Web Access to an Archaeological GIS

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Abstract

After examining the impact of publishing data on archaeological theory and methods on the Internet, we propose a client-server solution characterised by low costs and high processing power and which is at the same time easy to use. On the client side it requires only a commercial browser with no particular computer skill of the user. On the server side it is based on the Linux operating system with some freeware packages, integrated by a module created by us. This system, developed around an archaeological case study, is accessible on the Internet and has been conceived to host additional archaeological GIS applications.

Key words: GIS, Internet, remote access

1. GIS, theoretical issues and new ways of communication

The introduction of information technology in archaeology represents an element that is changing important aspects of the archaeological theory (Limp 1997, Moscati 1998, Voorrips 1997, Crescioli et al. 2000) such as, for instance, the investigation potential of 3D landscape using viewshed and cost surface analysis. Creating a new space-time framework, virtually constructed on the computer, has had important consequences both on the methodology and epistemology, contributing to the outline of what has been called a new perceptive metaphor of space (Wheatley 1993, Gillings 1997, Bampton 1997).

The use of GIS has already oriented the research in new previously unavailable directions, determining an innovative cognitive perspective of the landscape, which traditional methods could not explore (Barceló et al. 2000); using alternative economic, social and political models for the cultural investigation of the territory contributes to the social explanation of archaeological facts more than a simple description of the geometry of observed structures (Harris and Lock 1995).

However, notwithstanding significant advances, the use of GIS is not yet uniform. This is caused by different study and research backgrounds (arising from different traditions), which sometimes cause the unawareness of the methodological value of this new tool. Probably only a new and different way of communication between computer applications may defend computerised solutions (especially the GIS system) from a tenacious and resistant academic scepticism that prefers – at least in Italy – to consider the computer role as a modern and sophisticated "household appliance", ignoring the important consequences of its use on the theoretical and methodological side.

An obstacle in this evolution is presented in the limited visibility of GIS applications, which, so far, remain a theoretical subject of conferences instead of becoming a widely diffused technology. Every team, oriented into the construction of its own specific application instead of comparing the existing solutions, starts a new project ignoring the choices, methods and systems already adopted by others. Such behaviour should not be ascribed only to the limited co-operative attitude of different teams, but also to the limited circulation of existing applications. This results in the fact that most researchers ignore the procedures and methods adopted in individual solutions. An interesting recent debate on GIS and archaeological theory has therefore been confined to an abstract level, making it impossible to compare systems, and leaving only the comparison of system abstractions.

A necessary condition for this is the availability and visibility of applications: only thus, with direct access (even remote) to different solutions will it be possible to guarantee a real comparison, and avoid a mere quarrel between different schools and tendencies.

Even if it is not effective and manageable, including paper records in archaeological publications allows one to check data and to reconstruct the scientific process of discovery. In a similar way, the use of computers will significantly contribute to the dissemination of data, and not only the final synthesis and reconstruction. However, it is inconceivable that every researcher could learn to use the software programs necessary to understand the aims and strategies of another research project. This limitation in data availability and access underlines a reflection based on technical problems as well as on methodological questions: it is perhaps the absence of user-friendly interfaces that excludes most scholars from the debate. By limiting the participation to computer-skilled archaeologists only, GIS applications become the object of the study instead of being a tool which would ease archaeological investigations and ensure more widely spread data circulation.

Our approach, based on the integration of GIS into the WWW (World Wide Web), aims at going beyond the limits of their application to archaeology: the difficulty of accessing information without the software used to create GIS, and the need to know how to operate different programs, with learning curves that always require a substantial investment of resources.

Existing GIS-Web applications (for a list see, for instance, Web GIS and Interactive Mapping Sites, or Ploewe 1997) have, in our opinion, several drawbacks. The first drawback is the cost which prevents most archaeological budgets from using GIS-Web applications. Secondly, a large number of applications require considerable computer skills for setting up: the rare freeware ones pay little attention to unskilled use and are not completely bug-free. Perhaps this is why no archaeological application of this technology has as yet been proposed, at least as far as we know.

