Agent-based modeling, archaeology and social organisation: The robustness of Rome

Introduction

A fundamental problem in the social sciences is explaining how individual behaviours (free will) give rise to social reproduction and collective behaviour. Turning the question around, we can ask what happens to collective behaviour when individuals are lost from society? In this paper, I describe a methodology for exploring this question, using archaeological evidence for social networks in the Roman world as the framework for an agent-based model of Roman society. This project is in its infancy, and this paper is intended to describe the project and to introduce the problems and promise of agent-based modeling.

Recent scholarship has drawn attention to the social and personal networks of friendship and patronage in the Roman economy. Koenraad Verboven calls this *the economy of friends*. These networks, it has been argued, complement and extend the market economy of Rome, fulfilling the role that banking and the transfer of financial capital play in later epochs. The pivotal figure in all of this is the patron, the man whose contacts, *fides*, and personal power allow him to protect and promote the financial and social welfare of his clients. Patronage is an asymmetrical friendship, between individuals of differing social power. It creates social debts, and networks of financial and political support, binding different levels of Roman society together. These networks revolve around the linchpin of the patron (Verboven 2002, see also Wallace-Hadrill 1989, Saller 1982).

But what would happen if the patron was removed from the equation? Episodes of elite self-extermination mark many passages of Roman history, yet seemingly without any fundamental consequences for society at large. What is it about the structure of society in the Roman world which allowed it to weather the loss of major figures in social and economic life? In a culture where the economy is embedded in social and political networks, the development and changing pattern of those networks has important ramifications for understanding historical change.

Agent-based modeling

In any given social situation, there are a number of options an individual may choose. The one chosen becomes ‘history’, and the others become ‘might-have-beens’. As archaeologists, we find the traces of these individual decisions. How is this ‘micro’ level connected to the ‘macro’ level of society? Compounding the problem is that the social structure influences those decisions in a recursive, iterative fashion (see Giddens’ structuration theory 1984).

The traditional approach is to reduce the problem to its constituent parts. Unfortunately, reductionism is limited because it often cannot deal with how feedback generated by the interacting parts changes the way those parts interact. In these complex systems the whole cannot be understood in terms of the components, and the interrelationships between the different parts are not fixed but subject to change as a result of the dynamics of the system itself (Cilliers 1998: VIII-IX).

Agent-based models (ABM) are the main technique used for studying complex systems because in using these models, we do not specify the macro-scale behaviour of the system. We take a generative rather than reductionist approach (Epstein 1999: 41-42). An ABM is a type of simulation where phenomena are modeled in a computer using «self contained programs ['agents'] that can control their own actions based on their perceptions of their operating environment» (Huhns and Singh 1998 quoted in Gilbert and Troitzsch 2005: 172). The agents are usually autonomous, they have social ability, they can perceive and react to their environment, and can engage in goal-oriented behaviour (Gilbert and Troitzsch 2005: 173). They have basic operating instructions (rule-sets) to govern their decision making. These rules are the behaviours that in our case we observe in the archaeology, in the traces of individual interactions that we find, and in the historical literature. Then, we let them interact over and over again. As they interact larger-scale behaviour (an artificial society) begins to emerge. In using an ABM we are trying to generate the macro by studying the micro (Epstein 1999: 42).

Archaeological applications using ABM include studying the collapse of the Anasazi in the American South-West (Dean, Gummerman *et al.* 2000), and the colonisation of the archipelagos between New Guinea and Samoa (Di Piazza and Pearthree 1999). I have also used ABM to study the diffusion of information through the Roman Empire ('Models' in Graham 2005). I use the Netlogo modeling environment, freely available from Northwestern Univeristy's Center for Connected Learning (Wilensky 1999).

Society into numbers

With ABM, we can run our artificial society through a series of artificial histories. Then, we select the runs which seem to best correspond to the actual history which did occur. We look at our parameter settings for these best runs, and if our model has been carefully designed and validated, we will know something new about the original society.

There is the problem of developing the rule-sets, of encoding the relevant aspect of social behaviour. How does one reduce the complexity of social interaction to a mathematical function? The important thing is not to become fixated on the process of assigning a numerical value. Rather, what we want to do is design a rule that is broad enough to allow a range of behaviours and yet is narrow enough not to admit every possible behaviour (Agar 2003: 4.16-4.18). We want to design a certain 'phase-space' that matches what we believe to be true of our subject. The numbers themselves are only significant in that they allow a certain range of behaviours. ABM forces us to formalise our thoughts about the phenomenon under consideration. In order to encode the behaviour, we have to be specific about what we think, and why we think that way.

ABM allows us to do things to individuals we could never do in the real world (for instance, some models infect agents with a 'disease' to see how it spreads: Wilensky 1998). It allows us to connect individual interactions with global behaviours. It allows us to create data for statistical study that would be nearly impossible to obtain from the real-world phenomenon. These are its strengths. Its major weakness is related to its novelty. Standards of approach and evaluation are only starting to be developed. The use of authoring environments such as Netlogo which are transparent and freely available does help to mitigate that problem.

