GIS and Survey in the Archaeological and Landscape Park of Agrigento

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From 2007–2009, the Department of Cultural Heritage from the University of Palermo conducted a survey of the Archaeological and Landscape Park of Agrigento, a project completed on behalf of the Park Authority. The final results of this study are already published.[1]

This research was undertaken primarily to create an Archaeological Map of the Park as a means of protecting and conserving the known archaeological heritage of ancient Akragas, as well as to provide guidelines for future research and enhancement activities. At the same time, creating a comprehensive Archaeological Map proved useful not only in conglomerating the vast amount of archaeological information located within and beyond the city, but also in the creation of a GIS of the Archaeological Park through the collection of existing and newly discovered data. This GIS can now be continually referenced and updated, and acts as a valuable tool for the management of local archaeological heritage within the Park, as well as providing a starting point for the planning of new research.

The project began at the end of 2007, with a preliminary step devoted to assembling previously published topographic and urban planning studies of the site of Agrigento itself, as well as related archaeological research conducted inside the city and in the nearby suburbs. At the same time we proceeded to consult and acquire digital versions of archival maps and plans available from the I.G.M. (Istituto Geografico Militare), the Centro Regionale del Catalogo of Palermo, and from the State Archives of Palermo and Agrigento. With the assistance of the Special Office for the Regie Trazzere of Sicily we finally identified the path of the eighteenth and nineteenth century trails that pass through the area of the Park.

So, we achieved a useful collection of material for producing a diachronic interpretation of the evolution of the area. This in turn was combined with the aerial photo documentation, available both from the Centro Regionale del Catalogo of Palermo, and from the I.G.M. flights of 1955 and 1966; other series of particular interest were delivered by the Park, along with the most recent aerial images.

The survey was conducted in four phases:

1. Field survey
2. Analysis of historical maps and remote sensing data
3. Transfer of all data in the GIS platform and implementation of databases
4. Execution of cartographic models and spatial analyses

Building a GIS platform

Before starting the survey, a GIS platform was built, which acted as a useful baseline for field studies. We decided to work with ESRI products, and in particular with version 8.3 of the software ArcGIS Desktop, held by the Laboratory of Ancient Topography of the University of Palermo and by the Archaeological Park of Agrigento. This program includes a range of tools oriented to CAD and to the production of high quality maps. The use of this software allows

1. Belvedere – Burgio 2012.

Fig. 1. Database Access screenshot, Architectural Element Card (Belvedere – Burgio 2012, fig. 15).

the creation of GIS platforms, the management and updating of the different layers, data queries, and 3D spatial analysis.

The first stage of planning a GIS platform is the inputting of various sources of information into a single environment, such as: current and historical mapping, aerial photos, satellite images, and digital data gathered from existing files or from newly updated databases.

Thus, the sources of information are:

- Topographic Maps (10,000–25,000)
- Bibliographical Data
- Database Access (UT; Tombs; Architectural Element Card, fig. 1)
- Hydrography
- Geology
- Pedology
- Historical Routes and Trails
- Aerial Archaeology Data

Archaeological Survey

In January 2008 we started a systematic archaeological field survey of the entire park, an area of roughly 15 km^2.[2] In about three months the survey covered 74% of the total area, while the remaining 26% was surveyed at the end of the 2008 summer season, when the heat left the uncultivated or grassy areas visible. At the same time, the survey was extended to areas located south of the village of Villaseta, beyond the limits of the Archaeological Park, located between the SS 115 road to the north, the SS 640 road to the southwest, and the railway lines to the south.

The crew walked the whole area, taking as reference points the limits of each field, proceeding in parallel lines of regular intervals, which changed depending on the visibility of the soil (average distances of 10–20 m with excellent or good visibility, 5–10 m with medium or poor visibility). The team recorded the presence of surface archaeological finds and structures and noted down the degree of ground visibility for each field.

We adopted an intensive and systematic survey method,[3] and by using a handheld GPS[4] (with ArcPad 7.0), we could display the topographic maps (raster and vector) and aerial photos on the screen. The surveyors in the field were able to precisely georeference emerging structures (tombs, architectural elements), alignments, and other tracks in real time, UT, while also being able to record areas of find-concentrations, to collect artifacts with the aid of grids, and to fill in the map of density.

To record the visibility conditions, we used a scale similar to that of the Himera survey, identifying five degrees from more visible to less visible (1 – excellent, 2 – good, 3 – medium, 4 – poor, 5 – no visibility). The different degrees of visibility were then marked on a map (scale 1 : 10,000 CTR), with different colors for each degree (fig. 2).

