Mapping Tuscan Archaeological Heritage

Methods, leading edge technologies, communication and results

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ABSTRACT: The Department of Archaeology at University of Siena has been engaged for several decades in many Archaeological Mapping Projects in Tuscany collecting a data base upward of 18000 evidences. Our approach has been focused in the testing of new methodologies, new approaches and new instruments for construction of the archaeological record. Tuscan landscapes are characterized by a low levels of visibility that directed us towards the integration of remote sensing techniques. In particular we are working on a systematic program of aerial survey, on the analysis of Ikonos-2 and QuickBird-2 satellite imagery, on digital photogrammetry and LiDAR data. On the ground infra-site analysis has been improved by applying large scale magnetic, ERT and GPR survey; other gains have come from the systematic use of differential GPS and PDA devices. Along with the development of new technologies we have continued the study of historical aerial photographs and the use of field-walking survey, both of which still constitute, in our opinion, undeniably valuable sources for the archaeological study of ancient landscapes.

1 INTRODUCTION

A recent review of the research carried out over the past twenty years and more by the Department of Archaeology and History of Arts at the University of Siena made clear the vast amount of material that has been placed on the record for southern and central Tuscany, upward of 18000 evidences (Francovich, Valenti 2001). Work in the field of archaeological cartography has been based on remote earth observation systems, along with the enhancement of surface collection techniques through the application of new instruments and methods of data collection and documentation, for both the archaeological and the environmental records. Though still at the stage of 'work in progress' we are already putting into effect a new strategy of research. This is flexible, open-ended and based on the conviction that only through the integrated application of a wide range of research methods and information technology will we be able to confront the complexities inherent in the study of the landscapes of the past. So far, we have put in train the approaches summarized in this pipeline (Fig.1).

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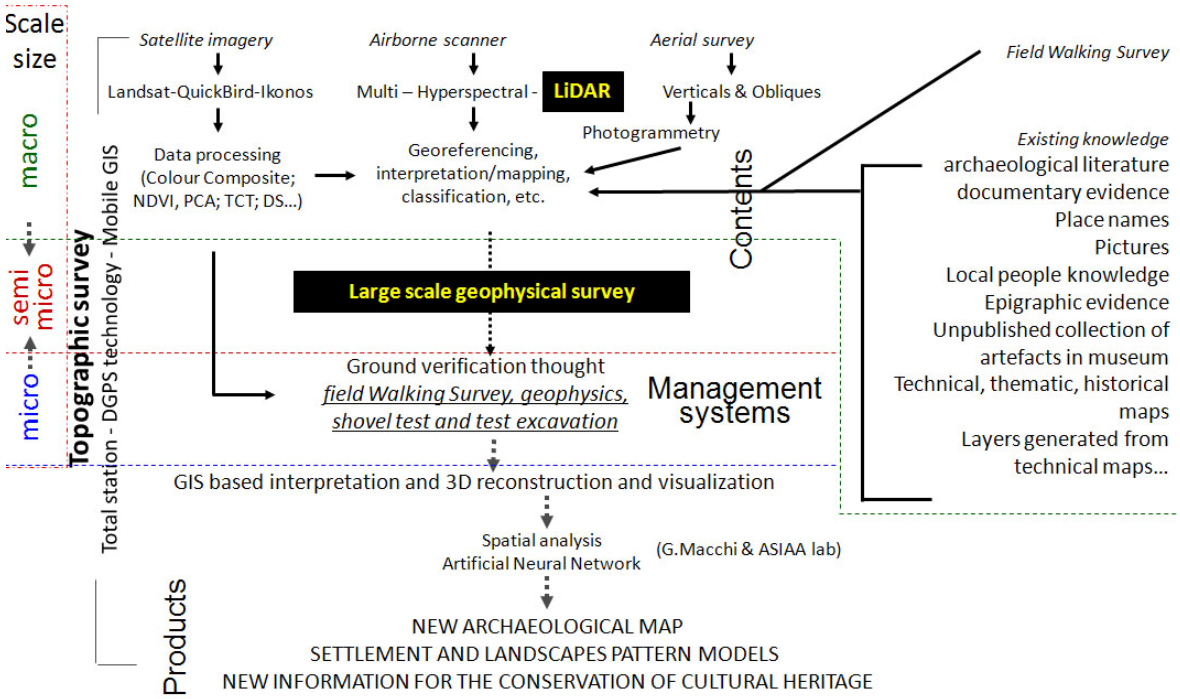

Figure1. Pipeline of the archaeological mapping process: strategy and related methods

