GEOMATIC APPLICATIONS IN ARCHAEOLOGICAL RESEARCH: THE MIDDLE AGES IN THE PO VALLEY LANDSCAPE

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ABSTRACT

The aim of the project "*Landscape heritage and resource management: an integrated information system of the Marchesato di Saluzzo*", funded by M.U.R.S.T. (Ministry of University, Scientific Research and Technology), is to verify geomatic technique integration inside the historical and archaeological studies on the Middle Ages in the Po Valle landscape, particularly on road networks and settlements dynamics between the X and XIV centuries. The ultimate objective of this research is to create an instrument, not only for historical and archaeological researchers, but also for the conservation and the valorisation of the Po Valley.
The used method is based on the archives and bibliography analysis in order to extract all the available information on "material structures" such as castles, churches, settlements, roads in the Middle Ages. Subsequently, a field survey performed in order to locate these structures and to identify which ones have disappeared and which ones still remain has been carried out. All the preserved parts of the identified buildings have been analysed by means of archaeological methods. All the data have been recorded and organised in a database structure strictly integrated in a geographic information system in which also most of the available data of the Valle Po area (e.g. technical, thematic, and deriving from geological and botanical research) have been collected and stored following the same criteria.
The merging of all the collected information allow one to perform complex queries and spatial analysis of the data and to underline interesting areas where it is possible to carry out deeper investigation in order to discover underground ruins.

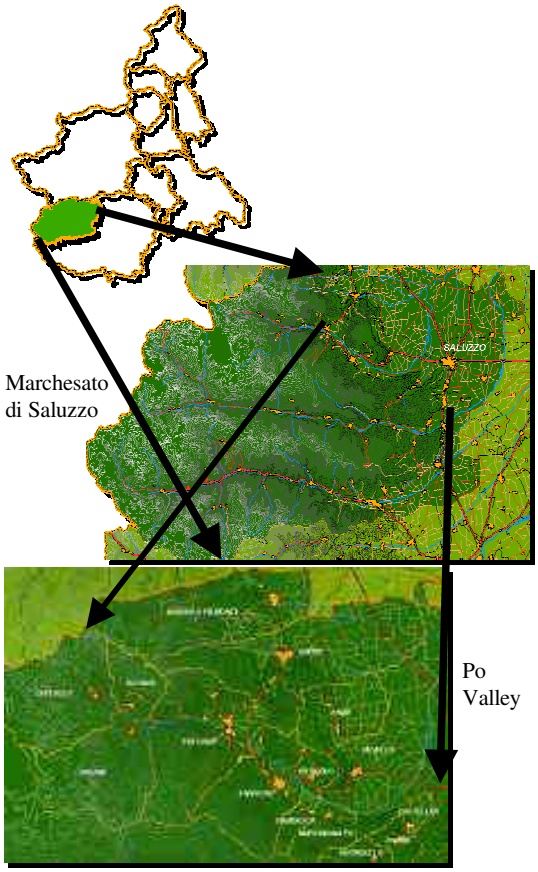
1. INTRODUCTION

The overall goal of this research project has been to study settlement development and the use of land underwent between X and XIV centuries in the Po Valley. In this period there was a transformation process of the settlement network. This process not only occurred in the Po Valley area, but also in many other north-west Italy areas. The phenomenon of the settlement distribution on the land and the territorial layout, is closely connected to actual morphological configuration.
In the last three years our research work aimed to create a G.I.S. in order to integrate different thematic data such as those coming from archaeology, geology, botany and cultural anthropology on a multi-scale cartography (from 1:250.000 to 1:1000) and high resolution satellite images. The geo-referencing of such various data will help a correct and affordable interpretation of the data themselves.
This interdisciplinary approach is a successful way to understand and completely know how environmental exploitation of resources influences dynamic settlements in those centuries. It is very important, for this kind of research, to characterize the environmental context where settlements were located. The historical documentation and the merging of the different analysis conducted by the other involved specialists allowed the individuation of roads and structures not visible today but well documented in the past. The G.I.S. approach has allowed the hypothetical location of those objects in such a probable area where deeper investigations (photo-interpretation, multi-spectral analysis and geophysical investigation) can confirm or at least restrict the probable location area of the searched objects.
The paper describes the standard functionalities implemented in the G.I.S. in order:

- to facilitate the collection of the multi-disciplinary information coming from the different studies performed by the specialists;
- to allow the merging of the acquired information;
- to perform spatial analysis and complex queries of the database.