Modeling a social economy

The brick industry in central Italy was a major component of the economy of the City of Rome. The extraction of clay for brick was considered an agricultural enterprise, and so many landowners participated. The practice of stamping bricks with the name of the estate, landowner, and brick maker allows one to draw together a social network centered on the exploitation of land. The people involved come from every stratum of Roman social life, from the Emperor and his household down. This network therefore provides a glimpse of Roman social structure (Graham and Ruffini forthcoming; Graham forthcoming; Graham 2002). Other networks can be discerned in the writings of Cicero or Pliny for example, where ties of friendship may be drawn out. These networks are the foundation for the agent-based model. They provide the 'starting configuration' of relationships of exchange. The ABM allows us to re-animate Roman social life from these fossils.

Prestige and status were pervasive features of social life and the ancient Roman economy. Everything was filtered through the lens of prestige and status. There was no such thing as a pure economic exchange. In the model therefore:

1. Agents examine their own status level (which initially is a function of how many people they know), and pay respects to individuals they know who have a higher status than themselves.
2. Being seen to have many high status 'clients' increases an agent's own status.
3. Being admitted to visit a high status 'patron' increases the status of the visitor.

These three rules are based on the morning ritual of *salutatio*, of paying respects to your social betters.

4. Gift-exchange occurs when agents pay respects, cementing their relationship and also allowing for the redistribution of wealth.
5. Trade occurs between agents of similar (though not exact) status level.

After paying their respects, agents manoeuvre through their world, seeking to trade (to play the game) with others of similar status. I have opted to model the basic mechanism of trade in my model as a type of game, where the chances of a favourable outcome depend on one's status. The mechanism is not a zero-sum game, where if one agent wins, the other necessarily loses. Rather, success depends on the agent's level of status compared against the chances of a favourable outcome given a particular economic 'climate' (set by the user). Both agents could win, only one could, or both could lose. The 'climate' stands in for a host of temporary influences. When two agents meet to trade, the 'climate' represents whether the agents have good market information, whether they are good dealers, whether one is having an off-day, or any one of the potential factors which influence whether one gets the best of any particular deal.

There is nothing 'traded' per se. Instead, I model the outcomes of economic exchanges, the idea being that the more prestigious you are, the more likely you will get the best of any particular encounter. If an agent wins, his money is increased by the 'risk-factor', a variable that sets how much an agent stands to win or lose. Similarly, if he loses, his money is decreased. Increasing money can lead to increasing status, but not necessarily (it depends on the agent's status in the first place. Think of Petronius' literary creation Trimalchio, the wealthy freedman who despite his enormous wealth still had very little status).

Early results

This simple model of Roman social organisation already displays interesting behaviour. When the model runs with only rules 1 to 3, enormous disparities in status level emerge. When rules 4 and 5 are turned on, the trading mechanism allows agents to make new acquaintances, i.e. they can learn about other agents previously unknown to them who have higher status. In this fashion they have opportunities to join new chains of patronage. The trading mechanism therefore opens up the possibility of social mobility. It is not success in trade that creates this possibility, but rather the process of becoming known to new individuals. If the trade mechanism is turned off, the process of paying respects alone causes the overall social structure to ossify.

The investigator can randomly kill high status agents, but if the overall difference in status in the artificial society between 'high' and 'low' is not great, social life continues – everyone moves up a notch to occupy the space vacated by the dead agents. If the spread is great however, the artificial society can quickly evolve to what resembles a kind of despotism where there is only one extremely high status individual and everyone else is extremely low status. Agents cease to pay respects to one another, and effectively the society has collapsed. In this situation, killing seems to have no effect, since no one pays respects (all are equal in terms of their status) and there is no possibility of changing status and occupying the vacant niches.

What is truly intriguing is that when the simulation is run on the social network suggested from the evidence of brick stamps or literature (rather than from a random configuration), very different behaviours emerge. Understanding these dynamics which emerge from a starting point based on archaeological patterns will have implications for understanding Roman society (and perhaps our own).

The mechanism for 'purging' the artificial society is not yet satisfactory. Work by Joshua Epstein (2002) on modeling political violence suggests a mechanism for allowing purges to emerge spontaneously from the model itself, perhaps by denying agents who are too low status the chance of paying their respects

– and so limiting access to networks of patronage – thus creating a ‘grievance’ and eventually a basis for political violence. This is still very much a work in progress, and these early results indicated here will no doubt change. It is my intention eventually to make the results and code of my model available via the Internet for other researchers to study, critique, replicate, adapt, and use for their own research.

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Developing data visualization and spatial statistics for archaeological inference

Introduction

The authors are developing a research project to explore archaeological questions using computerized data visualization methods that are derived from spatial statistical techniques. Specifically, we utilize techniques such spatial clustering routines and autocorrelation techniques in a GIS setting to generate visual output about attributes of archaeological sites and artifact deposits. The goal is to explore spatial data for patterns that are hidden or non-obvious during the initial mapping when using traditional data display methods derived strictly from standard measurement techniques.

GIS-based data visualization in archaeology is often approached in terms of making more accurate depictions of archaeological sites, structures or regions using the three-dimensional mapping or "standard overlay" and database functions of GIS software. Such projects usually involve the integration of satellite imagery, digital elevation models and other sources with archaeological data to give a more accurate and realistic representation of the sites or other archaeological phenomenon of interest. However, visualization of data should be a much broader topic, because visual imagery can be used to identify and analyze dimensions of sociocultural phenomena that are often hidden or obscured in "realistic" depictions of mapped archaeological sites (Kraak 1999).

