Towards prehistoric landscape interpretation: GIS analysis of stratigraphical and remote sensing data in Sesto Fiorentino plain

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ABSTRACT

This paper explores the contribution offered by an integrated analysis of stratigraphies and remote sensing data for prehistoric landscape interpretation of Sesto Fiorentino plain (Florence, Italy) performed through GIS tools. In particular, at this stage of the research we are focusing on the understanding of the palaeonvironmental framework in which the prehistoric settling process occurred. This paper shows the methodological approach adopted to combine the stratigraphical data deriving from test pits with other information related to geomorphological background. In particular we are interested to explore the potentialities of a spatial elaboration of geological stratigraphies taking into account their correlation with archaeological context. Actually we are testing, from a landscape archaeology point of view, a GIS application developed by the Direzione Generale Territorio e Urbanistica – Sistema Informativo Territoriale of the Lombardia Region institution. The application, named urca.avx, beyond the archive utilities offered by its database structure, works as an analytical tool which allows geologists to formulate hypotheses on the underground settings. Essentially we are testing the feasibility of this application for the interpretation of archaeological landscape. Moreover we are verifying if the geomorphological features derived by photo-interpretation show a relationship with information derived by geological tests. The complementarity of these data, also integrated with the help of this application, may provide a new exploration of the context.

INTRODUCTION

The project presented in this contribution concerns the prehistoric evidence emerged in the last twenty years in the plain of Sesto Fiorentino and their interpretation in terms of archaeological landscape. The paper is focused on the process of contextualisation and interpretation within a GIS framework of this archaeological evidence. The study area is constituted by an alluvial plain located the north-western side of Florence (Tuscany, Italy) at the foothills of Mount Morello. The progressive urban expansion occurred in the last decades transformed deeply the agricultural landuse which characterised this territorial context in a sub urban landscape (De Silva and Pizziolo, 2004; Azzari *et al.*, 2002). Consequently the building activities carried out in these years gave chance to archaeologists to discover a large amount of evidence. The rescue excavations undertaken by the University of Siena and the University of Firenze have been related to the archaeological heritage policy adopted by the Municipality of Sesto Fiorentino in collaboration with Soprintendenza per i Beni Archeologici which have planned systematic preliminary archaeological test pits in any area interested by building or infrastructure constructions. This investigation activity revealed 27 prehistoric sites that archaeologists excavated in rescue conditions due to the exigencies of a rapid urban expansion. Therefore it is unfeasible to excavate the archaeological site in continuity with its surroundings and in some cases it is also impossible to determine the complete extension of the site. In this perspective it is crucial to gain information also from other sources with the aim to obtain useful contributions for a contextual reading of the landscape palimpsest. In particular, at this stage of the research we are focusing on the palaeonvironmental framework in which the prehistoric settling process occurred. This paper shows the methodological approach adopted to combine into a unique system the stratigraphical data deriving from test pits with other information related to geomorphological background. In particular the management within GIS of stratigraphical has been attempted with the use of a specific application (named urca.avx) developed by the Geographical Information System Unit (Direzione Generale Territorio e Urbanistica – Sistema Informativo Territoriale) of the Lombardia Region institution.

1. THE PREHISTORIC CONTEXTS AND THE PALEOENVIRONMENTAL FRAMEWORK

Due to the The previous mentioned monitoring condition the archaeologists have dug more than 2500 test pits which revealed archaeological evidence approximately for the 10% of them. The thick clouds of small trenches (average dimension of 1x3 m. side and 3 m. depth) are disseminated irregularly in the study area and their distribution is biased by the urban expansion of Sesto. However the position/location of prehistoric sites suggests possible settlement trends and highlights how the area was increasingly occupied from the end of the V to the II millennium BC by prehistoric sites expanding towards south-east and slightly into the inner part of the plain (Fig. 1).
The Neolithic evidences are concentrated on four settlements characterised by structures probably in use for a short period. The Chalcolithic culture is attested in six sites, three of them in continuity with the previous Neolithic ones.