2 A STRATEGY IN SEARCH OF SOLUTIONS: STEPS TOWARDS AN IMPROVED INTEGRATION OF SURVEY METHODS IN THE RECONSTRUCTION OF SURFACE AND SUBSURFACE ARCHAEOLOGY

There are few fields of scientific research which make simultaneous use of so many and so widely varying methods and instruments as does archaeology, and in particular the section of archaeology addressed to the understanding of past landscapes. Our experience started almost thirty years ago using vertical aerial photographs. Spanning with their wide temporal range, represent an irreplaceable source for the analysis of the Tuscan landscape (Cosci 2005). Anyone interpreting the photographs through a digital photogrammetric workstation will see a 3D replica model of landscape as it was at different stage in the past, from 1938, 1954, 1976, etc untill the present days. In addition to their historical content, vertical photographs are of course an important source for the conduct of "aerial reconnaissance" and for mapping archaeological features. But it is undeniable that the vertical coverage was collected for essentially non-archaeological purposes, without any consideration of the factors that influence the visibility of archaeological evidence when viewed from the air. In making these observations we do not in any way imply that we should altogether reject the study of vertical air photographs, but we must acknowledge the limitation and to bring forward affective solutions.

To overcome the problems connected with verticals we started from the 2000 a programme of aerial survey averaging 45 hours of flight per year collecting more than 38000 oblique air photographs. The flexibility of the method in allowing us to respond to the development of archaeological traces with extreme rapidity is of great benefit and importance. In fact we should recognize that the correct application of this technique offers an extraordinary contribution to the search for new sites and for the continuous monitoring of the cultural heritage (Fig.2). This technique may be also extremely powerful for the documentation of standing monuments scattered in the countryside as castles, monastery, church or urban landscapes (Musson et al. 2005). The main limitations connected with oblique should be recognized in the dependence on the environmental conditions of the mo-

ment and is influenced by the experience of the individual archaeologist in choosing which part of the landscape to document.

We tried to face these problems starting a research on very high resolution satellite imagery, Ikonos and Quickbird. Satellite imagery was aimed in the first place at providing a total, continuous and objective view of a whole area at a particular moment of the year as planned by the archaeologist. The second feature is the capacity to provide multispectral data to monitor plant health and to detect water-stress in vegetation where it cannot be seen by the naked eye (Campana 2002).

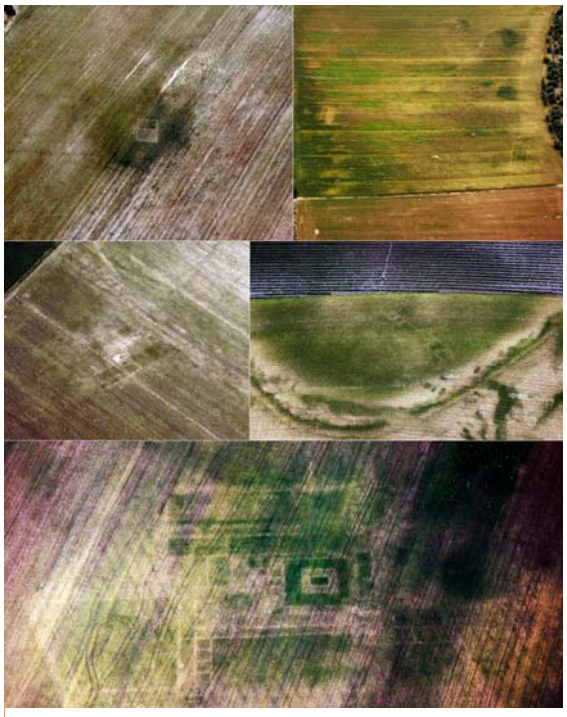

Figure2. Some examples of subsurface archaeological features visible through cropmaks related with roman villas

Finally, we must do something to address our present inability to deal in any significant way with the 50% of Tuscany that is covered in woodland. In this connection there are promising results from experiments in the United States and Great Britain in the use of lidar technology, an airborne laser-scanner that can record with great accuracy the surface morphology, 'seeing through' woodland cover and revealing in great detail the underlying micro-relief (Holden et al. 2002; Doneus, Brise 2006). In this context our laboratory developed thanks to a Culture 2000 project (European Landscapes: Past Present and Future) a first experience in 2005 in the lidar data acquisition, processing and interpretation of four sample areas in the provinces of Siena and Grosseto, through the good services of colleagues in England (Natural Environment Research Council & Unit for Landscape Modelling at University of Cambridge). The results we achieved allows us finally penetrate wooded areas and see archaeological sites before they have been destroyed by ploughing or by other human activities (Fig.3; Campana et al. forthcoming). We believe that nowadays certainly we are seeing only the tip of the iceberg and the development in the coming years will certainly have a very significant impact on knowledge about the landscape.