Spatial statistics are a collection of sophisticated and complex techniques that factor in the dependencies of spatial relationships in model building, in ways that conventional aspatial statistics cannot. By taking advantage of these spatial relationships, powerful imagery depicts spatial clustering, dispersion and randomness, among other qualities that are then evaluated by the analysts (Vasilev 1996). Grounded in anthropological theory, the analysts can use these techniques to explore, analyze and evaluate research questions. We have developed these analyses from recent archaeological investigations in northwestern Ohio in the U.S. K-means clustering and localized Moran statistics help the analysts to visually identify patterns in the spatial distribution of artifacts that may relate to cultural relationships of settlement patterning among the former inhabitants.

The statistical techniques are available in free spatial statistical packages such as CrimeStat and GeoDa, with output as .dbs or .shp files into Arcview GIS or Golden Surfer. In general, spatial statistical visualizations can aid the analyst in identifying the organization of artifacts, features and sites by identifying regions of clustering, dispersion and randomness using Moran's I, Moran, Ripley's K statistic, nearest neighbor hierarchical clustering and K-means clustering. Compu-

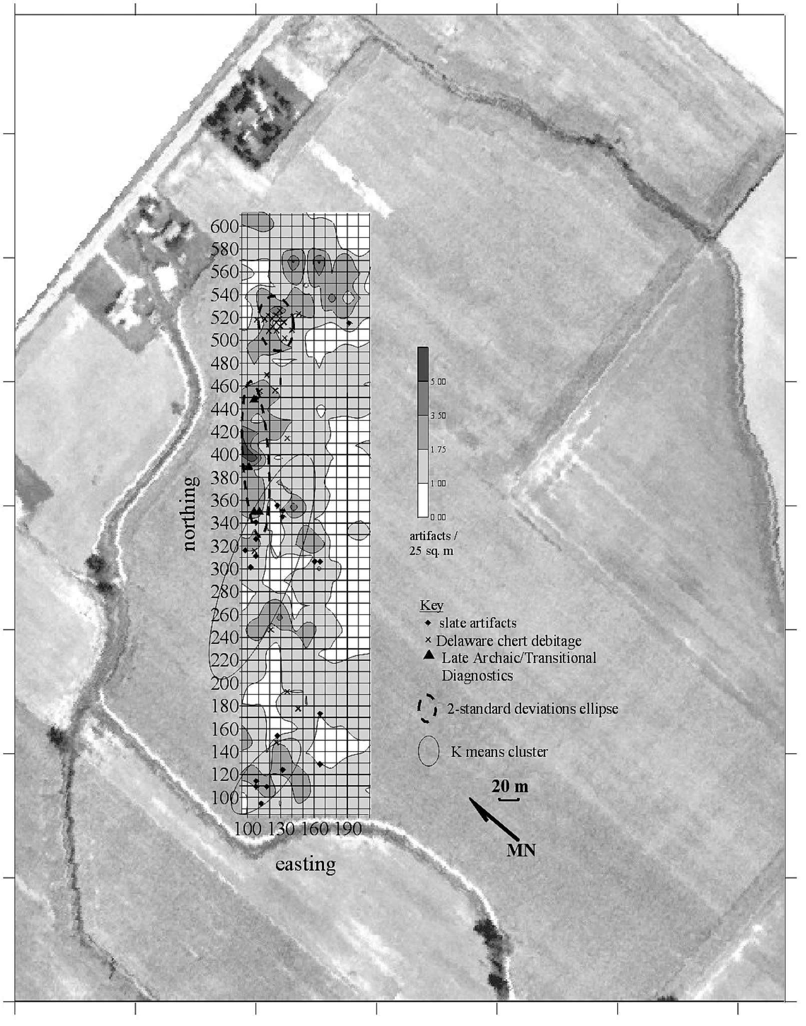

Fig. 1 – 33LU759 Combined map of artifact clusters and ellipses.

terized animation of mapped data and statistical imagery add a further dimension of interactivity in the visualization of spatial patterning (Kraak 1999).

Examples from a northwest Ohio multi-component Archaic site

Sites 33LU732 and 33LU733 (according to the Smithsonian trinonomial system used in the U.S.) were originally thought to be two distinct archaeological sites, bordering another site, 33LU736, which is immediately to the north. The sites are very large, mostly low density lithic scatters found in open terrain in Lucas Coun-