2. ARCHIVE AND BIBLIOGRAFY RESEARCH. DATABASE STRUCTURE DESIGN AND DATA INPUT

The census of all the data concerning the existence and the characteristics of ancient villages, churches, castles and other evidence such as road networks, mines, quarries or metallurgical sites has been performed by a detailed reading of all the historical documentation. The area selected as the large studying area was the "Marchesato di Saluzzo" located in the southern part of the Piedmont region (North-West Italy).
The first achieved results showed that a sub-area can be of particular interest in order to test a complete study: the Po Valley (see fig. 1). Two very particular collections of documents, the "cartario" of the Staffarda abbey and the "cartario" of the Rifreddo monastery have been completely analysed. This kind of collections are extremely important: they were written by the monks in order to control and manage the economic and religious life in the area.
The papers are about investitures, deeds of gift, sales contracts or other kind of agreements, so, examining them, we can collect many information about landscape organization between XI and XIII century.



During this period the Abbey of Staffarda and the monastery of Rifreddo were two important religious institutions, which had a strong control on the land and people in the whole Po Valley. The policy of these two ecclesiastic structures greatly affected the settlements dynamic and the environmental exploitation of the Po Valley natural resources.
So we have been able to investigate and catalogued data not only about villages, church, castles and communications roads, but also about the land use, examining whether they were wild or cultivated and what kind of farming was used, hydrological networks and their exploitation, sites of transformation such as water mills and any kind of forges.
The collection has been organized using a scheduled collection of key words and notes in order to allow an easy and affordable relational database implementation. Some of the used key words have been shared with other specialist in order to allow an easy merging of the data during spatial analysis.
All the involved specialists defined together the standard analysis to be performed on the data during the recording into the database in order to underline incongruous information coming form the different approach. All misalignments of the data have been discussed and solved by means of the use of a metadata structure useful to define the quality of the inserted data.
The database structure [Boccardo, 2002] of relationships was founded upon a triple core: each data related to a studied object is linked to:

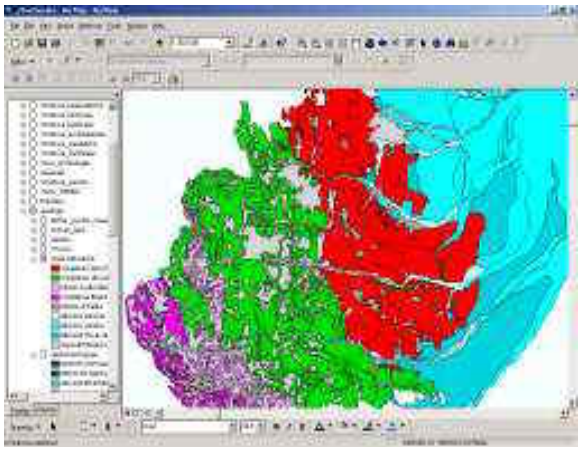
- a geospatial reference
- dating (time and chronological dimension is very important in historical and archaeological studies)
- source (documentary ones or recently published works, because they ensure the effective existence of the data).

3. G.I.S. DESIGN

One of the main topics of the G.I.S. is to share information between specialists in order to help the correct archaeological interpretation of the acquired data and, in the future, an efficient communication of the achieved results.
In the following, some basic elaboration of the data are showed in order to demonstrate the usefulness of the G.I.S. approach in the documentation of cultural sites.
The presented examples have been developed on the ARCGIS software by using the Visual Basic programming language for the realisation of the interfaces.

3.1 Thematic map generation

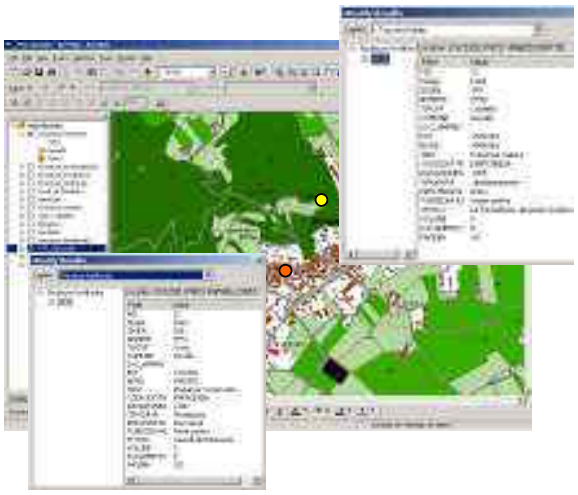
The possibility of creating thematic maps of the collected data is one of the most popular and helpful way to share information. All the specialists involved in the project defined some basic visualisation of the collected data.
Figure 3 shows a thematic map of the geologic description of the Marchesato di Saluzzo useful in order to understand the possible location of the mines and quarries used in the past for the extraction of the stones (mainly used for buildings and roads) and of the metals (mainly used for coins, sword, etc.).



