

ICOA908: INNOVATIVE METHODS FOR DIGITAL HERITAGE DOCUMENTATION: THE ARCHAEOLOGICAL SITE OF KYMISSALA IN RHODES

Subtheme 03: Protecting and Interpreting Cultural Heritage in the Age of Digital Empowerment

Session 1: Relevance of Digital Tools & Technology in Documentation, Conservation and Safeguarding
of Heritage & Community Engagement

Location: Silver Oak 2, India Habitat Centre

Time: December 13, 2017, 14:30 – 14:45

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Prof. Andreas Georgopoulos teaches Photogrammetry and Monument Documentation since 1980 in NTUA and as visiting professor in KULeuven (RLICC), CUT and the Aegean University. He is an Executive Board member, Secretary General (2010-2014), and currently President of CIPA-Heritage Documentation. He has participated in numerous research projects concerning Digital Photogrammetry and Monument Documentation. Vice President of the Research Committee of NTUA. He published more than 250 scientific papers in international journals and conference proceedings on cultural heritage 3D modeling, automation and contemporary digital techniques.

Abstract: The evolution of the contemporary information and communication technologies (ICT) has marked dramatic progress in the field of digital documentation of Cultural Heritage, tangible or intangible. These technological advances have greatly contributed to bridging the gap between experts and the public. Today's possibilities of digital data acquisition, but also the mentality of interdisciplinary approach to the highly important topic of preserving our Cultural Heritage, lead to the production of attractive digital base material in two or three dimensions which provide the necessary accuracy and detail for each case.

The 10 square kilometre area of the ancient Demos of Kymissala with a continuous history of 1300 years, lies approximately 70 km southwest of the city of Rhodes, in a wild and mountainous environment, covered with dense forests making it difficult to access but also characterizing it as a NATURA 2000 protected rural landscape. For the local community and the visitors to get to know the site, special visits are organized.

In this paper we use contemporary methods and innovative tools for producing the means to help bridge that gap. They are briefly presented and critically evaluated, based on the ten-year practical experience for the detailed digital geometric documentation of the acropolis, the necropolis and a major settlement in Kymissala, supporting the archaeological research of the University of the Aegean and the Ephorate of Antiquities in the area.

Apart from the classical 2D and 3D documentation products, the development of a virtual 3D environment is attempted to serve in a multitude of ways, firstly, to contribute to the education of

younger generations to get familiar with the site and secondly to enable interested visitors to admire the cultural and natural beauties before actually visiting Kymissala. These products are critically presented and evaluated.

Key words: *digital resources, interpretation, dissemination, accessibility*

Introduction

Cultural Heritage, tangible or intangible is recognized by all civilized countries of the world as the most important carrier of historical memory for mankind. However, as it is not respected and protected as it should it is in great danger and it may be destroyed, lost, altered, forgotten for a number of reasons.

The ideal way to protect Cultural Heritage is to constantly take care of it through certain protective actions. Such necessary actions, as dictated by the numerous International Conventions adopted by UNESCO, ICOMOS and other bodies are:

- Documentation, (2D and/or 3D) for archiving, for studies, for planning protective interventions etc.
- Accurate measurements, suitable for restoration, reconstruction, structural studies, protection etc.
- Monitoring, involving recording deformations, condition assessment etc.
- Proper Data Management for sustainability, risk management etc.
- Preservation possibilities especially suited for fragile objects (e.g. libraries etc.)
- Public Outreach, involving visualization, dissemination, raising public awareness etc.

Information Communication Technologies at the Service of Cultural Heritage

To this end, contemporary methods are a great tool, as they enable rapid, accurate and reliable data acquisition, management and storage. Nowadays, the rapid advances of Digital Technology (DT) also referred to as Information Communication Technologies (ICT), have provided scientists with new powerful tools to acquire, store, process, manage and present any kind of information in digital form. This may be done faster, more completely and it may ensure that this information may be easily available for a larger base of interested individuals. Those digital tools include instrumentation for data acquisition, such as scanners, digital cameras, digital total stations etc., software for processing and managing the collected data and computer hardware, for running the software, storing the data and presenting them in various forms.

The integrated documentation of monuments includes the acquisition of all possible data concerning the monument and which may contribute to its safeguarding in the future. Such data may include historical, archaeological, architectural information, but also administrative data, past drawings, sketches, photos etc. Moreover, these data also include metric information which defines the size, the form and the location of the monument in 3D space and which document the monument geometrically. The geometric documentation of a monument, which is an integral part of the integrated documentation of Cultural Heritage may be defined as the action of acquiring, processing, presenting and recording the necessary data for the determination of the position and the actual existing form, shape and size of a monument in the three-dimensional space at a particular given moment in time¹.

¹ (UNESCO, 2003).