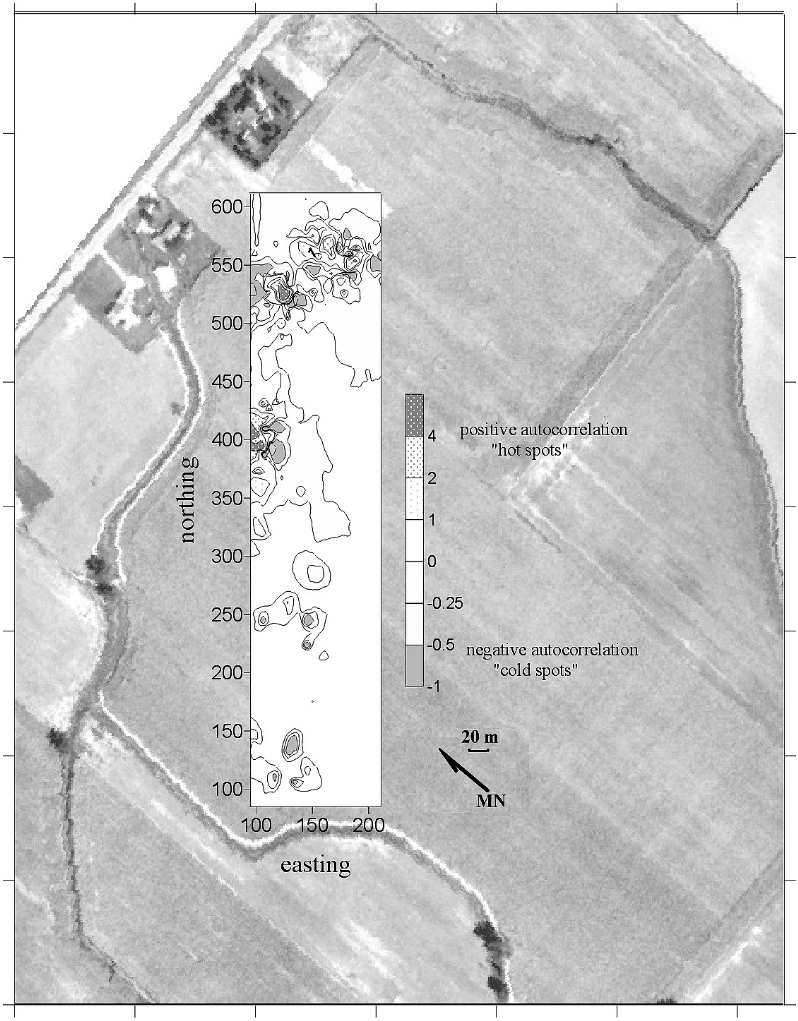

Fig. 2 – 33LU759 Local indicator of spatial associaton for total artifacts by count.

ty, in northwest Ohio, south of Toledo. A variety of mainly Archaic projectile points (7000 B.C.-1000 B.C.) and other diagnostics demonstrate what was likely episodic occupation of these locales, possibly to collect and process acorns and exploit game in the nearby Oak Openings vegetation zone. These are agricultural fields and the site areas are quite flat glacial terrain with the exception of a now channelized creek or ditch that borders to the east. The site was originally thought to be a series of overlapping camp sites, a spatial palimpsest that would be hard to understand by conventional analyses.

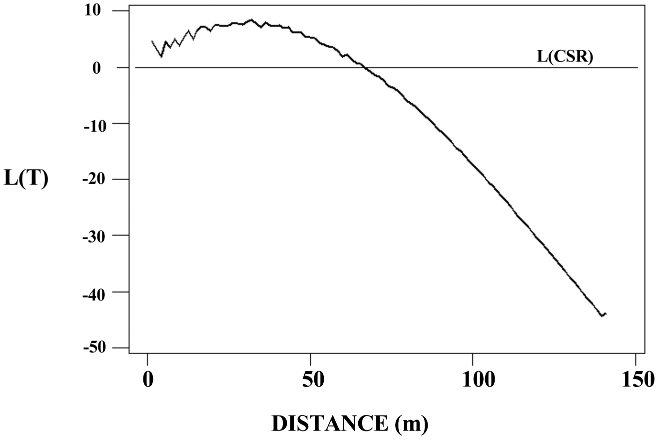

Fig. 3 – 33LU759 Ripley's K analysis plot of L(t) for total artifacts.

Fig. 4 – Flash animation designed for archaeological data visualization.

Controlled surface collection (CSC) was carried out across the entire site (a plowed field), utilizing a 5 m × 5 m block grid and a timed, three-minute surface collection per collection block. The CSC revealed that the three sites are part of one larger site because artifact distributions are continuous between them. Due to this fact it was elected to renumber the site, as 33LU759. The site extends eastward beyond the project boundaries.

Artifact data from 2365 surface collection blocks were tabulated in Microsoft Excel prior to being converted to a database file (.dbf). Within CrimeStat, autocorrelation statistics were run on the database to gauge the global spatial clustering of the distribution. The idea was to try to understand any clustering in the artifact distribution that might indicate the presence of primary camp sites. Artifact count and weight within the surface collection blocks was initially utilized to explore the data. Isoplethic density maps for artifacts were created to effectively visualize spatial distributions of artifacts. Data exploration was carried out through the creation of mapped statistical and clustering output in Golden Surfer and GeoDA. Data exploration consisted of a series of analyses designed to understand global and local spatial characteristics of the artifact distributions including techniques designed to reveal patterns of raw material distributions obscured by the overall artifact distribution.

K-means clustering and standard deviational ellipses were used to model raw material clusters identified in the intrasite artifact distribution (Aldenderfer and Blashfield 1984). It was noted that slate artifacts form two discrete clusters (Fig. 1) in the southwestern portions of the site (Total Sum of Squares= 0.02059; Total Mean Squared Error= 0.00137). Because the K-means routine requires specification of at least two clusters, 2-standard deviational ellipses had to be fit instead for the unimodal distributions (Levine 2002). For example, Delaware chert debitage (a chert source that outcrops in many areas in northern and central Ohio), formed a tight cluster in the northwestern portion of the site (Fig. 1), with several outliers. Four Late Archaic/Transitional (3000 B.C.-500 B.C.) diagnostic tools were found clustered on the western edge of the site (Fig. 1). Late Archaic diagnostic artifacts were a Brewerton Corner Notched projectile point, a Lamoka point, Trimble Side Notched point, and a Transitional/Early Woodland Slate Bar Amulet. The site extends westward beyond the boundaries of the project area and likely that the Late Archaic/Transitional component at the site extends into this area. A combined map that delineates these clusters and ellipses (Fig. 1) demonstrates that they have very little spatial overlap with each other. The clusters identified exist within the southern, central and northern portions of the site.

