

THE DIFFERENT METHODS TO DOCUMENT AND INTERPRET THE ARCHAEOLOGICAL SITES CONTAINING CART-RUTS

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ABSTRACT

The aim of this project is to document and interpret a number of archaeological sites containing cart-ruts and other related features. Landscapes with cart-ruts are known to exist in Sicily, Sardinia, Spain, Italy, Greece, France, but mostly in the Maltese Islands. The study of cart-ruts is critical for the understanding of past human interaction with certain landscapes across Europe and especially to comprehend the varied causes that created these features and how these evolved across space (Europe) and time (ancient till present). Two sites were chosen, one in Malta and another one in Spain. The site at Misrah Ghar il-Kbir, Malta, known for its rich archaeological remains, covers an area of about 250.000 square metres. The man-made interventions on the terrain indicate that the site constituted an important source of building stone, hence explaining, at least in part, the presence of such an elaborate and complex system of cart-ruts. Additionally, the site also supports a rich ecosystem of endemic flora and fauna. The terrain includes fields parcelled by rubble walls, vernacular structures and archaeological remains primarily cart-ruts, ancient quarries, tombs and cave dwellings.

The site in Spain is located in the village of Padul near Granada.

The project seeks to use state-of-the-art technology to document the cart-ruts and surrounding landscape found in the Maltese Islands and correlates the results with those collected from the Spanish site. This data will serve as the basis for the scientific study of these features which up to now have remained an enigma to distinguished authors who have tried to interpret them. So far, these attempts have been based on assumptions and limited scientific documentation and investigation. Unlike most sites which contain cart-ruts, the sites at Ghar il-Kbir, Malta and at Padul in Spain are still largely uncompromised by present development and may therefore shed new light and clearer evidence on the real use, function and date of the cart-ruts.

The first phase of this EU-funded project focussed on the development of suitable documentation techniques based on aerial and ground surveying systems which make use of photogrammetry and laser scanning techniques amongst others.

This documentation exercise will be followed by a restoration and conservation programme which will include the setting up of a user-interactive site interpretation scheme.

1. INTRODUCTION

The scope of this project – The Significance of Cart-Ruts in Ancient Landscapes, funded through the “Culture 2000” Framework of the European Union is to document and interpret a number of archaeological sites containing cart-ruts and other features of socio-cultural importance.



Figure 1. Project front page with logos of all entities involved in the project

This project is led by a consortium of Maltese stakeholders interested in the documentation, preservation, and interpretation of cart-rut sites which includes Heritage Malta, The Restoration Unit, the University of Malta and The Malta Environment and Planning Authority. The National Museum of Archaeology within Heritage Malta is responsible for the management of the Maltese Archaeological sites studied in this project, the Restoration Unit and the Malta Environment and Planning Authority possess the necessary expertise required for the documentation and presentation of the sites, while the Faculty of Archaeology within the University of Malta is providing the necessary academic expertise to ensure a valid contribution of all partners. The co-partners include APORTECO of Spain responsible for the management of the cart-rut site at the Caminos de los Molinos in Padul and the University of Urbino which boasts of a multi disciplinary pan-European team of experts specialised in the development of techniques for the documentation of archaeological sites similar to those found in Malta and Spain.

This one-year project commenced in October 2004. The first phase focussed on the development of suitable documentation systems based on aerial and ground surveying techniques. This was achieved by drawing on the vast experience acquired by the University of Urbino and through the knowledge of experts from Malta and Spain. The systems developed make use of photogrammetry, and laser scanning techniques. The second phase concentrated on the collection and elaboration of the data obtained from the two sites. This was carried out in the laboratories of the University of Urbino, The Restoration Unit

and the Malta Environment and Planning Authority. Experts will meet in Malta and Spain during the eighth and ninth month of the project to discuss the data collected and evaluate the results. The studies and findings will be disseminated to the public on two levels: academic and popular. Animations generated by this exercise will be distributed on the Internet and other forms of media. The sites studied in this project will feature on educational programmes which will be aired on the media of the countries participating in this project. A monograph of the study will also be published. Travelling exhibitions will be organised in European countries known to contain cart ruts with the aim of promoting the importance of similar sites and increasing awareness which to-date is quasi-inexistent.

