photographs, drawings and documentation). The acquisition of all graphic data, from general plans to single archaeological complexes (such as excavation detail plans) is carried out in vector format. This allows the enhancing of the capabilities of graphic data processing (e.g. automatic restitution of layers or thematic maps). The alphanumeric database can also carry on descriptive quantitative analysis (absolute and relative frequencies).

II phase (1997-1998). Implementing of this system on a GIS platform. Data management of archaeological excavations becomes therefore a module of a more complex GIS aimed at the management of data relevant to settlements at regional or interregional level. Application developments are aimed towards spatial analysis techniques. Other than GIS modules of land spatial analysis, quantitative analysis of artefacts (already present in the alphanumeric database) has been developed, by means of a graphic interface that permits plotting on the cartographic basis results coming from the queries posed to the alphanumeric database.

This II phase system is available on PC.

Hardware: Client-Server System, using an Ethernet network. Server: IBM RISC 6000 – 530 and numerous PC clients. Digitizer, plotter.

Software: RDMS Oracle (Oracle Corporation), Developer/2000 1.3 for Win95 NT for alphanumeric data; Geodis 6000 – Geodos (Automap, Roma) for cartography; ArcView for cartography and territorial data; SAS (SAS Institute) for statistical analyses; Adobe Photoshop for raster images; AutoCAD and Radar for computer graphics and 3D restitutions.

Application of descriptive standards: For the alphanumeric part, ICCD (Istituto Centrale per il Catalogo e la Documentazione) standards have been used. Inside the system controlled vocabularies are also included; they can be processed and statistically analysed. Among the most important kind of information associated to vocabularies, cf. classification data relevant to archaeological contexts; identification data of artefacts.

Application of Spatial Analysis: On a regional level: regression analysis for the study of artefact distribution; standard geographic analyses. On a detailed scale (excavation area; site): artefacts density represented on the cartographic basis, by means of a module developed for this purpose, which can extrapolate information from the alphanumeric database and plot their distribution on the excavation plan.

Other important information: For the presentation of the project cf. F. D'Andria (ed.), Metodologie di catalogazione per i Beni Culturali, CNR – Università di Lecce, BACT, Quaderno 1.1, Lecce-Bari 1997.

Address: Laboratorio di Informatica per l'archeologia, Dipartimento di Beni Culturali – Università di Lecce, via D. Birago 64, 73100 Lecce.

Tel. 0039-832-244818; Fax 0039-832-246485.

E-mail: semeraro@ingle01.unile.it
www address:

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Project 25:
Title of the project: Criteri e modelli di definizione di carte archeologiche provinciali e comunali per la Regione Sicilia.
Promoting Institution: Scuola Normale Superiore, Pisa.
Year of beginning: 1998.
Foreseen term: 1999.
Geographic area: Sicily (a)/ Contessa di Entellina municipal territory, Palermo (b) (cf. short description).
Excavation area:
Short description of the project: a) Model of provincial archaeological maps (with particular reference to the sistematic identification of the more significant archaeological themes); establishment, at the municipal scale, of a sample on which to test the thematic model, by means also of new surveys.
Hardware: cf. Linee-guida del Piano Territoriale Paesistico Regionale, Palermo 1996 (Assessorato dei BB.CC.AA. e P.I. della Regione Sicilia).
Software: idem.
Application of descriptive standards: idem.
Application of Spatial Analysis: idem.
Other important information: The project was born in the framework of the activity entrusted to the Ufficio del Piano Territoriale Paesistico Regionale dell'Assessorato dei BB.CC.AA. e P.I. of the Sicilia Region; it avails itself of the external consultants (in this case of the Scuola Normale Superiore of Pisa) for the study of territorial interrelationships between landscape/environmental features and cultural ones (i.e. historic-archaeological).
Address: M. Cecilia Parra, Scuola Normale Superiore, Piazza dei Cavalieri 7, Pisa.
E-mail: parra@sns.it
www address:

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Project 26:
Title of the project: Cartografia Archeologica Numerica del Centro Storico di Termini Imerese (Sicilia).
Promoting Institution: Università di Palermo, Istituto di Archeologia, Dipartimento di Rappresentazione.
Year of beginning: 1991.
Foreseen term: 1993.
Geographic area: Termini Imerese (Palermo).
Excavation area: Termini Imerese.