We completed an analysis of artifact counts using local Moran's I statistic, also termed Local Indicator of Spatial Association (Anselin 1995). This statistic produces local values for Moran's I that correspond to the spatial data from which they were derived and can thus be mapped. The output can be effectively mapped as areas of local positive spatial autocorrelation, "hotspots" and local negative autocorrelation, "cold spots" (Levine 2002: 289). In the case of 33LU759, the analysis reveals three local clusters of "hot spots" the correlation of like values (counts of artifacts per 5 m × 5 m grid square), surrounded by more diffuse areas of "cold spots," areas where there is spatial dispersion of artifact density values (Fig. 2).

Ripley's K statistic was also analyzed for total artifact count. The output consists of L(t) plotted against distance, which is used as a scalar indicator of spatial clustering (high positive values), complete spatial randomness – L(csr) – which has a value of 0, and spatial dispersion (high negative values). The plot indicates that spatial clustering exists at distances up to 66 m, but is strongest (the peak of the curve) between 14 m-29 m (Fig. 3). At distances beyond 70 m no clustering occurs and dispersion is indicated. A perusal of the artifact density map (Fig. 1) indicates that most of the areas of artifact concentrations above 3.5 artifacts / 25 sq. m are within the 66 m size of clusters indicated by the analysis.

The visualization techniques allowed the authors to conclude that the site was not a spatial palimpsest. A Late Archaic component was visible in the data and the computer-based visualization techniques helped in the identification of clusters of raw materials and diagnostic artifacts that may be activity areas or temporal components. The autocorrelated hotspots and clusters depict areas of artifact association that can be investigated through excavation to further determine the nature of the associations.

Conclusion and ongoing work

Data visualization is utilized here as a tool for the exploration of patterns thought to be present but obscured in the raw data. The goal is to use visual output of spatial statistical techniques to understand the global and local patterning of artifacts at the site(s) under study.

The authors are extending this work by integrating animation into their data visualization work (Dibiase *et al*. 1992). We are developing an animation application for archaeological visualization using Macromedia Flash. It is free and will interface with nearly any web browser, allowing easy access. The application is interactive, extensible, easily modifiable and is interoperable with statistical software and GIS. The basic idea is to create a web browser-based graphic animation application (Fig. 4) that allows the user to explore the archaeological data and display. We have also created a sharepoint site for discussion of data visualization in archaeology (http://jh214-srvr-01.iowa.uiowa.edu/sites/archvis/default.aspx), the same place that the Flash application can be viewed (you can register as "archvis" with a password "guest"). We would appreciate any comments or questions.

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GIS applications for the control and management of Cultural Heritage: The archaeological map of the Comune of Camaiore (Lucca)

Introduction and aims

During the creation of the new Structural Plan of the Comune of Camaiore (LU), in accordance with the policy of sustainable development pursued by Regional Law n. 5/95, the need for recording and organising all archaeological information concerning the territory became apparent and in cooperation with the Town Planning Department, the City Archaeological Museum, and the Superintendency of Archaeology in Tuscany, a proposal was advanced in order to meet this need and to safeguard and put to best advantage the historic and archaeological heritage of the city (Maffei Cardellini, Lucchesi 2000: 92-108; Paribeni 2001: 41-44; Parra 1999: 159-164).

The proposal of making a GIS of the archaeological, historical and monumental heritage of the municipality was approved of after the creation of a map (UTM-CTR 1:5000) of the archaeological sites, for which the relevant data were recorded on paper forms by the Archaeological Group of Camaiore in cooperation with the Archaeological Museum of Camaiore (1997).

The idea of creating an archaeological GIS for the Municipality of Camaiore (as for any other geographical area) arises from the need to know the precise location of archaeological sites in order to protect them. Moreover, the data can be consulted for scientific, administrative and other purposes and, once an open architecture is created, they can be easily integrated with new kinds of information derived from research on single contexts and their consequent elaboration in order to further increase the amount of information available (Fig. 1).

Data collection and elaboration

In the preliminary phase of data organisation, the collection of information was fundamental, both for programming the digital work and in evaluating the potential of the system in relation to the typology of the data. The quality of the archaeological information plays a key role in the conclusive results and the interpretative hypotheses. The acquisition of data in the field as well as with the other sources should follow a standardised process as closely as possible (Forte 2002: 37).

The research strategy was based on the analysis of paper data (site cards) and cartographic data (CTR 1:5000). In order to standardise the cards from different sites, an appropriate vocabulary was created for each single category of data. The methodology for the construction of the database consisted of:

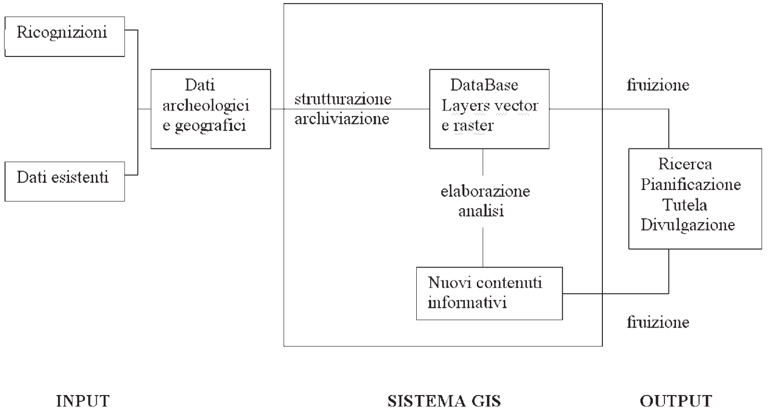

Fig. 1 – Flow chart of the GIS project of the archaeological map of Comune of Camaiore (LU).