So far Web use for archaeological research is not satisfactory even as far as the transmission of data and scientific results is concerned. Web sites have turned from embryonic presentation places, in a synthetic form and with limited illustration features, into real archaeological portals. The latter undoubtedly have the merit of favouring the circulation of data and information, but are often unable to go beyond the "search engine" logic (Guermandi 1999, Hermon and Niccolucci 2000).

Recently the Internet has begun to have a new impact on archaeological research thanks to the availability of papers, monographs and journals. Using the Internet in order to improve communication between professionals concerns also the diffusion of reports of still unedited investigations. This is particularly true in specific conditions: unequal development in different regions is typical for Internet archaeology, therefore successful anglo-american research or organisational models such as ADS (Archaeology Data Service) cannot be exported without adapting them to the local needs, culture, tradition and "prejudices".

In these cases, the Internet is still considered only as a modern (and extremely powerful) technological channel for information transmission, often substituting the traditional scientific printed publications with its high costs, but with a similar logic. From this perspective, Internet publishing will produce an improvement in the diffusion of scientific knowledge allowing a faster and wider distribution of contributions otherwise destined to remain accessible only to the chosen few. However, users and information providers are still unaware of the potential use of the Internet not only as a communication medium, but also as a tool to share and interchange processed and raw data.

Publishing alphanumeric and geographical data on the Internet, both with open remote access (Internet) and with restricted access (Intranet) will have two important consequences on scientific cooperation (Bogdanovich et al. in press, D'Andrea and Niccolucci 2000, Hermon and Niccolucci 2000). On the one hand it will induce data re-use, since other researchers will be able to use the same data to start new investigations, possibly from different perspectives. On the other hand, the network availability of data, and not only of the results, will ease the reconstruction of the scientific discovery process, allowing everybody, at least in theory, to re-examine the results starting from material sources as represented by their records. This consideration would naturally introduce the issue of metadata, which is not the central theme of the present paper and would lead us too far from its aim. However, it is necessary to be extremely cautious in taking for granted that there is an agreed – and simple – generalised metadata structure. In our opinion, many countries have still a very low metadata awareness and their attention focuses on semantic structures, thesauri and dictionaries, created by single teams. Therefore, to avoid another metadata proposal, we chose to take the easy way out, allowing a discursive description of data and leaving the responsibility of the description level to the authors, with the only constraint that an English translation is to be supplied: an issue that receives little attention by English-speaking people, being considered as obvious, what in other countries is decidedly not.

2. Publishing a GIS on the WWW: the features

In this paper we present a preliminary step in the path outlined above. Nonetheless, it has some features that deserve attention and that we wish to stress.

- The software we use is freely available, state-of-the-art and powerful.

  It often happens that the search for software to be used in an application stops at the best seller, however this often proves later on to be limited and unreliable. The little effort required to learn a new package is returned in terms of reliability, power and money saving. This is perhaps in conflict with the supporters of the "household appliance" theory, who love off-the-shelf solutions that allow the most computer unskilled archaeologist to develop a computer application by themselves: unfortunately for them, some competence is required, here as everywhere else, in order to build something effective.

- The customisation requires only a few new software codes.

  This ensures that the product will be reliable, since most of it relies on long tested packages, and will ease maintenance and updates. Moreover the source code is publicly available (and can be easily read and understood), and everybody can check and hopefully improve it. The source codes of base packages are also available, so that they may be extended or otherwise changed if needed, for instance for linking additional libraries or modules.

- The user needs only a commercial browser to access data, that is to interrogate the GIS.

  This allows a wider spread and easier use, ensures platform compatibility and will benefit of future improvements in the technology of browsers. In our opinion, browsers will be the glue to link different applications, since they already encapsulate (and this will only improve in the future) the tools to manage different protocols of information storage and transmission, as, for instance, XML (eXtensible Markup Language), (Goldfarb and Prescod

1998) and LDAP (Lightweight Directory Access Protocol), (Loshin 2000).

- Data formats are de-facto industry standards.

  This reduces the cost of data migration from other applications and guarantees future conversion to new format standards.

- It has been conceived having archaeological applications in mind.