To allow a correct representation of all the data, each thematic map can show only the information visible at the scale of the visualisation. This is possible defining for all information the appropriate range of the scales where they can be correctly represented.

3.2 Location query

The location query is a simple and easy way to inquire the database by using the location of the object of interest on a map.
The information showed after a query have been defined by the specialists in order to allow an easy understanding of the information: in fact sometimes the best information will not correspond to the visualisation of the whole acquired data.

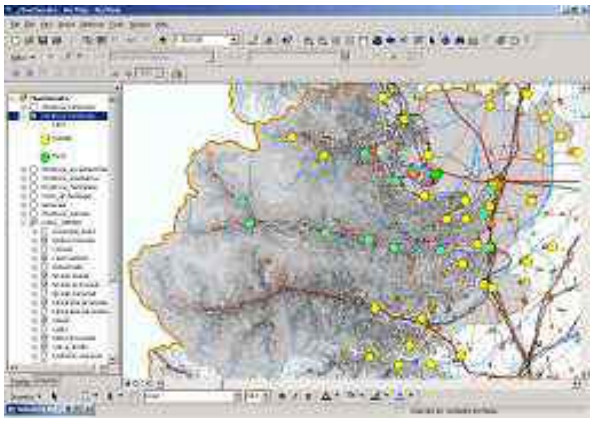


3.3 Condition query

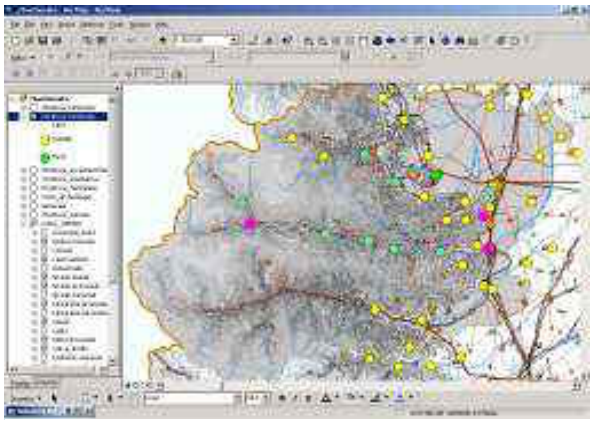
This operation allows to identify those geometric entities which have the properties asked by the query. The query can be simple or complex as the user want. The condition query is an instruments useful in order to suggest to the specialists new interpretations of the data, deeper investigations.
Figure 5 and 6 shows the selection of all the castles and towers documented by historical documents and a subsequent visualisation of the destroyed buildings.

3.4 Temporal query

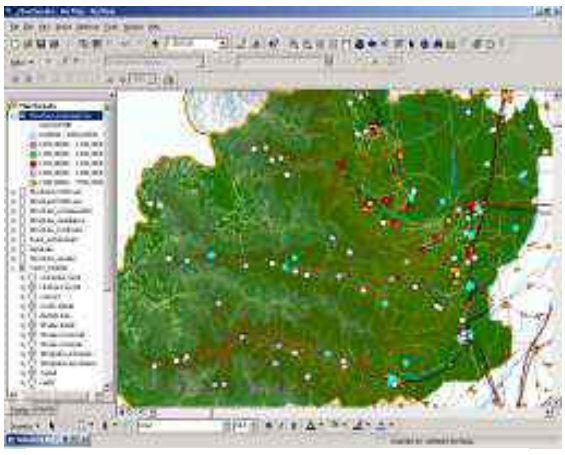
The dating of the information has a great importance in this experience. The possibility of reconstruct the real life of an old settlement is strongly based on the correct chronological reconstruction of the events.