With the help of the GPS, the limits of each UT were precisely defined and the UTM coordinates calculated, with the resulting perimeter and position marked on the topographic map. Given the high background noise and wide dispersion of the surface pottery sherds, and the abundance of artifacts in the suburban area, it was necessary to record the density of the findings systematically. With the field as the minimum unit of the survey, the resulting maps show the different values of pottery fragments found for each field (fig. 3), and an overall archaeological map (fig. 4). The collection of finds was not exhaustive, but limited to the most significant of the visible phases, in order to obtain an indicative chronology for each archaeological site. The finds were collected, recorded, classified, and photographed, and were finally deposited at the Villa Aurea, home to the offices of the Park.

Survey inside the ancient city

Quite different were the problems posed by our survey within the limits of the ancient city, where we adopted strategies of data collection typical for the exploration of an urban area. These were aimed at identifying the use of the various zones and functional areas, the assessment of the human activities

2. Belvedere 2012.

3. Alliata et al. 1988, 3–14; Belvedere 1994; Belvedere et al. 2002, 6–22; Belvedere 2011.
4. Campana 2006.

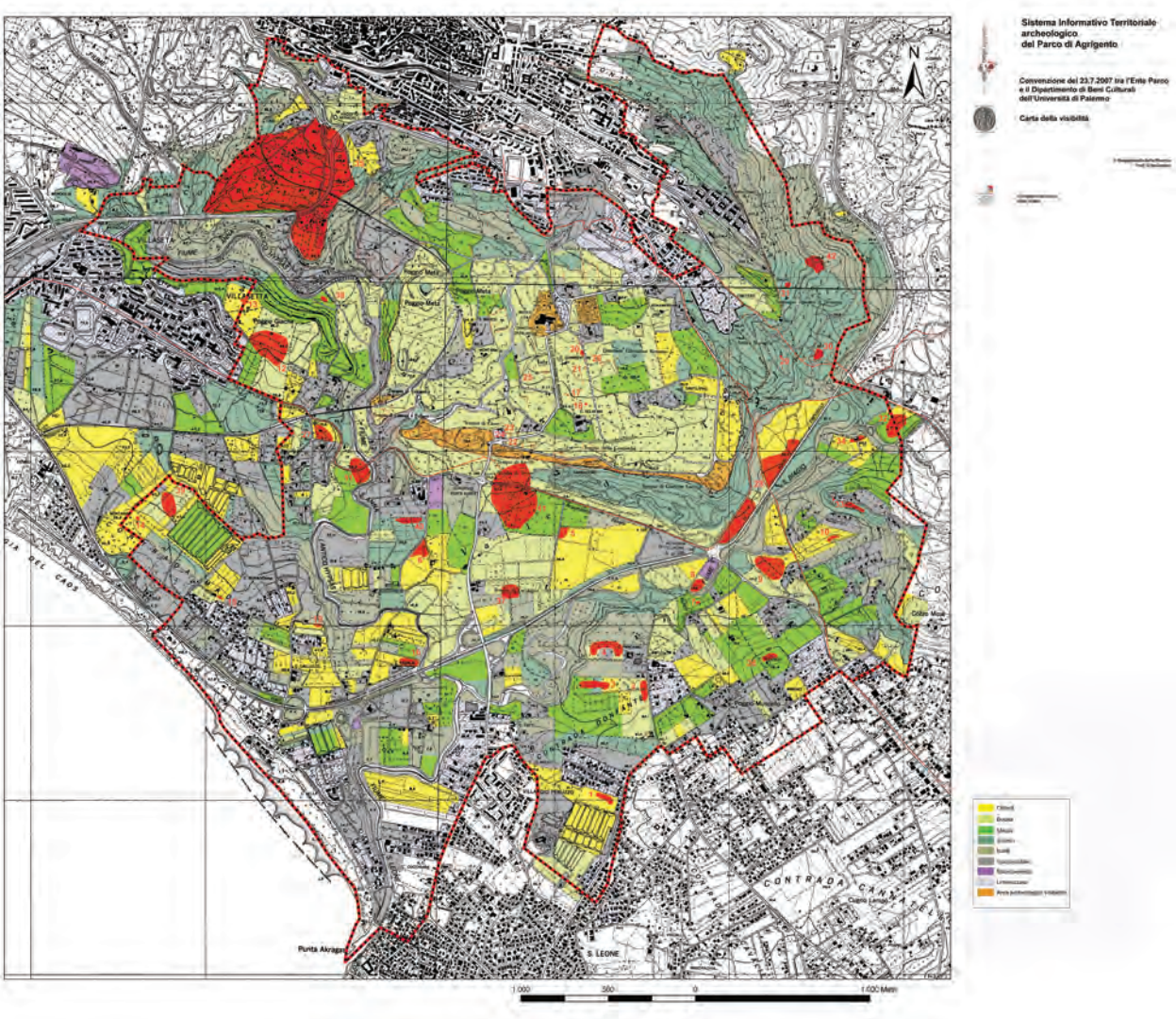

Fig. 2. Map with different degrees of visibility: from more visible to less visible (1 – excellent, 2 – good, 3 – medium, 4 – poor, 5 – no visibility). (Belvedere – Burgio 2012, map).

themselves, and the definition of chronological sub-areas. Additionally, we monitored the density of the finds, their distribution, and the typology and chronology of the artifacts.