3. Case study

Starting from a previous experiment of remote access to an archaeological GIS, our case study considers the interrogation and the processing of alphanumeric and geographic data concerning the Etruscan cemetery of Pontecagnano (D'Andrea and Niccolucci 2000). Data was acquired during the investigation of a vast funerary area discovered by the expansion of the modern centre, and more than 8,000 burials were discovered, dating between the ninth and the third century BC. This vast amount of data has been stored and managed with a GIS, which aims at supporting scientific research, at improving administrative preservation activity and at the integration with the local Master Plan (D'Andrea 1999). This system is based on Mapinfo and consists of some thematic layers: modern cartography (at different scales: 1:10,000, 1:2,000); the cadastre (1:4,000); aerial photos; the limits of explored areas; and finally the tombs. Alphanumeric data concerning each tomb, such as its description, the osteologic remains and the goods found in the grave, are related to the graphical objects by means of a geo-relational model.

The first experiment was based on MapExtreme, a map server by Mapinfo based on Java classes. The prototype used a trial, limited time version with full functionality. This choice was immediately abandoned for the high cost (over 20,000 US$ at the time) and a development framework with low customisation possibility. However, it was an useful test to verify the potential of such an approach.

4. Publishing a GIS on the WWW: the application

The system we present uses the following software.

4.1. Server side

Operating system: Linux (SuSe distribution)
HTTP server: Apache with PHP3 module
GIS package: GRASS version 5.0

Apache is a well known web server, the most diffused in the world, and PHP3 is a scripting language used to generate HTML pages and to interface them to several packages as database management systems. PHP3 is included in the majority of Linux distribution.

GRASS is downloadable under the GNU licence from several sites in Europe and the USA. It is very powerful, has almost any conceivable function and now is endowed with a very nice GUI (Graphical User Interface) that substantially simplifies its use and makes it comparable with most other GIS. It also has an important feature for our aims, i.e. it works silently in the background obeying the command lines sent to him and sending the results to a "virtual" monitor, from which they can be picked and sent (after format conversion) to any other program, user's browser included. This is the mechanism we adopted to display maps, as explained in greater detail below. The format conversion is performed by a set of libraries included in the Linux distribution.

From this point of view, our solution derives from Grasslinks, the well-known University of Berkeley web Grass software. However, it has been completely re-engineered and greatly simplified, in order to be prepared for future improvements that may include the use of java applets and/or XML related archives instead of a relational database.

4.2. Client side

As already stated only a browser is necessary on the user side. The user gets HTML pages with maps included in them as GIF files, so storing the downloaded data for future use locally needs only the browser "Save as" function. The session history is also based on the "Back" and "Forward" browser buttons: this allows flawless navigation through the searches with no impact on the connection, simply using the cache memory of the browser. However, creating new maps, zooming and moving in the map window require a new computation, in order to always maintain the highest level of accuracy of the displayed map, which is re-calculated and re-drawn by the server using the original data. This is particularly important when zooming in: the resolution of the original raster or the precision of the original vector map avoids enlarging the displayed image based only on the poor screen resolution of the transmitted map.

Transmitted data is very "light" in terms of storage, so the system works quickly even with a limited bandwidth: a complicate map usually requires sending and image of no more than 30Kbyte.

4.3. Data formats

Raster maps may be stored in any of the standard raster formats, which can easily be converted to a web format (GIF, JPEG or PNG). Vector maps are archived as DXF files. Practically any GIS software has filters to export data to these formats, so data transfer from any previous application is easily performed.

4.4. The database

The database is based on PostgreSQL, a relational database management system (RDBMS) that can be linked to GRASS and interfaced by PHP3. PostgreSQL is included for free in the Linux distribution. This RDBMS is very powerful and flexible and may be customised according to the needs, introducing new functions and data types. The database will store alphanumeric data related to the case study and will also link the fuzzy database presented in this proceedings (Niccolucci et al. this volume) to its geographic information.

Connection to different kind of archives, such as free-text documents, is still under study, but there are plans to develop a prototype which links XML-encoded documents to geographic information contained in them within the year 2000.