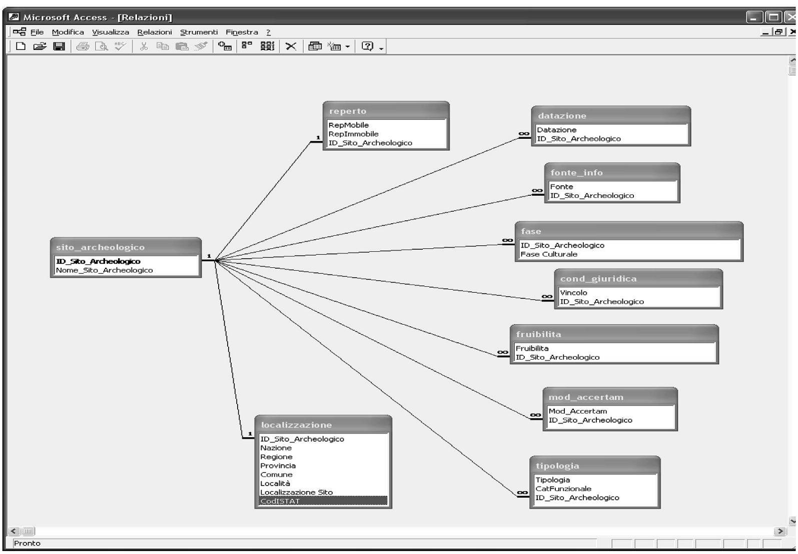

Fig. 2 – Chart of the DBMS of the archaeological map of Comune of Camaiore (LU) in MS Access.

a) Codification of information and structuring of the alphanumeric archive through the creation of a relational database. The analysis and creation of the database structure is quite an elaborate process, which could not be concluded in the phase that precedes the codification and programming of the database. It was necessary to adjust the structure of the tables during the research process (Fronza 2002: 37-42; Parra, Arnese, Gargini 2004: 381-391).

The archive was organised according to the data on the paper forms used for describing archaeological sites, which are standard throughout the Region of Tuscany (Paribeni 2001: 41-44) and therefore consists of ten main headings: archaeological site, location, finds, source of information, modes of assessment, cultural phase, dating, typology, juridical condition and benefits.

The main entry is obviously the archaeological site, which consists of the name and number of the site attributes. The latter represents the ID and permits the creation of relations 1:1 and 1: m between tables. Hence, for every site there can be only one location and presence/absence of movable and non movable finds (1:1), while for every site there can be many, one or no sources of information, modes of assessment, cultural phases, chronology, typologies of settlement, bonds and modes of exploitation (1: m).

The database is relational and consists of entities, attributes and relations, with a flexible structure, easily implemented and capable of managing a large amount of data. It constitutes the quantitative data of the GIS associated, by means of attributes, to certain elements defined by their spatial attributes, such as sites, archaeological areas and monuments. After the planning phase of the Data Base Management System (DBMS), which constitutes the framework both of the physical and the logical structure of the final GIS, we proceeded to program the DBMS using MS Access software, which operates on Windows (Fig. 2).

b) *Creation of vocabularies*. A relevant vocabulary was developed for every category of data, in order to have a standardised file system to facilitate data input and avoid lexical problems or redundancies. An attempt was also made to respect, as much as possible, the terminology used by the compilers of the Archaeological Sites cards, which, as previously mentioned, reflect the regulations of the Region of Tuscany (Paribeni 1999: 41-44).

c) *Use of a georeferenced cartography and attribution of a numeric code to graphic objects that explain single units*. All graphic data, already in vector format, were provided by the Urban Office of Camaiore Municipality. This type of transformation was necessary in order to permit the correct location of the sites, monuments and archaeological areas. To acquire the sites, monuments and archaeological areas we used the regional geo-referenced technical map 1:10000. However, paper cartography in which the archaeological sites and areas were located was a CTR 1:5000.

We then proceeded with the attribution of a numerical code for the sites, monuments and archaeological areas to build up a direct link with the related tables of DBMS, allocating to each point/polygon, which identifies the site or the archaeological area, its related archaeological site number, as an attribute.

d) *Integration of alphanumeric information and graphic data through GIS software ArcView 3.2*. The GIS system, with its file visualisation .dwg and with the link to the database through SQL connection, represents the core engine of the system. The software used is ESRI ArcView 3.2, with some of its extensions. ArcView is a vector GIS software widely used for various purposes. Even if it is classified among mapping desktops, rather than GISs, it has optimal performance with associated relational databases and allows network data elaboration with a server-client structure. The user interface is functional and easy to customise; for this reason it constitutes the most popular standard for territory agencies and had already been used by the Comune of Camaiore (Di Cocco 2002: 52).