The archaeological sites of the ancient Deme of Kymissaleis

The ancient *Deme of Kymissaleis* in Kymissala is situated at the south-west part of Rhodes, north of mount Akramitis, extending between the modern localities of the villages Sianna and Monolithos. It is a large geographical archaeological site which incorporates settlements, acropolis, fortresses, graveyards, burial monuments, quarries, springs, and a system of roads that reflect social stratifications and establishments in a vast chronological period, starting from the late Mycenaean period until Late Antiquity. The sites of Kymissala have been investigated by the Department of Mediterranean Studies and the Ephorate of Antiquities of the Dodecanese since 2006, with the participation of the NTUA since 2007, in the context of the “Kymissala Archaeological Research Project (KARP)” of the University of the Aegean.²

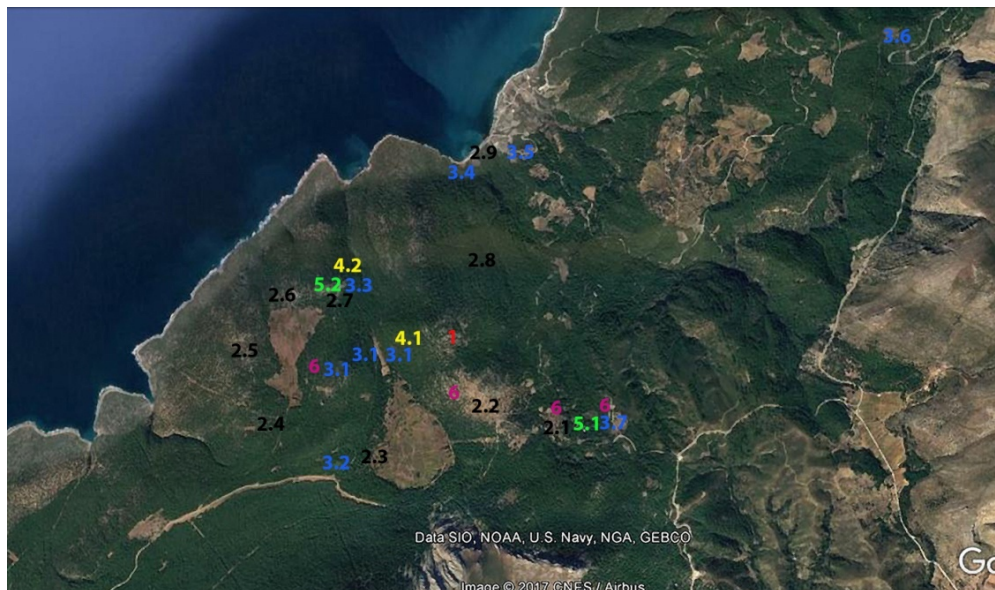


Fig.1– The archaeological sites of Kymissala investigated by the KARP:

1 ACROPOLIS. 2 SETTLEMENTS/INSTALLATIONS: 2.1 Stelies; 2.2 Marmarounia; 2.3 Kampanes; 2.4 Unidentified location west of the hill of Kymissala; 2.5 Atoumas hill; 2.6 Vassilika; 2.7 Napes; 2.8 Charakas/Amelantrou; 2.9 Glyphada/Monossyria. 3 CEMETERIES: 3.1 The Necropolis of Kymissala (Sectors I, III, IV); 3.2 Kampanes; 3.3 Napes; 3.4 Glyphada/Oglyma; 3.5 Glyphada/Hagios Georgios; 3.6 Pouggas; 3.7 Alonia. 4 QUARRIES: 4.1 Hagios Phokas; 4.2 Napes; 5 OTHER SITES: 5.1 Spring; 5.2 Fort; 6 ANCIENT ROAD (KARP, background Google Earth 2017).

The approximately 10 square kilometers’ area of the ancient deme of Kymissaleis with a continuous history of more than 1500 years, has been thoroughly investigated by organized walking expeditions to discern the relationship between geography, spatial development, urban organization and political division, as well as to elucidate the ways in which collective settlements form and how they inter-relate. So far, many sites have been identified (fig.1) including a walled acropolis at the hilltop of Hagios Phokas, dominating two fertile basins on east and west. Nine settlements of various sizes extend around the Acropolis, with the one at the site of Vassilika being by far the best preserved and the most interesting, and two major necropoleis seem to serve the two distinct basins: the central necropolis of Kymissala and the necropolis at Glyphada/Oglyma, with many smaller cemeteries near the various

²(Stefanakis, 2009); (Stefanakis and Patsiada, 2009-2011); (Stefanakis, 2015); (Stefanakis *et al.*, 2015); (Stefanakis, in print).

settlements. A small fort on the hilltop of Napes, two major quarrying areas, and a possible ancient fountain have also been identified, while part of a network of roads connecting sites has been located.³

Within this framework of sites, the KARP has focused on three major sites so far: the hilltop of Hagios Phokas, the necropolis of Kymissala and the site of Vassilika.⁴ The central necropolis of Kymissala is quite extensive. Excavation has been carried out in sectors I and III, bringing to light mainly chamber tombs dug in the rocky slopes of the hills of Hagios Phokas and Kymissala dating from the late seventh century BC to Late Antiquity. Some of them are quite large and elaborate, while grave monuments and inscribed pedestals have been cleaned and recorded in sector IV.⁵



Fig.2– Hagios Phokas (Acropolis), fortifications (KARP. Drawing after Maiuri 1916, 290, fig. 7).