The project seeks to use state-of-the-art technology to document the cart-ruts and landscape of Misrah Ghar il-Kbir in Malta and correlate the results with those collected from the Padul cart-ruts site in Spain. This scientific data will serve as the basis for the study of these features which up to now have remained a mystery.

2. PROJECT DESCRIPTION

Landscapes with cart-ruts are known to exist in Sicily, Sardinia, Spain, Italy, Greece, France, but mostly in the Maltese Islands. The study of cart-ruts is critical for the understanding of past human interaction with certain landscapes across Europe, especially to comprehend the varied causes that created these features and how these evolved across space (Europe) and time (ancient till present).

Two sites were chosen; one in Malta and another one in Spain. The site in Malta is located at Misrah Ghar il-Kbir, covering an area of about 250.000 square metres (fig. 2). The site is rich in historical and archaeological features and merits to be documented. Additionally, the site also supports a rich garigue ecosystem of typical and rare flora and fauna. The site is articulated by fields parcelled by rubble walls, vernacular structures and archaeological features that include cart-ruts, ancient quarries, tombs and cave dwellings.(fig.3).

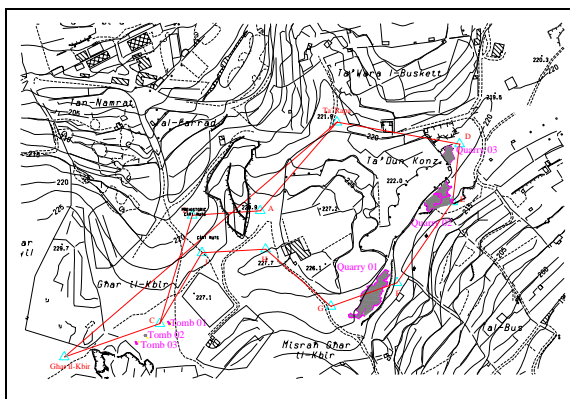


Figure 2. Archaeological Site Misrah Ghar il – Kbir - Rabat in Malta



Figure 3. Misrah Ghar il – Kbir - The different areas surveyed with laser scanning techniques

The site in Spain is located in the village of Padul near Granada (fig. 4). The area is known for its ancient flourmills as well as for a number of archaeological features including cart-ruts.



Figure 4. Archaeological Site Camino des los Molinos – Padul – Granada - Spain

The project aims at achieving various objectives. It lends itself as a source of debate bringing cultural heritage within the public domain whilst addressing the role of culture in the socio-economic development of the country. The project is also envisaged to promote good practices in sustainable conservation, integrated heritage management and networking between stakeholders at both local and pan-European levels.

The aim of documenting these two sites is to highlight common cultural characteristics of European significance, and to promote dialogue between European academics, locals and visitors, encouraging creativity, exchange and dissemination of interpretative thought about a subject which would have otherwise remained an enigma. Cart-rut sites are still widely misapprehended and consequently are often under threat from urban sprawl. Through a deeper understanding, cart-ruts may become a more understandable cultural component of Europe's rich archaeological heritage. Moreover, similar sites in Europe can become official heritage sites due to their increased archaeological importance and popularity and therefore generate income, which would be re-invested for their protection.

A number of long-term benefits will be derived from this project. The documentation and interpretation exercise will be followed by a conservation programme which will include the restoration of the rubble walls, rural features and structures set within the rural landscape of the two sites. It is envisaged that the study will give a complete evaluation and assessment of cart-ruts facilitating comparative studies with identical landscapes found in Europe and other countries. An on-going management programme of the two sites will be formulated to help visitors relate to the natural and archaeological features of the terrain.

3. THE DOCUMENTATION OF THE SITES

The basic idea behind preserving and enhancing the value of cultural wealth is respect, not only for the work of art, but also for the closely associated historical data encapsulated. Ancient sites, in fact, nearly always appear as stratified palimpsests, difficult to interpret. If we assess them from a formal point of view only, we can run the risk of taking only their final evolution into account, losing enormous cultural wealth. It is only by correctly documenting these sites that we can appreciate the diachronic complexity of this archaeological heritage enabling us to preserve and hand down this patrimony unharmed to future generations.