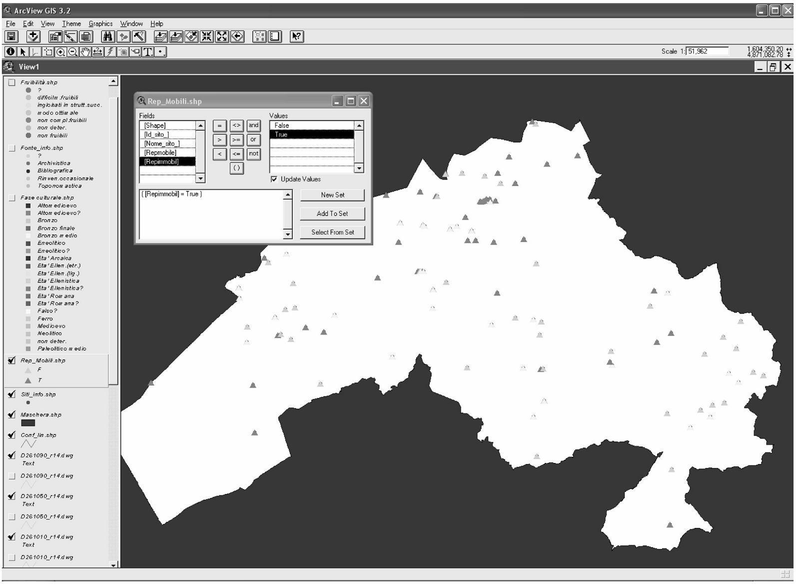

Fig. 3 – Example of ArcViev 3.2 query on the view modality.

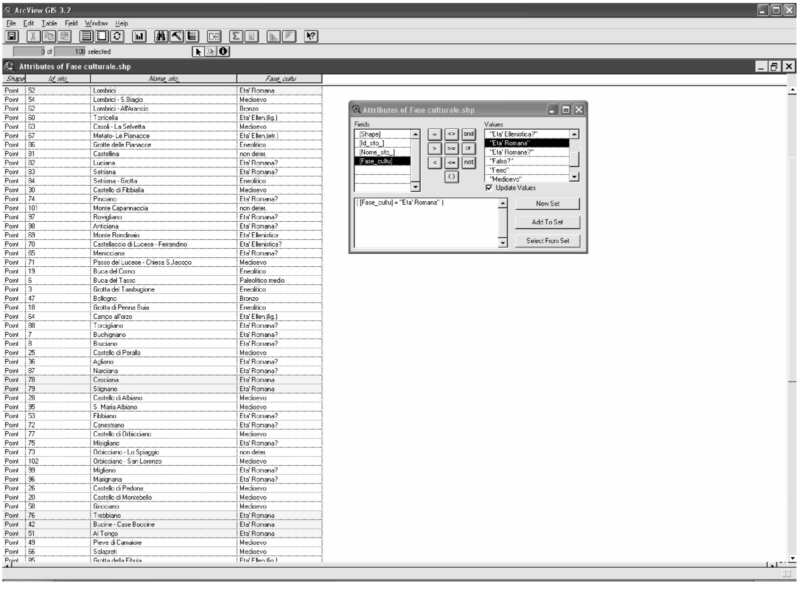

Fig. 4 – Example of ArcViev 3.2 query on the table modality.

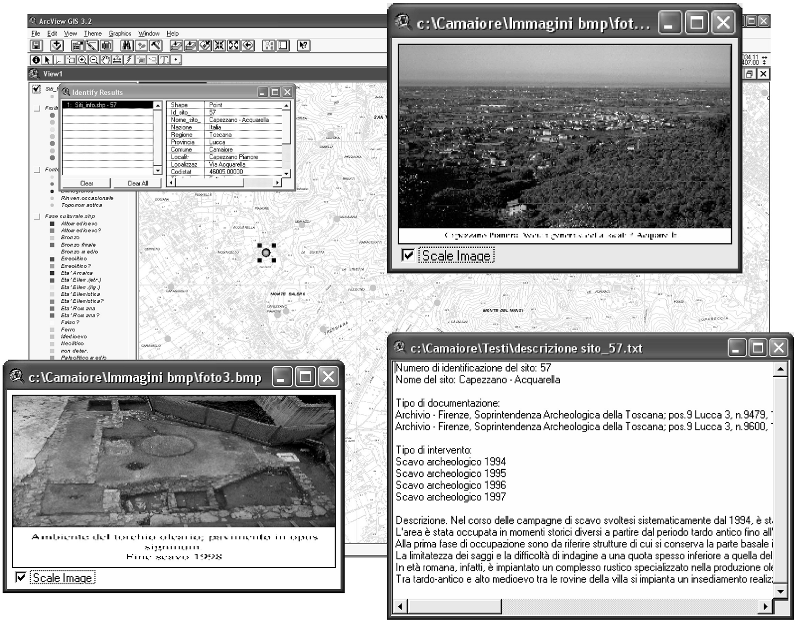

Fig. 5 – Hot Links of the archaeological site n. 57, the Roman *villa* at Capezzano Pianore (LU).

Some links (join) were created between the database and the attribute tables of the graphical associated entities (sites/archaeological areas) to be explored; for instance, the sites of the Eneolithic, Roman period or Middle Ages, or the sites that have mobile finds (ceramics, jewellery, coins, bones, etc.) or structures (walls, roads, etc.). Some links were subsequently converted to shapefile, thus creating real topic maps (maps of phase, distribution, usability, etc). It is also possible to have all the relevant information through formulating queries both on the view modality and on the table (Figs. 3-4).