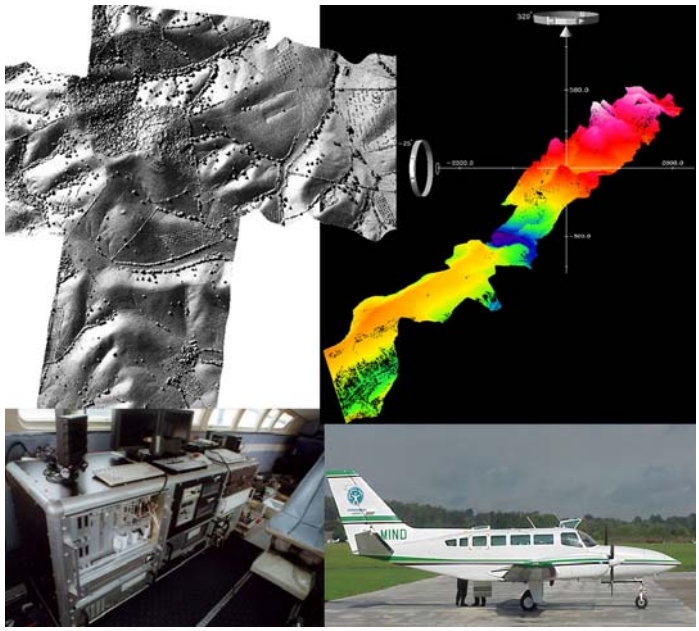

Figure 3. Grayscale imagery of LiDAR data collected in Tuscany, 3D visualization, Natural Environment Research Council sensor and aircraft

Moreover we addressed our effort to the implementation of ground-based sensing with particular regard to geophysics. Only some years ago geophysics belonged mainly to geophysicists. Nowadays the hard work done by geophysicists allows the archaeologists to undertake some parts of the work and extending more and more the scale of the research form site to landscape (Powlesland 2006; Campa-

na et al. 2006). New tools aimed at the acquisition of large scale geophysical coverage has been test by our laboratory, an particularly: multiple antenna radar system GSSI Terravision (Finzi et al. 2005), fast electrical imaging ARP® (electrical resistivity tomography – ERT – developed by the CNRS, Dabas et al. 2005) and magnetic survey system Foerster MULTICAT (Campana 2006). The results we achieved in the last years are extremely significant. The tests show archaeological feature before completely invisible to the traditional archaeological research methods. Moreover the integration – for instance – of magnetic and ERT allow us to see new evidences (Fig.4; Campana forthcoming).

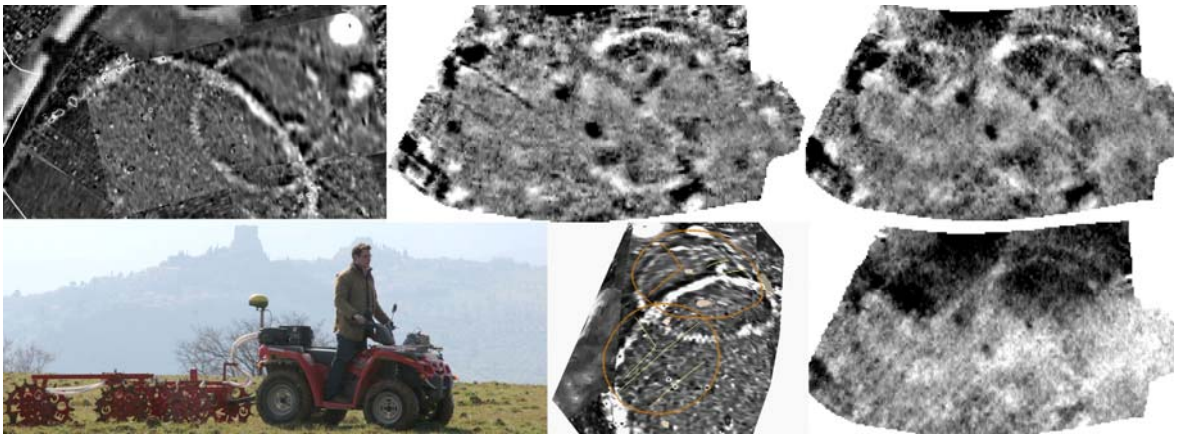

Figure 4. Magnetic map where is clearly visible one big circular feature, ERT maps at 50 cm, 1 m, 1.5 m dept where are clearly visible two big circular features, 3D visualization and draping of the magnetic map on the DGPS DTM with overlaid the ERT interpretation

Without mapping all the information collected and recognized across the wide range of remote sensing techniques we will not obtain the full value of our work and will never be able to integrate knowledge. Mapping means to fix in the geographic space archaeological features that represent the first requirement we need to achieve for the knowledge and the conservation of the cultural heritage. If the archaeological evidence, even if interpreted, understood and described, is not reproduced in map form it is only another site which cannot be protected (Fig.5).