Short description of the project: Computerised mapping of all archaeological finds and excavations within the historical town center.

Hardware: PC 486/ 8 MB RAM/ 1 HD 300 MB

Software: RS Machine.

Application of descriptive standards:

Application of Spatial Analysis: Analysis of the orientation of ancient structures with respect to those of modern roads and buildings.

Other important information: Key references: V. Franco, C. Quattrocchi, La carta numerica archeologica, in AA.VV., Termini Imerese, Ricerche di topografia e di archeologia urbana, Palermo 1993, 291-295.

Address: Istituto di Archeologia, Viale delle Scienze, 90128 Palermo.

E-mail: belvedere@ipalet.unipa.it

www address: ipalet.unipa.it

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Project 27:

Title of the project: Valle del Belice.

Promoting Institution: CINECA, Bologna; University of Göteborg; Icarus Project.

Year of beginning: 1997.

Foreseen term: 1997-98.

Geographic area: Castelvetrano and Selinunte (Sicily).

Excavation area: Mokarta, Valle del Belice.

Short description of the project: Realisation of a GIS and development of remote sensing applications for the archaeological areas of the Valle del Belice and the Selinunte territory.

Hardware: SGI 02, PC Pentium 133 MHz.

Software: GRASS, GRASSLAND, ER MAPPER.

Application of descriptive standards: Integration of raster and vector data; digital cartography; creation of customised DEM; texture mapping of air photographs and satellite images; territorial databases; excavation data; thematic maps; desktop Virtual Reality.

Application of Spatial Analysis:

Other important information:

Address: Maurizio Forte, International Association of Computing in Archaeology, Via Magnanelli 6/3, 40033 – Casalecchio di Reno (Bologna).

E-mail: aiace@sirio.cineca.it / maurizio.forte@bo.nettuno.it

www address: http://www.cineca.it/projects/aiace/

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Project 28:

Title of the project: Metodologie multidisciplinari per il rilevamento archeologico su scala urbana e territoriale.

Promoting Institution: CNR – Centro di studi sull'archeologia greca, Catania.
Year of beginning: 1996.
Foreseen term: 2001.
Geographic area: Eastern Sicily; Crete.
Excavation area: Catania, Lentini (Siracusa); Prinias.
Short description of the project:
Hardware: Server IBM 3CT RISC 6000 + Clients PC Pentium II + input-output devices.
Software: ArcInfo, ArcView, AutoCAD, Access '97, Oracle server 7.0.
Application of descriptive standards: ICCD (Istituto Centrale per il Catalogo e la Documentazione) descriptive standards.
Application of Spatial Analysis:
Other important information:
Address: Centro di studi sull'archeologia greca del CNR, Via di Sangiuliano 262, 95124 Catania.
E-mail: csag@arct.area.ct.cnr.it
www address: http://www.archeo.unict.it

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Project 29:
Title of the project: Il paesaggio iberico nella valle del Guadalquivir e del Guadalimar.
Promoting Institution: CINECA, Bologna; AIACE, Bologna; Università di Jaen, Icarus Project.
Year of beginning: 1995-1996.
Foreseen term: 1998.
Geographic area: Jaen, Andalusia, Spain.
Excavation area: Puente Tablas.
Short description of the project: GIS applications; image processing and remote sensing applications for the study of the population and the Iberian territory (Iron Age) until the romanisation. Study of the medieval settlements of the same area.
Hardware: SGI INDI, INDIGO II Extreme, PC Pentium 133 MHz.
Software: ER MAPPER, GRASS, AutoCAD.
Application of descriptive standards: Digital classification; spatial filters; raster-vector integration; digital cartography; automatic vectorialisation; creation of DEM; raster texture mapping on DTM; spatial analyses of the settlements; territorial databases.
Application of Spatial Analysis: Yes.
Other important information:
Address: Maurizio Forte, International Association of Computing in Archaeology, Via Magnanelli 6/3, 40033 Casalecchio di Reno (Bologna).