All significant archaeological evidence was mapped with the help of GPS, including functional architectural elements (columns, capitals, mouldings), as well as features indicative of urban planning, such as wall alignments, field boundaries, rows of trees, and ancient roads. The cave tombs (*grotticelle*) and the excavation areas were also included in this survey.

Because of the high concentration of pottery sherds inside the city area, we developed a particular survey strategy for monitoring the density of the artifacts. We built a »virtual« grid (squares of 25 m^2) in vector format within the GIS platform, oriented to the north (File SHP »grid«). This grid was inserted as a layer in the ArcPad platform on the handheld GPS used during the field survey. This allowed us to record the density of sherds located on the field.

The surveyors, covering the fields at an average distance of 5–10 m from each other, placed five squares of 1 m^2 within each square of 25 m^2, and

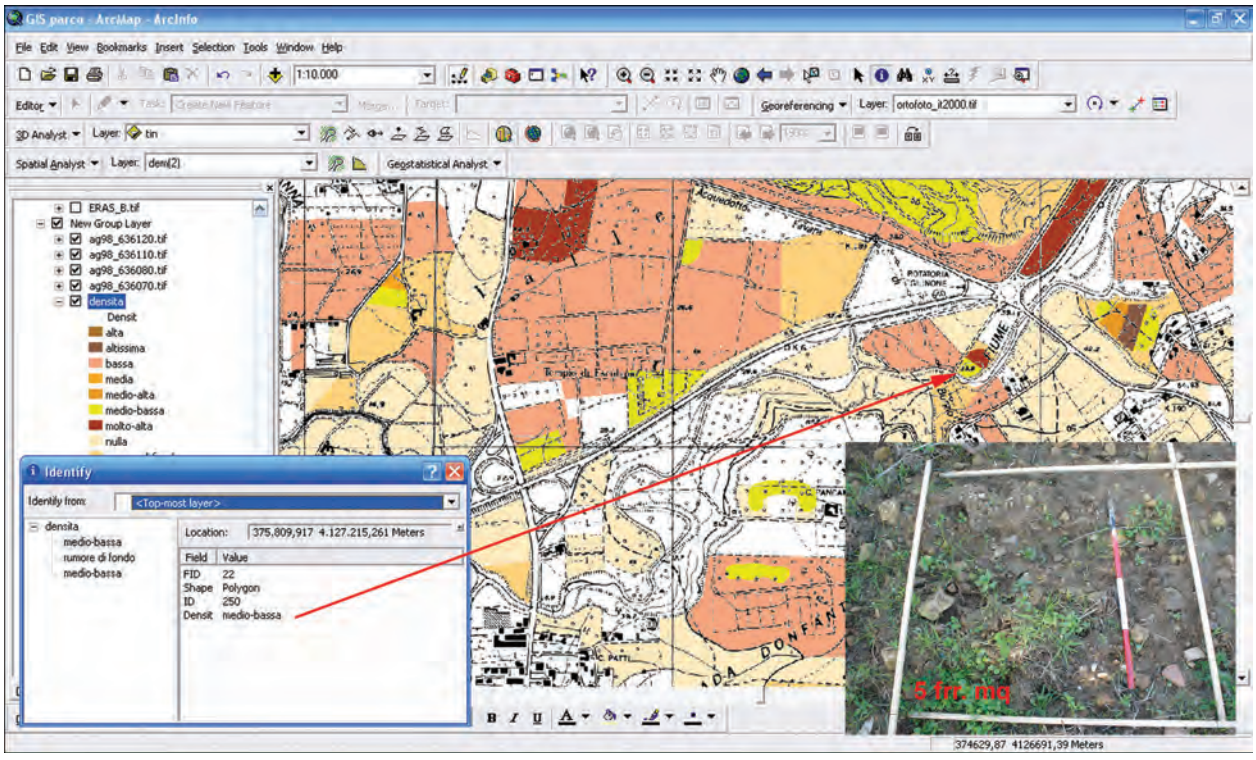

Fig. 3. Database Archmap screenshot, indication of density of pottery finds (Belvedere – Burgio 2012, fig. 31).

counted the number of pottery sherds. The average density calculated in the five squares was then attributed to the entire square of 25 m^2, and a subsequent density value was assigned to each field unit (fig. 5).