(Martini and Sarti, 1993). A first substantial change in the history of the peopling of the plain is appreciable at the end of the III mill. when the phenomenon of the Bell Baker culture was widely diffused on Sesto plain. Some of these sites offer a consistent chronological continuity till the first phase of the Bronze Age (Sarti and Martini, 1998). At the end of the III mill. people started to exploit paleoriver beds using them as drainage structures. In some case in multiphase settlements the use of the palaeoriver is attested till the complete filling in of the bed (Sarti, 1997). In particular the top of the draining layer constitutes the palaeosurface on which the inhabitants lived. The interpretation of these contexts and of the ancient spatial appropriation of territories is strongly related to the analysis of landscape transformation which occurred in the area. The Sesto Fiorentino plain is part of the large system of Firenze-Prato-Pistoia plain originated on a lacustrine basin developed during Villafranchian time. The lacustrine sedimentation has been covered by recent alluvial deposition laid down by the Arno River and other tributaries. Nowadays the watercourses are mostly regularised and transformed into channels especially when they flow in the plain area. Therefore the present day landscape is characterised by the evidence of different reclamation activities undertaken several times in the past to drainage a territory with a naturally wetland predisposition. The research adopts a landscape archaeology perspective leading to the comparison of different sources at different scale within a general framework. In particular the integration of ancient cartography (De Silva and Pizziolo, 2004) and remote sensing data (Pizziolo, in press) in a GIS environment provided useful information for the understanding of landscape transformation. For the analysis of prehistoric settlement strategy a key point consists in setting up the geomorphological framework. Important studies (Condera and Ercoli, 1973; Capecchi *et al.*, 1975) suggested that in the past the inner basin of the Florentine plain was a wetland area and that creeks, marshes and bogs dominated the landscape. Geomorphological features have been input into the GIS paying particular attention to define/describe alluvial fans and palaeorivers.

Due to recovery conditions, it becomes crucial to examine other sources in order to contextualise prehistoric sites and to develop a reading of the archaeological landscape. As we have already assessed the historical aerial photos and the historical cadastral maps (De Silva and Pizziolo, 2004) provide interesting information on field pattern which can be generally used to individuate hydrological anomalies, moreover they contain in themselves information on water network that we can compare with other information as direct or indirect archaeological data. But this set of information needs to be related with data regarding the underground settings. At this stage of the research we would like to test the contribution of stratigraphic data in providing information on ancient landscape and in exploring the potentialities of a spatial elaboration of them taking into consideration their correlation to geo-archaeological context.

2. STRATIGRAPHIC DATA IN A GIS ENVIRONMENT: THE URCA.AVX APPLICATION

The stratigraphic data available for the project derive from different sources. From the Municipality archive we have collected the description of geognostic drillings executed in the last two decades in the territory of Sesto Fiorentino. These tests, which have been dug to obtain information on the subsoil for setting building foundations; are generally available as stratigraphic reports recorded in form of columns where each stratum is associated to a brief written description. These reports are very heterogeneous in terms of accuracy, details and criteria adopted for the identification of stratigraphic units. Moreover the depth of each drilling may vary from three to about thirty meters according to the kind of works planned for the area. The other set of data that we have used is constituted by reports of the archaeological preliminary test pits excavated in any part of territory interested by the urbanisation activities. The trenches are generally four or five meters depth and different strata are identified by archaeologists who examined the trenches at a detailed scale of investigation but generally with a simplified description from a geological "point of view".

In order to use this kind of heterogeneous information we need to standardise them and to manage them in a georeferenced way, which includes the third dimension. Actually we are testing a specific application developed by the Geographical Information System Unit (Direzione Generale Territorio e Urbanistica – Sistema Informativo Territoriale) of the Lombardia Region institution. The application was created for handling geological data in order to produce the 1:50000 geological map of Milano that is part of a project regarding the national geological cartography. The application named *urca.avx*, developed for ArcView 3.2, has been produced in collaboration between geologists and computer scientist in order to acquire, manage, analyse and visualise different kind of data related to drillings, test pits, logs, samples, geological investigations and test *in situ*. This GIS tool has been created to standardise different investigations conducted in the Lombardia territory in order to record in an homogeneous way all the information available. The geographical position of any stratigraphy is acquired in ArcView as a couple of coordinates then the information related to each test pit is recorded in a relational database (Access) related to each point. One great advantage of this application is that for any stratum input in the DB a systematic description is organised in terms of first, second and third lithologies which compose it, specifying the reciprocal ratio between the lithologies. The initial and final depths of each stratum are recorded as well as other detailed information. The DB is efficaciously structured to standardise data otherwise reported in heterogeneous way. Once drillings and logs have been input into ArcView and the Access database has been fulfilled the *urca.avx* allows correlating any stratigraphy via the setting up of an *ad hoc* cross section view. In fact within the GIS environment it is possible to draw lines of section on which the user choose to project or attribute any selected test pit previously acquired. Throughout this procedure we obtain a cross section which provides information in corrected georeferenced way about