E-mail: aiace@sirio.cineca.it / maurizio.forte@bo.nettuno.it
www address: http://www.cineca.it/projects/aiace/

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Project 30:
Title of the project: Cartographie Informatisé du Patrimoine (Tunisie).
Promoting Institution: Comunità Europea.
Year of beginning: 1997.
Foreseen term: 2000.
Geographic area: Northern Africa.
Excavation area:
Short description of the project: Computerised cartography by means of multispectral orbital, aerial, low altitude images, interfaced with a G.I.S. established on the previous databases.
Hardware: Spark, 4 PC Pentium Compaq, scanner HP; plotter A0.
Software: Erdas Imagine, Microstation MGE ,"Archeo".
Application of descriptive standards:
Application of Spatial Analysis:
Other important information:
Address: G. Gullini, C.A. Birocco, L. Pompeo, L.A.T.E.R., P.zza Vittorio Veneto 14, Torino.
Tel. 0039-11-8125023; Fax 0039-11-8126190.
E-mail:
www address:

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Project 31:
Title of the project: Cartografia da immagini satellitari della Siria, area di Palmira.
Promoting Institution: UNESCO.
Year of beginning: 1994.
Foreseen term: 1998.
Geographic area: Near Est.
Excavation area:
Short description of the project: Large scale thematic maps of cultural and natural resources relevant to human presence, from Paleolithic to Islamic period.
Hardware: Sun Sparc, 4 PC Pentium Compaq, scanner, MP plotter A0.
Software: Erdas Imagine, Microstation MGE, "Archeo".
Application of descriptive standards:
Application of Spatial Analysis:
Other important information:

Address: G. Gullini, C.A. Birocco, L. Pompeo, L.A.T.E.R., P.zza Vittorio Veneto 14, Torino.
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E-mail:
www address:

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Project 32:

Title of the project: Murghab Archaeological Map.

Promoting Institution: Istituto Italiano per l'Africa e l'Oriente; State University of Turkmenistan; Russian Academy of Sciences, Institute of Archaeology.

Year of beginning: 1990.

Foreseen term:

Geographic area: Murghab river Delta (Turkmenistan).

Excavation area: Tarhirbaj depe.

Short description of the project: Intensive survey with GPS connected to a data storing system.

Hardware: PC Pentium 133 (32 MB RAM).

Software: Maps: AutoCAD. Database: Access. Spatial analysis: IDRISI and ArcView (just started).

Application of descriptive standards:

Application of Spatial Analysis: Thematic maps and simple spatial analysis procedures (buffer, Thiessen polygons, Rank size maps).

Other important information: Remote sensing procedures based on Soyuz, Spot and Landsat images. Aerophotographic interpreting with particular attention to geomorphological information.

Address: Istituto Italiano per l'Africa e l'Oriente – Via Merulana, 248 – Roma.
Tel.: 06/4741835; Fax: 06/4873138.
E-mail:
www address:

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Project 33:

Title of the project: The Ramat Beth-Shemesh Regional Project

Promoting Institution: Israel Antiquities Authority - Hebrew University GIS Center

Year of beginning: 1996.

Foreseen term: Five-ten years (hopefully: we're budgeted on a yearly basis).