Aerial archaeology data

- 1955 Volo E.R.A.S. (copertura Città di Agrigento)
- 1955 Volo I.G.M.
- 1966 Volo I.G.M.
- 1970 Volo M.P.I.
- 1987 Volo A.T.A.
- 2000 Volo Regione Sicilia

Simultaneously with the archaeological survey, an analysis of historical and modern aerial photos was performed, combined with an examination of satellite imagery (Quickbird, Google Earth). The latter, with its exceptional image resolution,

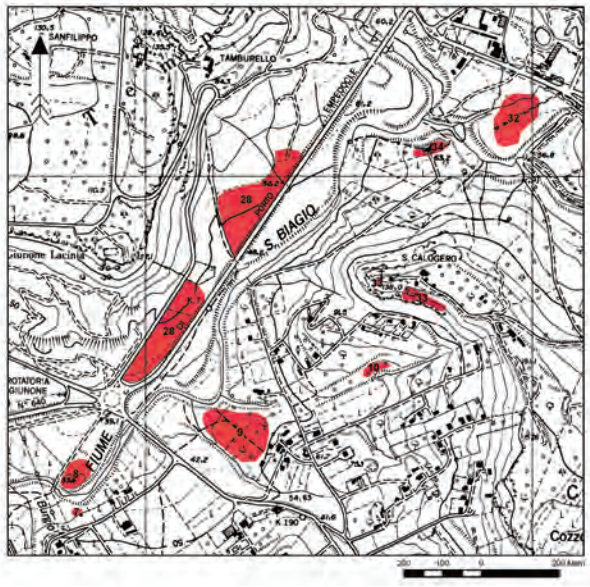

Fig. 4. Archaeological map of Agrigento, detail of contrada San Biaggio (Belvedere – Burgio 2012, fig. 131).

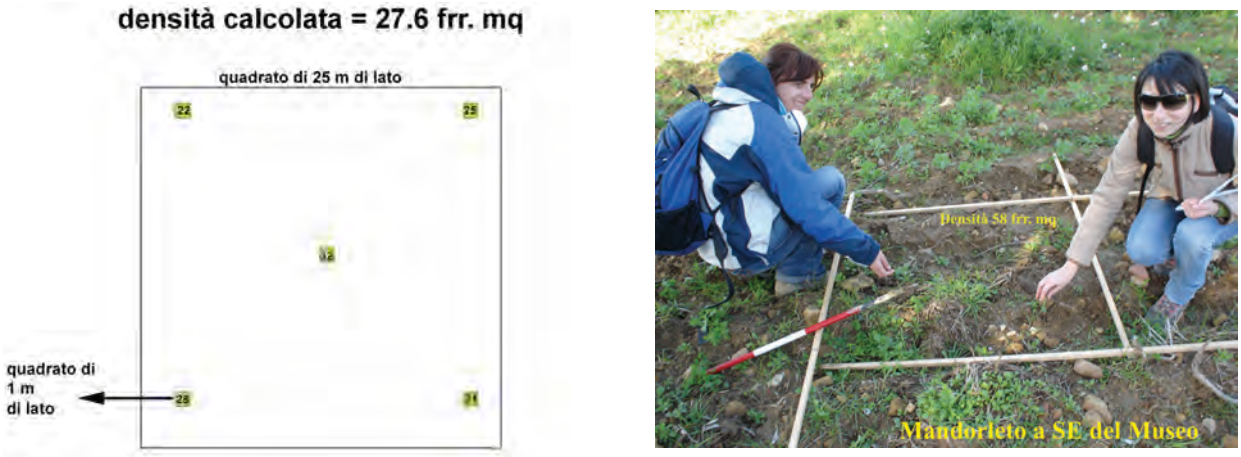

Fig. 5. Archaeological survey – density calculation (Belvedere – Burgio 2012, fig. 39-40).

allowed detailed comparisons with the soil and dump marks recognized on the aerial photos and the traces identified on the ground. Photo examination and orthorectification were done using the ZMap software of Menci Softwares, which facilitates the fabrication of photo mosaics (fig. 6).