distance between test pits and their composition of lithologies visualising the depth of each stratum relative to its height on the sea level. The application allows one to visualise, in a correct spatial way, the data related to the line of section through standardised and hierarchical symbols (Fig. 2).
In the Sesto Fiorentino context the research has been focused in the exploring of gravel distribution and in better defining the nature of paleorivers. Consequently several cross sections have been drawn in the areas where geomorphologists indicated the existence of palaeorivers. The analysis of the section views shows interesting sequences of deposits which probably confirm the presence of river beds. Furthermore the urca.avx permits also to indicate, through a specific marking system, in which units of any stratigraphy of the section it is recognisable a geological surface. It is therefore possible to draw signs on units in stratigraphic columns or to create virtual points located out of the columns which are referable to a hypothetical geological surface. Position and type of points marking the surface are highlighted also in the traditional bidimensional View in ArcView (Fig. 3).
For instance, in our case study it is therefore possible to mark hypothetical palaeoriver beds distinguishing real and virtual points which may attest the discontinuity in the sequence of stratigraphies related by the cross sections views. Thus the application, beyond the archive utilities offered by its database structure, works as an analytical tool which allows geologists to formulate hypotheses on the underground settings verifying data both in cross section and traditional view. Actually we are exploring the potentialities of this application working within a landscape archaeology perspective.

3. INTEGRATION OF INFORMATION: STRATIGRAPHIC COLUMNS AND REMOTE SENSING DATA IN SESTO FIORENTINO PLAIN

As we mentioned in the previous paragraphs we need to contextualise data deriving from archaeological excavations and to reconstruct the landscape of prehistoric time. A key point for the project is to define in a more detailed way the geomorphological features which characterise the wetland plain. We need to go deep into the general schema offered by aerial photo interpretation using the contribution provided by chronological and stratigraphical information. One of the goals of the research is to explore the features which characterise the plain since the III mill. B.C. It is therefore important to outline the presence of gravel deposits on the hypothetical prehistoric terrain surface; thus the presence of palaeoriver beds and/or the distribution of isolated lenses or of marginal accumulations of gravel. The stratigraphic data input into the GIS have been explored through the drawing of cross section lines and the observation of cross section views. Little by little it is possible to connect information together and to formulate hypothesis on the nature of sequences of sand, lime, clay and gravel deposits individuating areas where we can suppose a flow of water. The possibility to mark the stratigraphic columns in a georeferenced way permits to build up hypothetical sketches of the hydrological settings of the plain. The great potential consists in the integration of aerial photographs of different kinds. For instance some differences in color tones or micro-reliefs may find a correspondence with sequences of strata recorded at a particular depth. Through this procedure it is possible to find a confirmation to hypothesis as well as to individuate promising new area where we can test the geomorphological reconstruction. It is moreover interesting to explore within this framework the stratigraphical position of archaeological features aiming to individuate a chronology of them and consequently to individuate, throughout the interpolation of data, a prehistoric terrain surface.
A further development consists in visualising the information recorded in the DB directly in the 3D environment provided by ArcGis 8.2. The observation of present day surface will be enriched/augmented with the view of features representing in a 3D format the stratigraphical columns (Fig. 4).
In this way an interactive simultaneous exploration of stratigraphies and aerial photos provides a powerful environment in which we can formulate interpretation on landscape settings. Furthermore the use of sketches created with the help of cross section views provides useful information, directly available into the system, which may highlight area where we can individuate peculiar contexts. The hypotheses formulated using stratigraphies may be assessed through further analysis of remote sensing data or vice versa. In Sesto Fiorentino a precious source is constituted by historical aerial photographs as they provide information about previous settings in which geomorphological features may be more visible and not covered by urban expansion. Moreover in this research direction interesting results have been obtained with the further integration into the system of historical cartography. Throughout these research procedures we have defined in more details the palaeo hydrological settings and obtained a better understanding of nature and distribution of gravel deposits.

4. CONCLUSION

The complementarities of data may provide a useful integration of information which is fundamental in studying a disturbed archaeological context. Integrating different sources we are attempting to interpret the prehistoric landscape and the settlement strategies occurred in the area. Moreover the possibility to import the data in a 3d GIS environment enhances the exploration and analyse of stratigraphical data in a more manageable way, allowing us to better correlate data and suggest interpolation surfaces. We conclude underlining that in the Sesto Fiorentino plain, which has been

dramatically altered in the recent past, it is worth comparing each and every one of the resources at our disposal. The work is still in progress but we can suggest that the use of stratigraphic data promises interesting development in the interpretation of the archeological landscape.