Command of the site is tightly related to the critical use of the technical and working instrumentation available. These are designed to compliment the analytical study of the terrain and insert themselves within the methodological programme devised for the preservation of the site.

The digital tools which are available today allow us to make interactive representation models which can provide the restorer with a continuous archive of both qualitative and quantitative information.

In the management of works on an architectural complex, the development of three dimensional models based on laser scans serve to provide the preliminary basis for the development of specialised data banks, associated with the various disciplines involved in the knowledge acquisition phase which normally preceeds a restoration project.

The first level of information indisputably concerns size. It is a critical operation involving the selection of points and gathering of metric data which can then be processed and refined according to the needs of the various kinds of analyses.

For a project involving preservation and value enhancement, surveying provides the analytic and diagnostic sector with information which is not only of a geometrical nature, but which concerns also the deterioration of materials, its localisation and quantification.

The representation of the geometrical survey of a site, now directly available in a numerical form thanks to the current systems of topographic and photogrammetrical surveying, from the most sophisticated to the simplest, becomes the cartographic basis and the method for geo-referencing every kind of information.

Three-dimensionality offers various representation opportunities. Amongst other applications, the model can be used by the conservator to map and/or simulate phenomena of decay as well as a geo-referencing tool for non-geometrically related information.

In recent years, digital techniques have given a strong impulse to knowledge acquisition processes in this field. These range from techniques developed to build photographic models based on the use of QTVR (Apple QuickTime VR) processing software. This process entails the stitching of a sequence of photo images on a cylindrical surface enabling the user to carry out 360° extended and uninterrupted interactive observations. The major drawback of such QTVR products is that they do not provide metric information, and only permit a visual exploration and “diving” by the user into the scene, without permitting any acquisition of data.

By associating architectural surveying procedures, particularly, photogrammetrical and topographical techniques, with laser scanner bearing processes, one can obtain a tool equally effective in representing fixed or animated synthetic images, structuring data and representing knowledge, and supporting information management system.

This project entails the documentation of complex archaeological relics. By their very nature, cart-ruts are irregularly-shaped shallow channels excavated in the rugged terrain, at times indiscernible to the untrained eye. In the case of the Maltese site this complexity is even more critical as these cart-ruts coexist with other archaeological remains comprising

Roman-Punic tombs, Roman quarry sites, remains of troglodytic settlements and dry rubble wall constructions.

The documentation methodology for these sites was intentionally developed to fulfil two distinct exigencies. On one hand, it was necessary to document the territories in their complexity at a cartographic level, while on the other hand it was essential to document important characteristics at scales ranging from 1:200 to 1:50. The methodology adopted for this project integrates various techniques enabling the generation of a three-dimensional model which will form the basis for the various studies undertaken by the multidisciplinary team of experts analysing the sites.

The large-scale representation of the two sites is based on the cartographic information available for the two countries; Malta and Spain. The DTM (Digital Terrain Model) of the two areas of studies was obtained from the elaboration of this data by adopting meshes whose intensity was varied to reflect the complexity of the site and detail intensity. The tracks were then traced from orthophotos generated for the sites. This restitution was carried out by experienced photogrammetrists using analytical stereo plotters. The resulting model, essential to facilitate the legibility of the terrain provided the skeleton for the inclusion of the more-detailed surveys undertaken for the more important areas of the site (fig. 5)

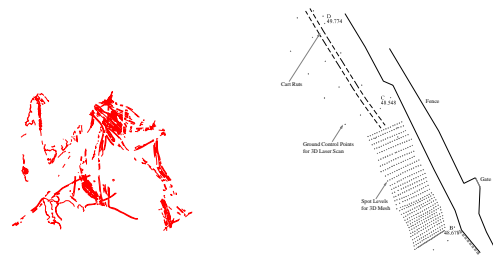


Figure 5. Misrah Ghar il-Kbir and Caminos des los Molinos – trace of Cart-Ruts obtained by the restitution of aerial photographs.