Once the frames are oriented and the blocks are assembled, it is possible to browse and compare the visible marks from several stereoscopic and georeferenced models. By overlaying several of these models, it is possible to carry out orthoprojection of the strips on the DEM, culminating in orthomosaics, which are then exported into the GIS. The marks observed from aerial photographs or recognized on the ground during the survey are displayed on the stereoscopic model and are compared with those interpreted by Giulio Schmiedt and Pietro Griffo (fig. 7).[5]

This work allowed a series of statistical comparisons to be made, for example, between the percentage of traces and marks actually recognized on the ground and those marked on the map of G. Schmiedt and P. Griffo (52% still visible against 48% not traced). Additionally, this work allowed us to compare the percentage of still recognizable traces from several aerophotogrammetric strips to those set out in the map of 1958, and furthermore, to calculate the percentage of new traces identified in each of the subsequent flights against those recognized by G. Schmiedt in the 1955 flight (fig. 8).

The comparison between the tracks still recognizable in the field and those read on several photographic series (from 22% to 67% in the flights taken into account) was particularly interesting, confirming that the season, the altitude, and the quality of the image capture greatly influence the results. As usual, it is also possible to observe that most of the identified traces are located in areas with good ground visibility and where the density of finds is greater.

After reviewing the aerial archaeology data and 3D images, targeted inspections were also carried out, for example in the Poggio Meta area within the ancient city, in the western necropolis (contrada Pezzino), and on the site of the suburban sanctuary of S. Anna (UT 27). The results of these targeted investigations provided a better understanding of the traces read on aerial and satellite images as well as of the state of conservation of archaeological structures and deposits.

Survey outside the ancient city

In the area outside the city 42 UT have been identified, many of them unpublished and previously unknown, dating from prehistory to late antiquity. We obtained a complete picture of the population of the area of Akragas before the foundation of