For the most important archaeological sites, some hot links were established, in order to offer the relevant graphic documentation (photographs, plans, sections, etc.) for each site (Fig. 5).

Results achieved

The project was conducted as part of an internship for a Master's degree in Geographical Information Systems at the Università degli Studi di Milano; therefore it would be desirable to have an opportunity to improve and complete it.

This work involved the entire Municipality of Camaiore, which includes around 110 archaeological presences both in the urban and extra-urban territory, spread over a period of time which ranges from the Middle-Paleolithic up to the Middle Ages. It is now possible to consult the system in order to obtain information on the location of sites and archaeological areas, the sources used, the modalities of verification adopted, the dating and cultural phases, the housing typology, the usability of the sites, and the judiciary status. The part related to the documentation of the *Via Francigena* and *Via Aemilia* and the archaeological finds still needs to be completed. In fact the GIS project focused mainly on the indication of presence/absence (yes/no) of finds and structures on the sites. It would be desirable to build up records of archaeological finds with associated images available for consultation when needed. This would be of great help in the management of new material coming from recent excavations that are housed in the Museum.

We should point out that it would have been better to indicate the archaeological sites with the term "evidence", because of the elements in the "sites" table that can indicate an archaeological presence such as toponyms or persistence of Roman centuriation. It is preferable, consequently, to give more detailed archaeological information in relation to the general, traditional identification of "site", which can provide useful indications in the description, interpretation and reconstruction of the landscape and ancient settlements (Cattani 1997: 113-134).

The results so far achieved show how the methodology proposed, which offers the possibility of easily storing, using and elaborating data, gives an important contribution towards those involved in filing, research, management and preservation of the heritage as well as towards those involved in land use planning. The next step should be the creation of a map of archaeological risk, so that the planning of public and private works will be consistent with the historic characteristics of the places involved, thus avoiding keeping the safeguarding of cultural heritage separate from the processes of environmental transformation and use (La Regina 2001: 30).

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Increased joy through delegated reading

Currently the websites of academic journals tend to be built on the premise that the readers are human. The use of RSS would undermine this assumption. By having computers scan RSS feeds, it could be possible to search more journals than by eye and highlight potentially important articles in undervalued publications, like the Archaeological Computing Newsletter.

RSS is Really Simple Syndication, a data format used by some websites to transmit information about their contents. There are various forms of RSS but the factors they have in common is that they are very simplistic. They will have information on the title of a page and the web address of it. More usefully they frequently carry a brief description of the page and also a publication date. What they do not contain is information on layout. Hence while the HTML of websites may vary wildly in coding, RSS feeds look pretty much the same, making it easier for computers to read them.

Mike Heyworth (2003) has already considered the role of RSS in transmitting information from weblogs in to the wider world. More recently *Planet* style software (http://www.planetplanet.org/) has shown that RSS is suitable for computerised aggregation. Planet reads many feeds and files any items into a database. It can then display them in reverse chronological order for any human viewer. This in turn has been taken as a model for FeedWordPress (http://projects.radgeek.com/feedwordpress/) a plug-in for the WordPress weblog software (http://wordpress.org/). Like Planet, FeedWordPress places items from an RSS feed into a database. However because WordPress is search-friendly items stored can be easily retrieved via search. Additionally FeedWordPress allows hard-coding of categorisation for feeds. This overcomes a problem identified by Paul Miller (2003), that re-processing of RSS feeds can create unfocussed blocks of information. For an example of categorisation *Damasus* currently distinguishes between various categories, including Archaeology (http://archaeoastronomy.co.uk/damasus/?cat=3) and Classics (http://archaeoastronomy.co.uk/damasus/?cat=7).

Damasus differs from the usual Planet style website as it does not take feeds from weblogs. Instead it examines the RSS feeds of peer-reviewed journals. Most of these feeds are from either FindArticles or Ingenta Connect. There are a few exceptions, such as Internet Archaeology, which publishes its own RSS feed, but most are provided via these two sites. The information stored is usually title, author, and abstract. As a proof of concept it would appear to be sound. If more journals had their own RSS feeds, aggregation and storage of abstracts would be feasible. Such a system would not replace BIDS or EDINA, but could complement it.

The benefit of aggregating these feeds, and journals producing them, is that they provide a means of mass searching journals. While few libraries carry every journal, nearly any article is available to researchers at a UK university, even if only via inter-library loan. Relatively low-circulation journals with RSS feeds would be more attractive fora to publish in. Personally I'd rather prefer my articles be read by ten people who have an interest in the contents of a low circulation journal than be ignored by a hundred people between the covers of a higher circulation publication.

Finally a long-term abstract database would give articles longevity. Rather than browsing along a shelf in search of relevant articles, an RSS database would be able to pull items from across the world from any time since the database's origin. It may eventually be possible to produce better research by delegating the first search of material to the computer. This would produce a more targeted pool of papers for the human researcher to analyse. Making sense of such articles will however remain a distinctly human task for the foreseeable future.

Anyone wishing to set up their own databank of RSS feeds will need to rent a web server that supports PHP (around £15pa), a copy of WordPress (free), FeedWordPress (free) and a list of relevant RSS feeds (priceless). An example prototype by the author is accessible via http://damasus.archaeoastronomy.co.uk/.

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For information visit: http://www.archaeologists.net/modules/icontent/index.php?page=18

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New books

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