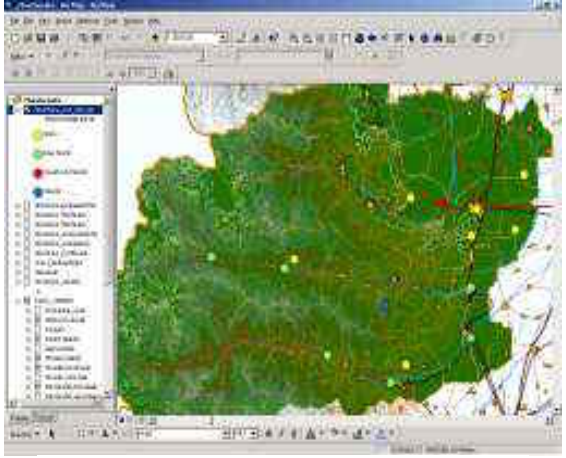


The archaeologies can have more information on the



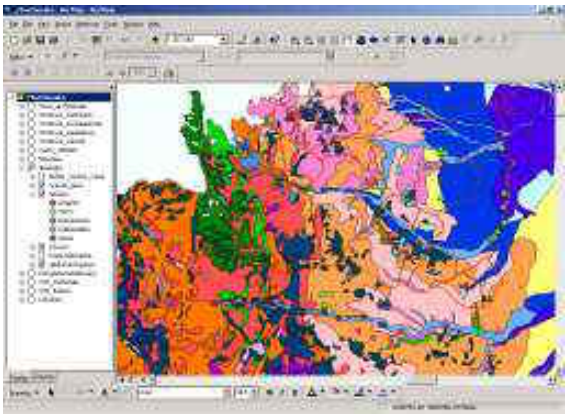
development of a phenomenon and recover missing data if the known information are visualized on a geographic support. This is particularly true in the case of old and non yet existing road reconstruction (e.g. all the castels usually were connected by roads and also farms, churches and settelments were conneted in same way).
Figure 7 shows the buildings and the colours indicates the erection year.
Figure 8 shows the precision of the dating information for each building.





3.5 Selection by location

This type of query allows the selection of different entities which are on different layers of the G.I.S.



The selection can be done by *intersection* (e.g. the selection of an area crossed by a line), *distance* (e.g. the selection of al the entities with a fixed distance from a specified element), *pattern* (e.g. the selection of the entities completely enclosed in a different entity), *superimposition* (e.g. the section of the entities completely superimposed on other entities or which have line or point shared with other entities).
A common application in the project has been the control of the material extracted form the mines and the geology of the area. Thanks to archaeological field survey we has been able to analyze the materials and to assume where were the mines they came from. The pattern analysis made by merging the document information and the actual geology confirmed or disproved the conjecture
Another interesting application of the selection by location has been the selection of the building which could be used for activities needing water (see fig. 10): only the buildings far less than an appropriate distance can accomplish this hypothesis.

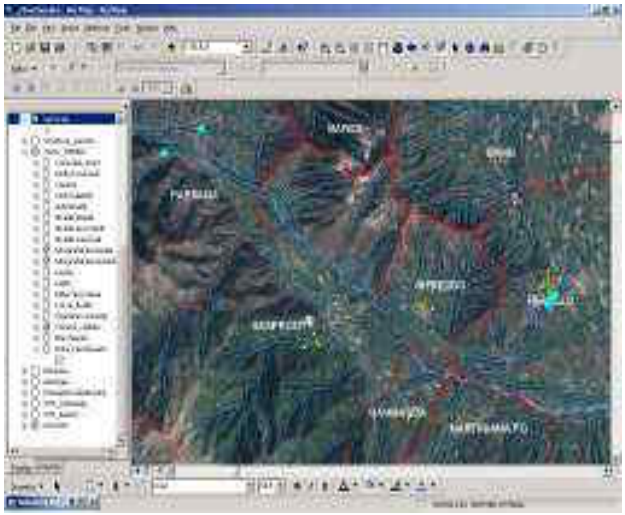
3.6 Location likelihood

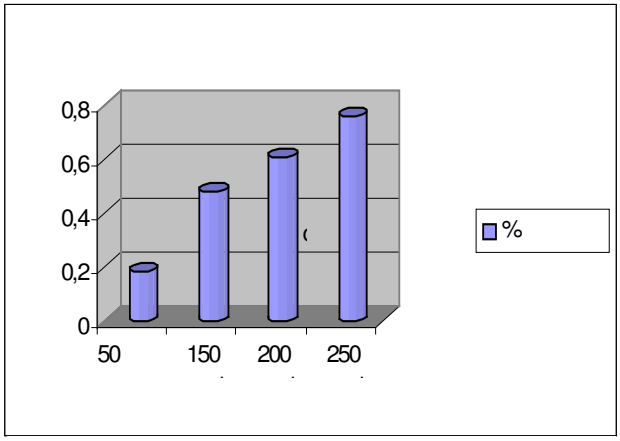
One of the more difficult parts of the research has been the correct localisation of the sites and buildings mentioned by the documents.
For examples, many buildings are well preserved and still used, but in many cases the building has been completely modified or destroyed. In some cases the same building, or road, is mentioned in more than a document by using different name but other information seem to demonstrate the coincidence between the different objects described.