5. Schmiedt – Griffo 1958; Belvedere et al. 2009.

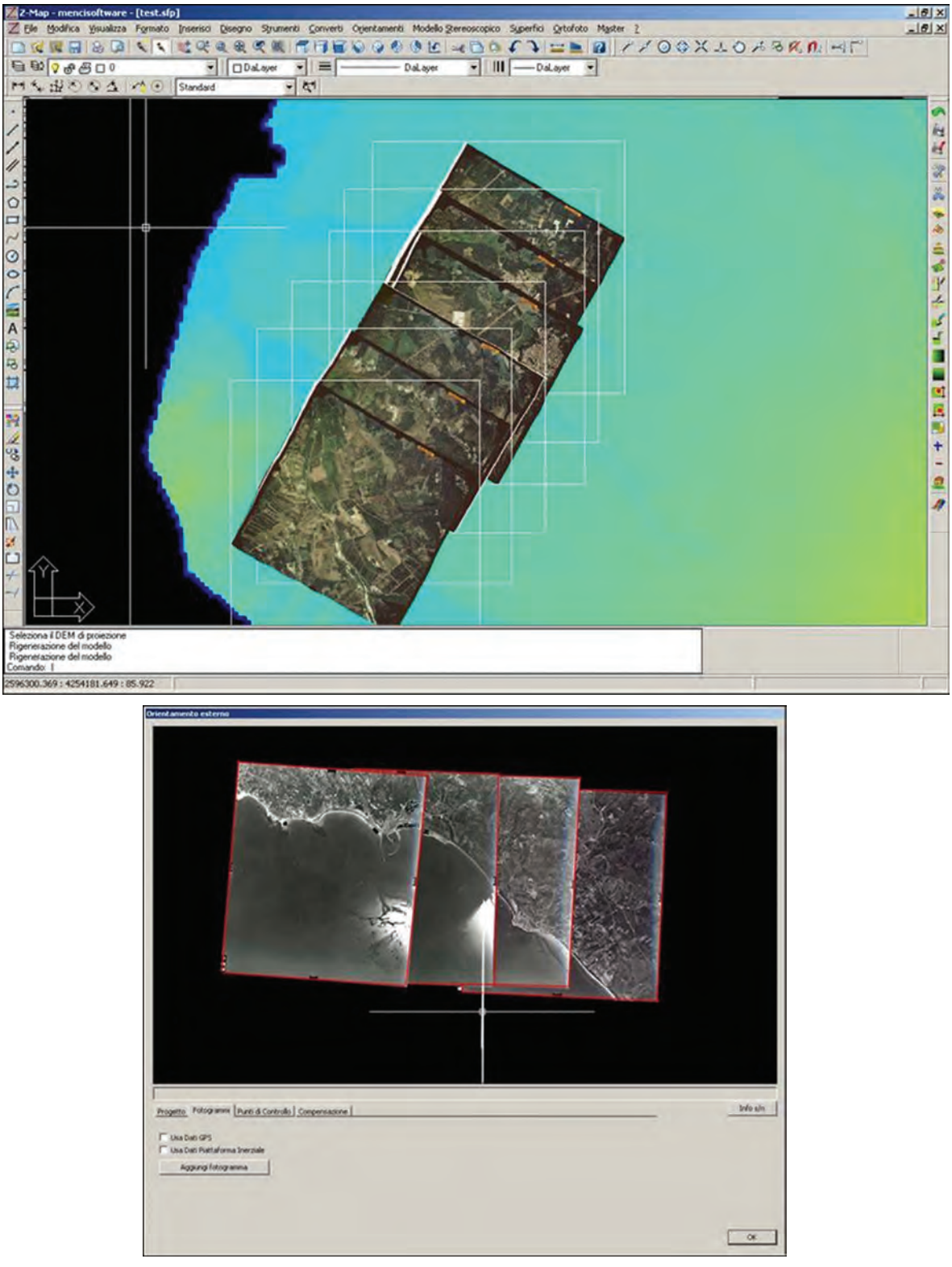

Fig. 6. ZMap (Menci Softwares), screenshots of photo mosaics (O. Belvedere and Belvedere – Burgio 2012, fig. 45).

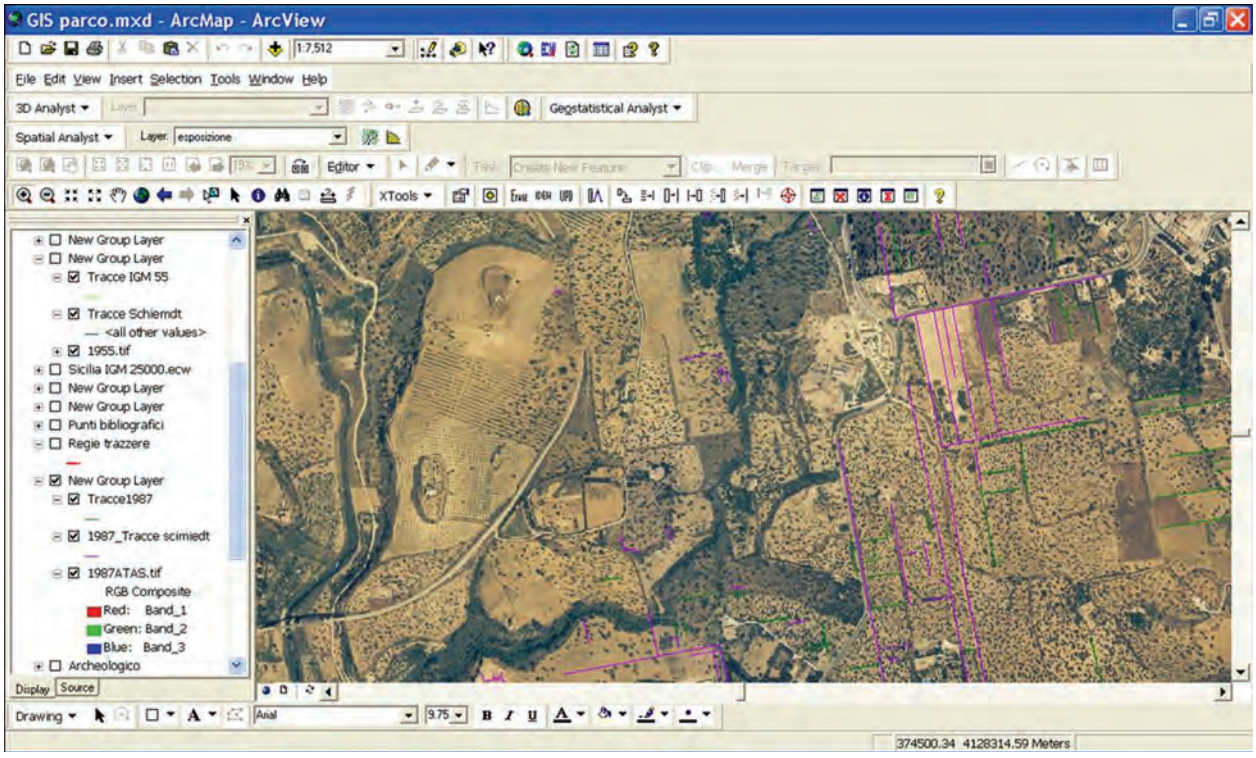

Fig. 7. Stereoscopic model: Visualisation of ZMAp data with Arc GIS, screenshot (Belvedere – Burgio 2012, fig. 49).

the city, and after the establishment of the Greek colony, and identified areas of activity of Archaic-Classical and Hellenistic age. The latter were located in the immediate suburban district and consisted of building materials and pottery kilns for the production of large containers and building materials, features characterized by the presence of processing waste, (e.g. such as UT 28. fig. 9. UT 5).