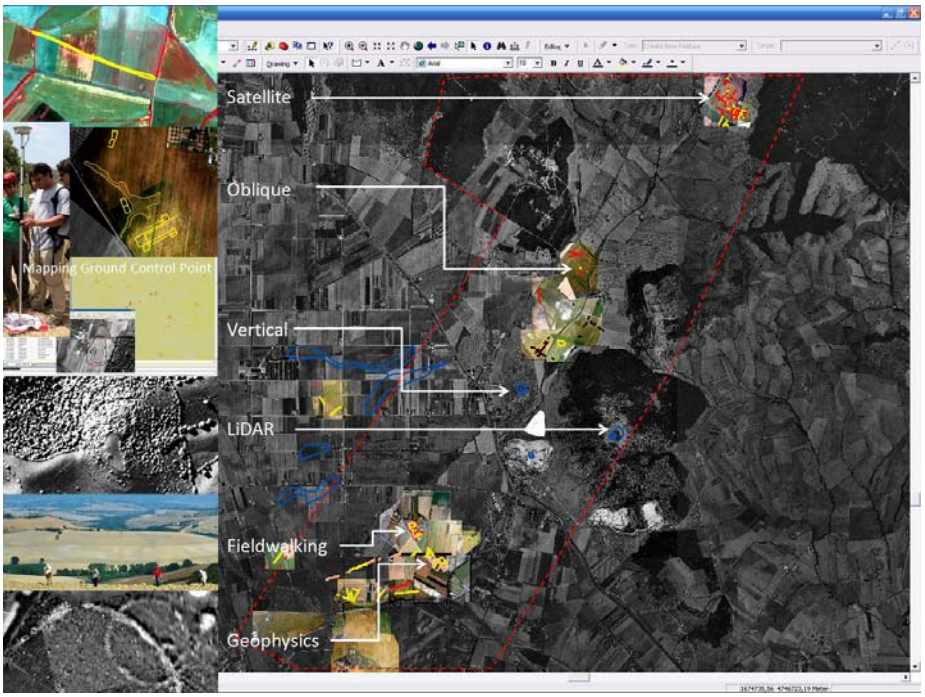

Figure 5. Integrated mapping process

Remote sensing techniques are a very important part

of the archaeological process but remote sensing is not the only approach we should use in landscape studies. Field-walking survey is a relatively traditional method but still represents an extremely productive technique for the search for the archaeological evidence in the Mediterranean zone. This research method has – like all others – some limitations but for instance the application of mobile technology or the practice of test-excavation greatly improves the quality of the results (Campana, Francovich 2007). Just as for remote sensing, the mapping of data from field walking survey allows from one side the conservation of the site and form the other the data stratification year after year.
At the end of the archaeological process we are left with a huge amount of information. We have previously highlighted the mapping process because only through mapping is it possible to re-build the puzzle of historical signs scattered and survived in the modern landscape (Guaitoli 2003). Finally we have to emphasize that we can quite easily manage data of small scale sample like catchments areas but we should consider that our landscape is the whole Tuscan region. Nowadays, we believe, the only way to face such an amount of data is to develop spatial analysis tool and artificial neural network systems (Macchi 2005). We believe that the result of our work should be addressed to the better understanding of cultural patterns, to the development of cultural resources management strategies and to making our own contribution to landscape planning. Information and analysis tools should be directed towards problem solving and decision making.

S.C.

3 CONCLUSION

In this brief paper we hope to have shown that the introduction of research techniques has to respond to specific needs, so as to overcome or at least to ameliorate the difficulties of the context in which we work, to respond to historical and archaeological questions at the heart of our research into the region, and to make a real contribution to the care and monitoring of the historic environment. In conclusion, although we can point to significant progress in our understanding of the archaeological and landscape evidence, we must not become over-optimistic. We must always bear in mind that, however great our own resources, the archaeological resource itself is subject to a constant and irresistible process of degradation. It is our belief that, in our efforts to delay this process and at the same time to address specific historical problems, a leading role can be played by broadening the range of remote sensing techniques that we use, along the lines suggested above, and by applying them systematically and extensively in our regional research-work. We are confident that these approaches will greatly increase our capacity to understand the archaeological resource, despite the difficulties still represented by questions of archaeological visibility.

S.C.&R.F.

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