In order to help the archaeologies to solve the correct identification of the elements, each information, also the less meaningful ones (names of the sites, etc.), has been recorded in a separate structure of the database.
A specific algorithm has been developed in order to merge in an appropriate way all the acquired information about an object (e.g. a building, a road, a site, etc.) and to visualize the areas of different location likelihood.
The specialist can choose, between all the selected areas the more interesting in order to make deeper investigations.

4. PHOTO INTERPRETATION, REMOTE SENSING AND FIELD SURVEYS

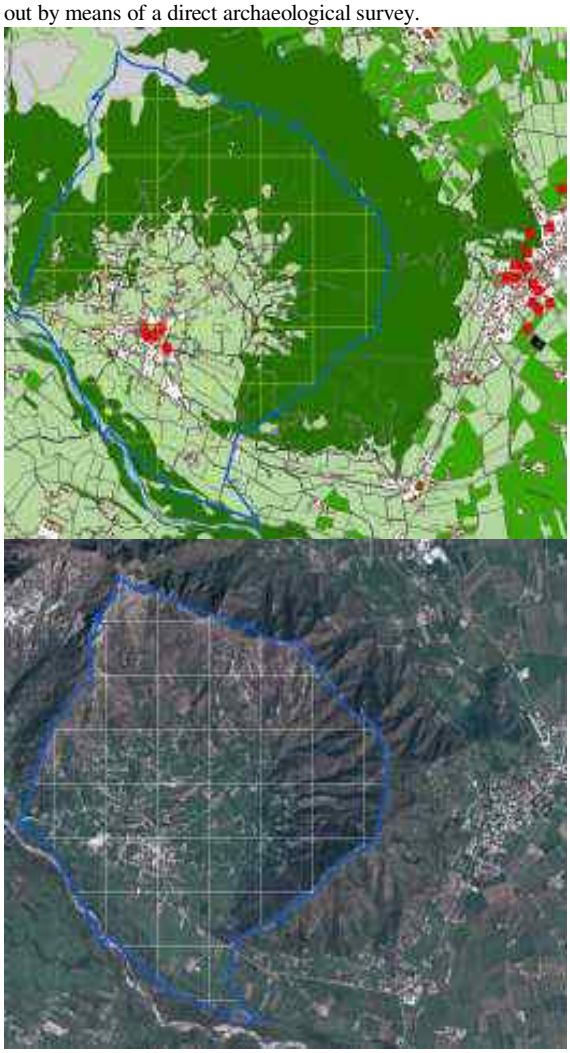
After the relational database structure design and implementation, the second step consisted in an archaeological survey, aimed to find out and locate all the structures mentioned in bibliographical sources. For almost everyone of these structures was extremely difficult to find





out the geospatial location. Sometime very precise details have been extracted from the documents but it was not possible to geo-referencing them by points on cartographic maps. Sometimes it was also possible to guess the area where the structure were probably located (see par. 3.6)
In these cases, the data have been stored waiting for more accurate information (e.g. deriving by field survey) and G.I.S.

analysis in order to spot areas or points where the location likelihood of the data is higher than elsewhere.
During Centuries, almost everyone of these structures have undergone many transformations: some of them have disappeared, some have remained and some others have been preserved as ruins.
A complete census of the visible leftovers has been carried out by means of a direct archaeological survey.



This steps have permitted to pay attention to areas where there is a real difference between archive source description and present scene and to point out the areas where remote sensing, geophysics and excavation can be used to verify or disprove the hypothesis coming from the first investigation.
Photo-interpretation of aerial and high resolution images and the multi-spectral analysis using data coming form the MIVIS sensor [Ardissone, 2003] allowed a closely examination of uncertain selected areas thank to a circumstantial research of buried structures, which have been pointed out by physical and morphological anomalies of the ground.
These anomalies and archaeological features will be checked on the ground and interpreted; then they will be entered in the G.I.S.
This surveying techniques, used in such a way, achieve better results for predictive and preventive Archaeology.

5. CONCLUSIONS

This paper shows an example of integration into historical and archaeological studies of a three different type of research: remote sensing, archive research and field survey. We think that an accurate planning of the link between these three kind of research thanks to G.I.S. applications can provide much more useful and richer information than single studies for a characterization of a not yet still present middle age landscape.
But the real object of this project is not only to increase knowledge about a not yet still present middle age landscape, nor to give a significant aid to historical and archaeological research.
Another important role is to spread historical and archaeological culture and finally, such an archaeological G.I.S., helps local administrations to realize a correct environmental management and an accurate safeguard of cultural heritage [Agosto, 2003]
The achieved results demonstrate that a correct documentation of a cultural site can be easily performed by means of G.I.S. technology and by merging data coming from different specialists.

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