Laser scans of the irregular terrain and rectified images of the flat quarry sites obtained by unconventional digital photogrammetric techniques were employed for the more detailed surveys.

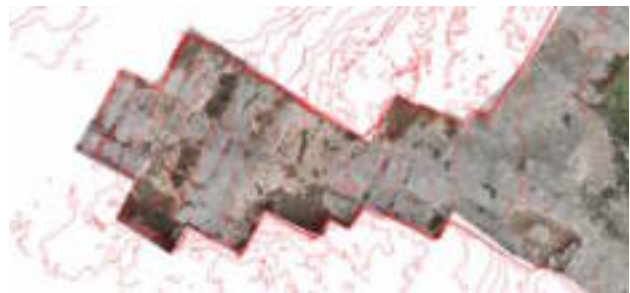


Figure 6. Misrah Ghar il-Kbir - Orthophoto map with contours lines obtained by laser scanning

4. LASER SCANNING DOCUMENTATION

The Leica HDS 2500 laser scanner was used for the documentation of both sites. This scanner uses time of flight technology, has a range of 100m (optimum performance 1-50m) and a horizontal and vertical angle of view of 40°. When working within a range of 1.5m to 50m from the object, the scanner can reach a precision of ± 6mm. The minimum distance between each point is 0.25mm in both horizontal and

vertical directions with scanning capabilities of a maximum of 2000 and 1000 points in the respective directions. The Leica HDS 2500 reaches a scanning velocity of one column per second for a resolution of 1000 points or two columns having a resolution of 200 points per second.



Figure 7. The Leica HDS 2500 laser scanner being used on site at Misrah Ghar il-Kbir, Malta.

Laser scans were used at Misrah Ghar il-Kbir to document a number of features considered of significant archaeological importance. These included Roman-Punic tombs, caves, old quarries and cart-ruts. In all, around 105 scans were carried out, acquiring a cloud of more than 50 million points at a resolution of around 10 millimetres. Most of the scans were carried out from ground level; however significant information was obtained from higher levels with the scanner mounted on scaffold platforms and tower ladders.

A number of targets detectable by the laser scanner were used to facilitate the automatic superimposition of the different scans during the elaboration of the data. This stitching procedure was further facilitated by the correlation of homologous points identifiable in the overlap of adjacent scans.