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FIGURES

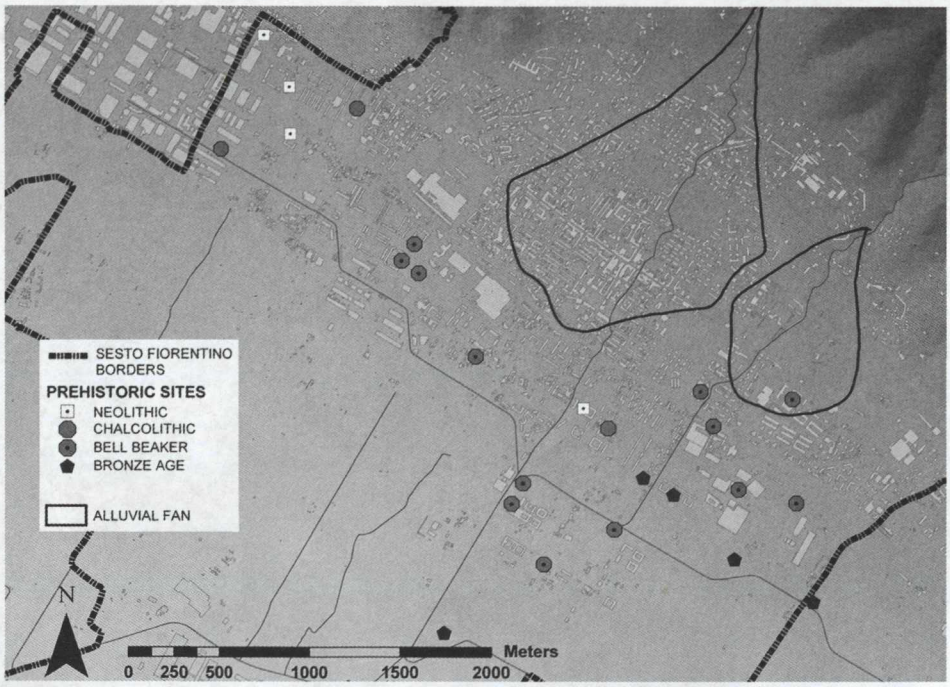

Fig. 1 – Prehistoric site distribution in the Sesto Fiorentino territory.