Some sites, can be interpreted as rural settlements of Archaic and Classical age, dispersed around the city, especially on the south side, between the two rivers, and between them and the coast (UT 1. 3. 4. 16. 19. 36), a phenomenon more relevant in the Hellenistic period (UT 1–4. 6. 8. 11. 16. 39). In the Roman Republican and Imperial age, only a few of the Hellenistic settlements (UT 4. 8. 16) show continuity of life, while sites (UT 9. 34. 37) are now situated along the main rivers, as along the river S. Anna. At least in one of these sites the material is scattered across a wide area (UT 9), while a second, where mosaic *tesserae* were found, might be identified as a suburban villa (UT 8. fig. 10). A few others (UT 7. 11) seem to show continuity of life into the Byzantine period.

Processing the data

Other data useful for the historical reconstructions of the territory have been obtained from the DEM processing, thanks mainly to 3D applications offered by the GIS software. Thus, we have obtained maps of the ground slope, their level of vegetation and sun exposure, and significant analyses of the inter-visibility among the various sites (fig. 11).

Work in progress

To move to a new phase of the research, it a cartographic map at a more detailed scale (1 : 500 or 1 : 1,000, rather than the available 1 : 10,000) would be necessary, as this is essential for the proper positioning of all archaeological features and for the creation of careful 3D models, as well as for exact measuring and spatial analysis.

However, to reconstruct the urban layout, it is necessary to plan new archaeological investigations, both survey and excavations. Survey should be aimed at generating more detailed knowledge of the various

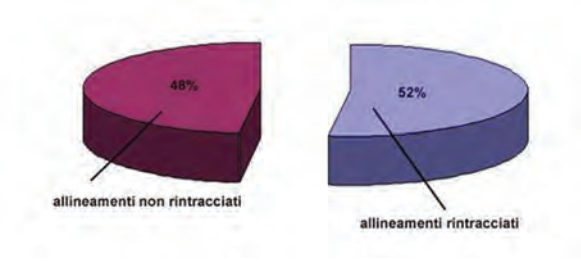

Fig. 8. Comparative reading of recognizable traces from aerophotogrammetric strips with those recognized by G. Schmiedt in the 1955 flight (Belvedere – Burgio 2012, fig. 69).

Fig. 9. Processing waste of pottery kilns, survey finds at contrada San Biaggio (Belvedere – Burgio 2012, fig. 133).

Fig. 10. Location of suburban villa at Piana di S. Gregorio (Belvedere – Burgio 2012, fig. 95).