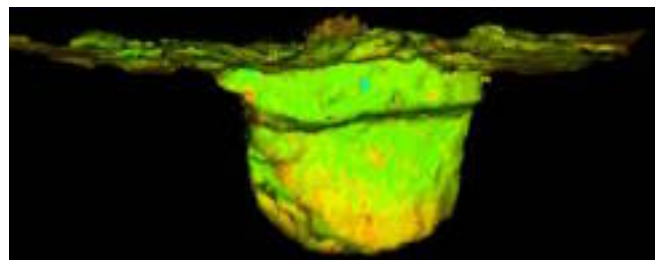
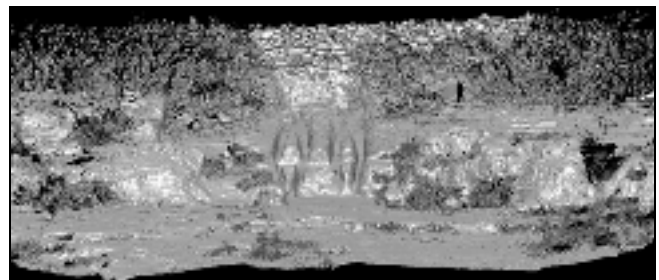
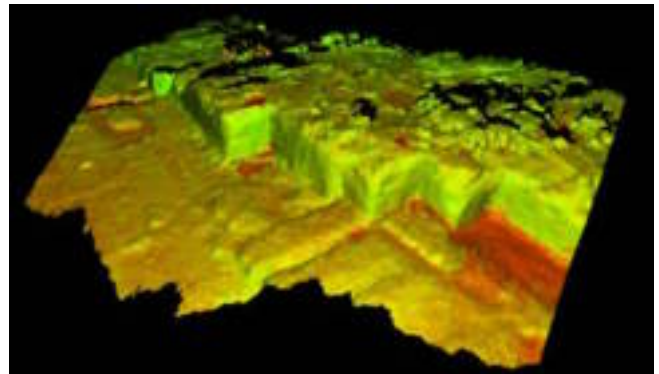
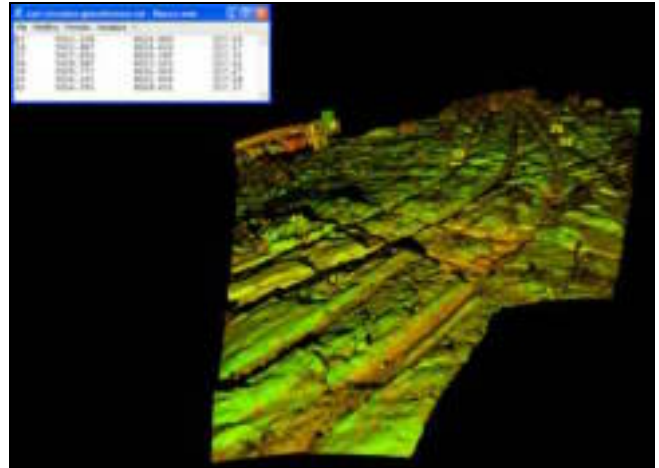
Complimentary to this, a detailed topographic survey of the site was carried out enabling the geo-referencing of the cloud of points by collimating the targets used in the scanning procedure. The archaeological site at Caminos des los Molinos near Granada is significantly smaller and less complex than that in Malta. To this end, the survey focussed primarily on the area of terrain immediate to the pair of cart-ruts traversing the landscape. In an effort to increase the legibility of the shallow ruts incised in the rough landscape and eliminate any shadows which could negatively affect the quality of the end product, most of the scans were executed from a mobile elevated platform mounted approximately 10m above ground level.



Figure 8. Surveying of cart-ruts at Caminos des los Molinos

Fifteen scans were affected to produce a cloud of around 10 million points.

The scans were scrupulously cleaned from any unimportant information and all files were stitched without decimating any of the raw data. The coordinates acquired by topographic means were used to geo-reference the cloud of points.



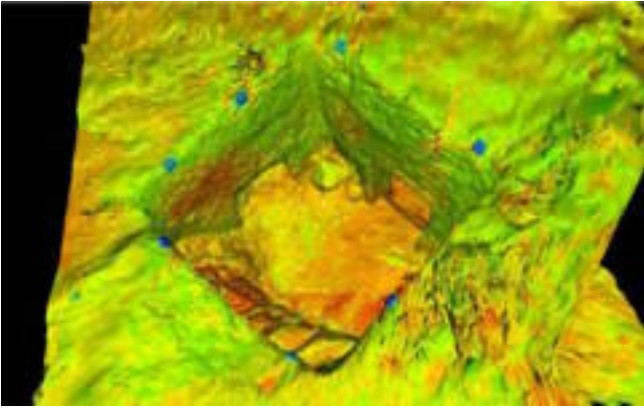


Figure 9. Triangulated model of a different areas at Misrah Ghar il-Kbir

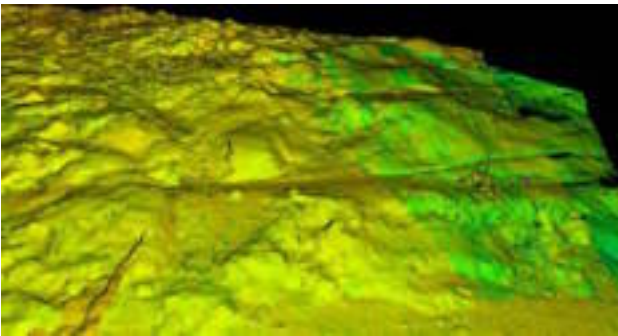


Figure 10. Triangulated model of a section of the site at Caminos des los Molinos

The model facilitated the production of graphical representations such as sections and contoured representations of the terrain providing the team of experts with new tools to help them understand better the context of these archaeological phenomena.

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