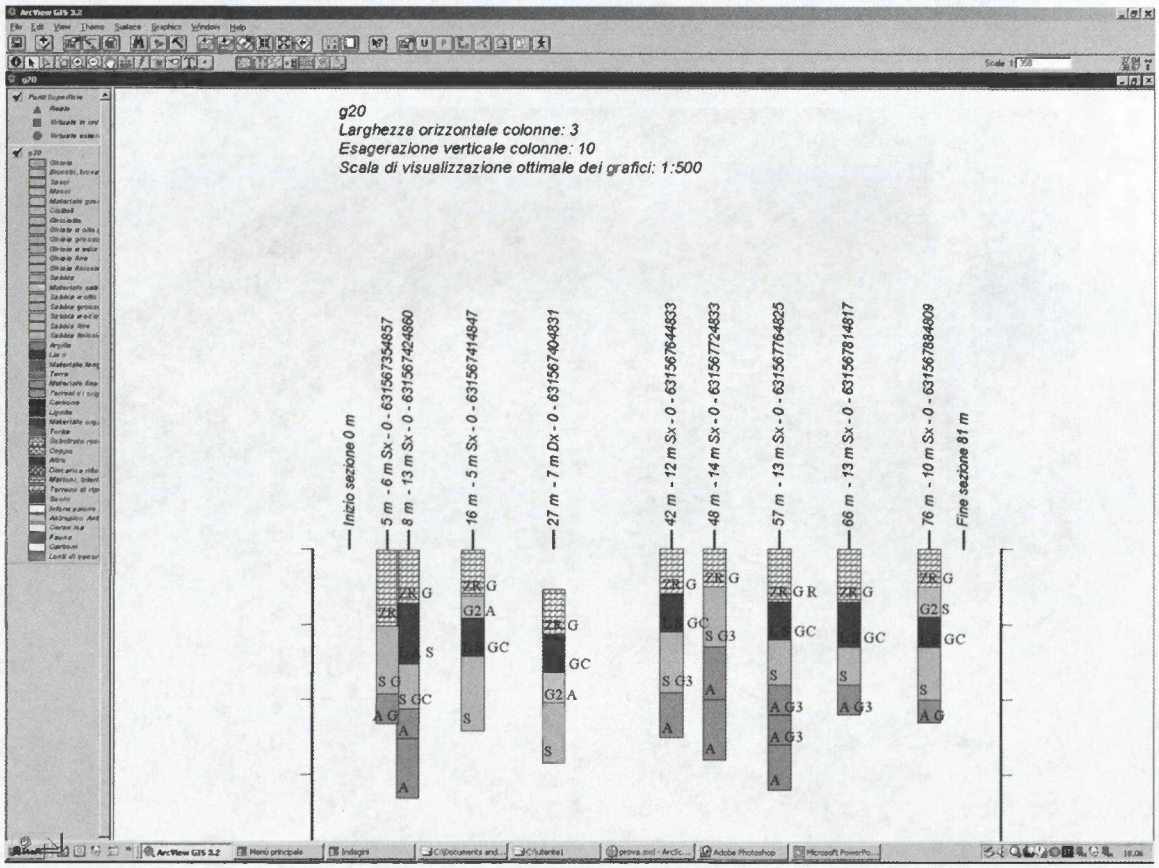

Fig. 2 – The cross section view of some stratigraphic columns.

Fig. 3 – The line of section and the projected samples. In background historical aerial photo and the interpretation of palaeoriver.

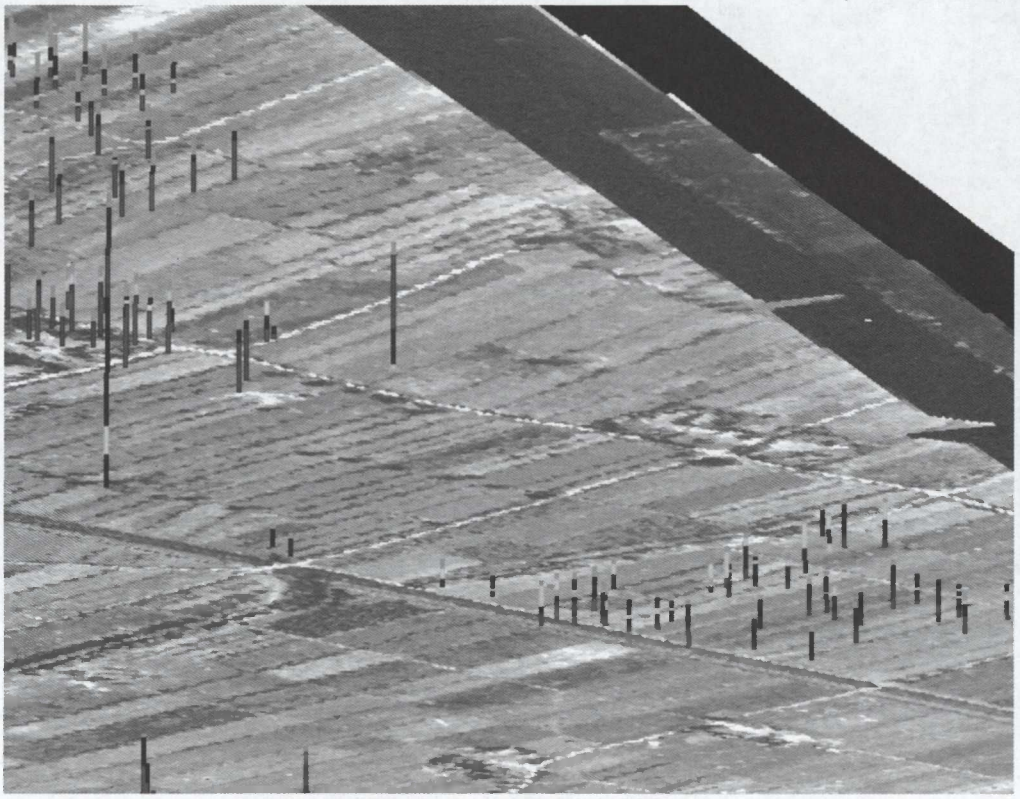

Fig. 4 – A 3D view of the stratigraphic columns seen from beneath the terrain surface on which is draped an historical aerial photo.