Geographic area: Israel, the shefela (the foothills between the judean mountains and the coastal plain) about midway between Jerusalem and Tel-Aviv

Excavation area: The project includes intensive survey, test pits, and salvage excavations on a 7 x 8 km. area, on which there are some 5 town (or large village) size sites (which are not endangered and won't be dug) and some 400 small sites, rang-

ing from farmsteads to rock-cut installations or spots of ceramic concentrations in fields - and dating between the Neolithic and the Ottoman period.

Short description of the project: Part of a master-plan to solve the demographic problems of Israel into the 2000's calls for the establishment of a new urban center between Jerusalem and Tel Aviv. A 7 x 8 km. plot, south of the present town of Beth Shemesh was chosen, and it is planned to be a city of 200,000 inhabitants by the year 2010. As part of the planning and execution of this project, a cultural resource management supervisory was set up, headed by Yehuda Dagan of the Israel Antiquities Authority. Its purpose is to survey and record all evidence of human occupation in the area about to be built up, as well as all the resources available to ancient human societies in that area; to advise the planners and contractors as to how to minimize the damage to ancient sites; and to excavate all the sites which cannot be saved. Yehuda Dagan, on behalf of the IAA, approached Ilan Sharon, of the Hebrew University about using the Ramat Beth Shemesh project as a pilot-study for the use of GIS technology in the archaeology of Israel. The role of GIS in this project is first as a recording tool - capable of dealing, in a single system, with the different types of data - archaeological survey data, excavation data, botanical survey, zoological survey, geological survey, aerial photo analysis, climatological readings, soil samples etc. - which are being collected. Second, GIS is used as an analytical tool, mainly in confronting the archaeological and environmental data - in order to answer questions like site-location, distribution and patterning.

Hardware: The project uses the resources of the Hebrew University GIS center, which currently include five SUN workstations plus some ten additional X-terminals, spread over the four campuses of the university and connected through the university LAN (1 of the X-terms is at the Institute of Archaeology). Peripherals include digitizers, high-resolution scanners, plotters and color laser & inkjet printers (up to A1 size).

Software: UNIX operating system, with ArcInfo, ArcView and ERDAS.

Application of descriptive standards: See above.

Application of Spatial Analysis: See above.

Other important information:

Address: Yehuda Dagan, Israel Antiquities Authority, POB 586 Jerusalem, ISRAEL.

Ilan Sharon, Institute of Archaeology, Hebrew University, Jerusalem ISRAEL.

Gilah Zionit, Institute of Archaeology, Hebrew University, Jerusalem ISRAEL.

E-mail: sharon@hum.huji.ac.il sharona@tigris.soc.huji.ac.il

www address:

ABSTRACT

The present article is an attempt to stress some methodological concerns and evolutionary trends that characterise the use of GIS in Italian archaeological research. The cognitive base to realise this synthesis is offered by the analysis of answers to the questionnaire on "GIS and Archaeology", that was distributed in the framework of our "Caere Project", promoted within the more general "Progetto Finalizzato Beni Cul-

turali" of the Italian C.N.R. The description of the results obtained follows a general definition of GIS and of their capabilities. Computerised archaeological projects in which GIS are used have interested nearly the entire national territory, from the Valle d'Aosta to Puglia and to the two principal islands. We have also recorded Italian projects that regard archaeological areas outside national limits. In general there is also a rather limited use of GIS in the management of archaeological excavations; in fact, the use of CAD software is more diffused.

One of the emerging issues in GIS applications in archaeology is the distinction between projects carried out by istitutions dealing with the administration and safeguarding of the national cultural patrimony and those carried out by the academic and research institutes. Cultural Resource Management in Italy is generally connected to the activities carried out by central and regional offices under the direction of the Ministry of Cultural Heritage and addressed to the problems of management, safeguarding, maintenance and exploitation of the national patrimony. As for GIS projects carried out in the framework of the research sector, one of the characteristics of Italian studies seems to be the presence of two areas of investigation: the first one pertains to regional studies while the second one is devoted to the study of ancient towns, either abandoned or obscured by modern evidence.