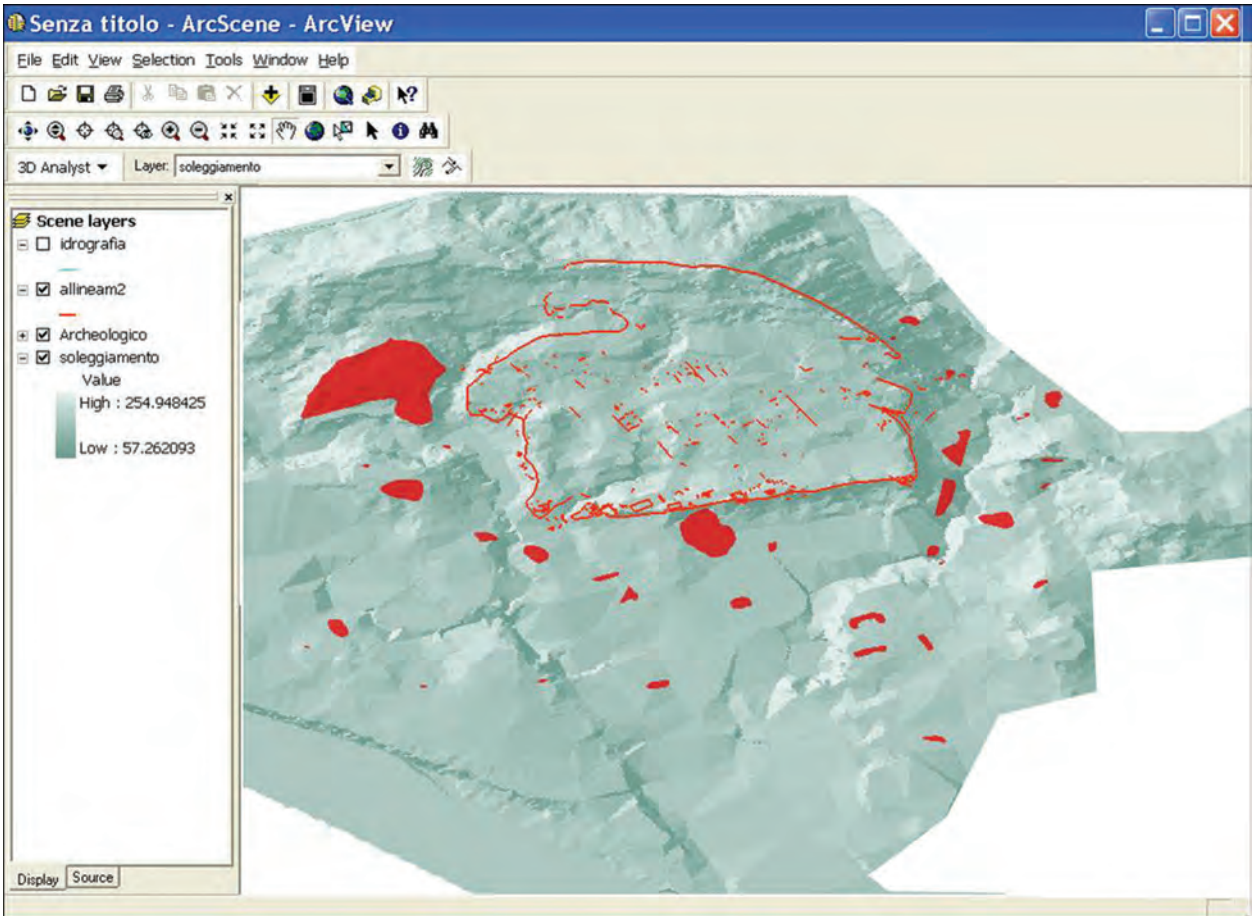

Fig. 11. Intervisibility of archaeological sites at Agrigento, ArcScene screenshot (O. Belvedere).

areas of the city, given the uneven level of existing archaeological data. To this end we need a controlled collection of finds in the urban area by sample areas, the potential result of which could permit the functional demarcation of different urban spaces on the basis of the artifacts visible on the ground.

Outside the ancient town, any future surveys should be aimed at understanding the relationship between the city and its suburbs, and how the town was related to the suburban structures, such as the cemeteries, the emporion, the suburban sanctuaries, and the agricultural and industrial facilities. The key issue in this regard is a more detailed reconstruction and identification of visible traces of the road system and of ancient trails, which can then be loaded as a separate layer in the GIS. We should then proceed to spatial analysis, in particular analyzing the intervisibility between urban and suburban sanctuaries and among the monuments of the necropolis and the urban areas. Bringing all these diverse data sources together will improve our understanding of the link between the city and the territory in antiquity, and help us understand the cognitive, symbolic, and ideal relationship between the urban and suburban landscape.

References

Alliata et al. 1988
V. Alliata – O. Belvedere – A. Cantoni – G. Cusimano – P. Marescalchi – S. Vassallo, Himera 3, 1. Prospezione archeologica nel territorio (Roma 1988).

Belvedere 1994
O. Belvedere, La ricognizione sul terreno, RTopAnt 4, 1994, 69–84.

Belvedere et al. 2002
O. Belvedere – A. Bertini – G. Boschian – A. Burgio – A. Contino – R. M. Cucco – D. Lauro, Himera III, 2. Prospezione archeologica nel territorio (Roma 2002).

Belvedere et al. 2009
O. Belvedere – A. Burgio – D. Lauro – M. A. Papa, Una rilettura topografica e urbanistica di Agrigento da dati aereofotografici. Metodologie e risultati preliminari, Archeologia Aerea 4, 2009, 209–218.

Belvedere 2011
O. Belvedere, La ricognizione di superficie. Bilancio e prospettive, RTopAnt 20, 2010, 31–40.

Belvedere 2012
O. Belvedere, Metodologie di indagine per la Carta archeologica e il Sistema Informativo Territoriale del Parco archeologico e paesaggistico di Agrigento, in: J. Bergemann (Hrsg.), Griechen in Übersee und der historische Raum, Göttinger Studien zur Mediterranen Archäologie 3 (Rahden/ Westf. 2012), 141–147.

Belvedere – Burgio 2012
O. Belvedere – A.Burgio (a c. di), Carta archeologica e sistema informativo territoriale del parco archeologico e paesaggistico della Valle dei Templi di Agrigento (Palermo 2012).

Campana 2006
S. Campana, DGPS e MobileGPS per l'archeologia dei paesaggi, in: S. Campana – R. Francovich (a c. di), Laser scanner e GPS: paesaggi archeologici e tecnologie digitali 1. Atti del workshop Grosseto 3 marzo 2005 (Firenze 2006), 214–217.

Schmiedt – Griffo 1958
G. Schmiedt – P. Griffo, Agrigento antica dalle fotografie aeree e dai recenti scavi (Firenze 1958)