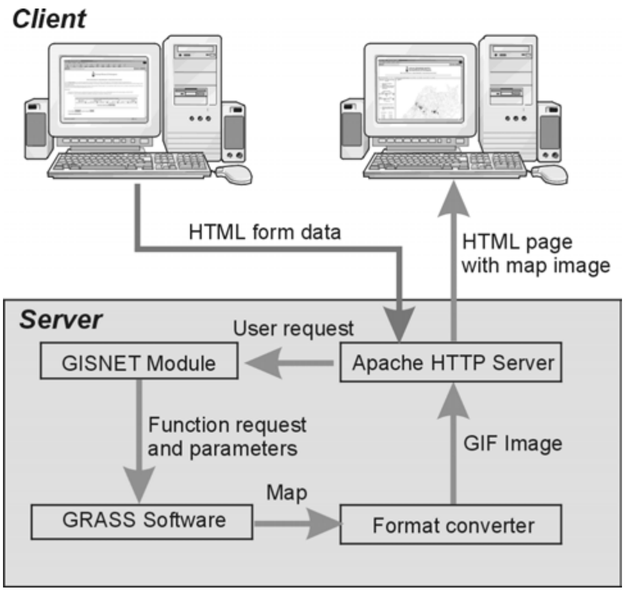

Figure 1: Functional scheme of the map server.

4.5. How it works

From a functional point of view, the system is very simple. It consists of a CGI module (a short Unix shell script) that intercepts the browser request to the server and asks GRASS to prepare the desired map. After converting the result to a web-compatible graphical format (GIF, at present), it passes the image to the HTTP server that sends it back to the browser together with the HTML page. Introducing new GIS functions thus requires only adding more CGI modules, similar to the existing one. The mechanism, shown in figure 1, relies heavily on the browser-server dialogue characteristics and is therefore very robust. Moreover, it may include restriction in a very simple way, for instance to limit access during investigation only to authorised users.

In detail, the definition of the task is performed by means of some HTML forms filled by the user, choosing options with the usual mouse clicking. This creates a string of parameters that are passed on to the server and activate the map creation

The menu page accesses information which is contained in configuration files or, as far as the map list is concerned, within the GIS itself, so the display is always automatically updated to the latest version of the GIS and variations in the GIS structure require no further maintenance.

Since the user has only to choose among the menu options, no computer skill is required.

5. Conclusions

In our opinion, this application should prove the feasibility of what we stated as the inevitable future of Internet use in archaeology, namely data sharing and co-operative research. However, we conceived it also as a service, addressing two categories of archaeologists.

The first one consists of information providers, to whom we offer a simple, inexpensive and effective way to publish their information. Neighter a science-fiction laboratory nor a computer guru is needed for that, and also a small budget can afford the cost of maintaining a web site with the above described tools. The second group is formed by the public body of archaeologists, who can thus benefit from a powerful tool for their research with a small investment of learning how to use the Internet, which nowadays they would be obliged to learn anyway.

Figure 2: A snapshot of the screen showing the area of tombs superimposed on the cadastre map.

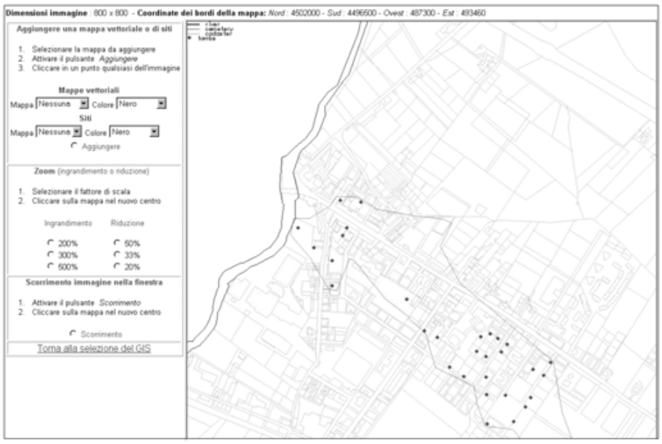

Figure 3: A zoom of the previous screen with the additions of the limits of urban cemetery.

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