The Acropolis on the hilltop of Hagios Phokas⁶ is fortified and at the top there lies a small Hellenistic temple of the third-second century BC.⁷ The fortification (fig.2), which runs all around the hilltop, is elaborate on the west side, where a part of the wall, preserved at a length of approx.18 m and reaching 3 m in height shows an elaborate stonework, dated to the fourth-third century BC.⁸

Of special interest is the site of Vassilika (fig.3), where a settlement is preserved, severely damaged, probably by an earthquake, and heavily looted during the last centuries by villagers collecting building material. Among the preserved ruins substantial remains of ancient buildings are observable, including a shrine, domestic quarters, and parts of a strong perimeter wall of polygonal masonry, forming part of a carefully planned settlement.⁹

³(Stefanakis and Patsiada, 2009-2011: 64-67); (Stefanakis 2015: 48-51);(Stefanakis *et al.*, 2015:263-265); (Stefanakis, in print).

⁴(Stefanakis and Patsiada, 2009-2011: 72);(Stefanakis *et al.*, 2015:265).

⁵(Stefanakis and Patsiada, 2009-2011: 76-86);(Stefanakis 2015: 55-60);(Stefanakis *et al.*, 2015: 266-283); (Stefanakis, in print); (Patsiada, in print);(Dreliosi-Heraklidou and Litinas, in print).

⁶(Stefanakis, in print); (Stefanakis and Patsiada, 2009-2011: 72-76); (Stefanakis 2015: 52-55); (Stefanakis *et al.*, 2015: 265-266).

⁷(Stefanakis and Patsiada, 2009-2011: 72-74); (Stefanakis 2015: 52-53); (Stefanakis *et al.*, 2015:265).

⁸(Stefanakis and Patsiada, 2009-2011: 74-76); (Stefanakis 2015: 53-55); (Stefanakis *et al.*, 2015:265-266).

⁹(Stefanakis and Patsiada, 2009-2011: 88-901); (Stefanakis 2015: 50-51); (Stefanakis, in print).



Fig.3– Vassilika, settlement (KARP).

Bridging the Gap

For many decades the geometric documentation has been the responsibility of experts concerned with the care of the Cultural Heritage, who belonged to the field of archaeology and architecture. However, over the past decades more and different specialists developed an interest in the monuments, as they were definitely able to contribute to their study, maintenance, and care. Among them are surveyors, photogrammetrists, and geomatics engineers, as the technological advances have enabled them to produce interesting, alternative and accurate geometric documentation products¹⁰. Today the mentality is gradually changing and traditionally involved experts tend to accept and recognize the contribution of other disciplines to Cultural Heritage. Hence it is rapidly becoming an interdisciplinary and intercultural issue.

Nowadays Geomatics science and digital technology can support the work of the archaeologists in many ways. It is apparent that all stages of common and conventional archaeological practice may be positively affected by the introduction and exploitation of Digital Topographic Technologies. Contemporary survey technologies, such as photogrammetry, terrestrial laser scanning, and digital imaging, may be used to produce accurate base maps for further study, or 3D virtual renderings and visualizations, as already mentioned. The collected data may be stored in interactive databases, georeferenced or not, and managed according to the needs of the experts.

In all three above mentioned sites of interest, the Laboratory of Photogrammetry of NTUA has carried out detailed digital geometric documentation, supporting the archaeological research of the University of the Aegean and the Ephorate of Antiquities in the area and implementing exactly this mentality of interdisciplinarity. This cooperation serves a two-fold aim. On one hand, the responsible archaeologists receive complete and accurate digital documentation products and on the other young Geomatics students are exposed to contemporary techniques applied to archaeology and introduced to interdisciplinarity and communication with cultural heritage experts.

The photogrammetric methodology has been applied extensively during the past ten years in the Kymissala archaeological site. The following examples are selected to demonstrate the main possibilities.

¹⁰(Georgopoulos, 2017).

All products have been referenced to a common reference system established in the area in the form of a network of trigonometric points, whose coordinates have been determined using GPS measurements and a network adjustment. During this establishment of the network, an archaeological map was also compiled to serve as a broad overview of the site.

For reasons of grasping the Kymissala archaeological area, extending in a mountainous and mostly wooded region interspersed with cultivated fields, mostly vineyards, color aerial photography was used to produce an orthophotograph of the whole region. Two strips of four images each were available at a scale of 1:10000 covering the area. Several control points were determined using accurate GPS measurements to orient the images and produce a dense Digital Terrain Model (DTM) with the help of which the final orthophotos were produced, which in turn were combined into the final orthophoto mosaic. It is obvious that that kind of map product is an indispensable tool for the management and planning of interventions in the area as it has all metric advantages of a conventional map, but also carries the valuable photographic qualitative information.

Detailed documentation products, at a much larger scale, have been produced in the last ten years. As a first example, two of the many graves in the eastern necropolis were documented using a full combination of the available digital methods. These data acquisition methods resulted in an extensive geometric documentation of the graves both in 2D and in 3D. In addition, the wall of the Acropolis has also been documented (Fig.4).

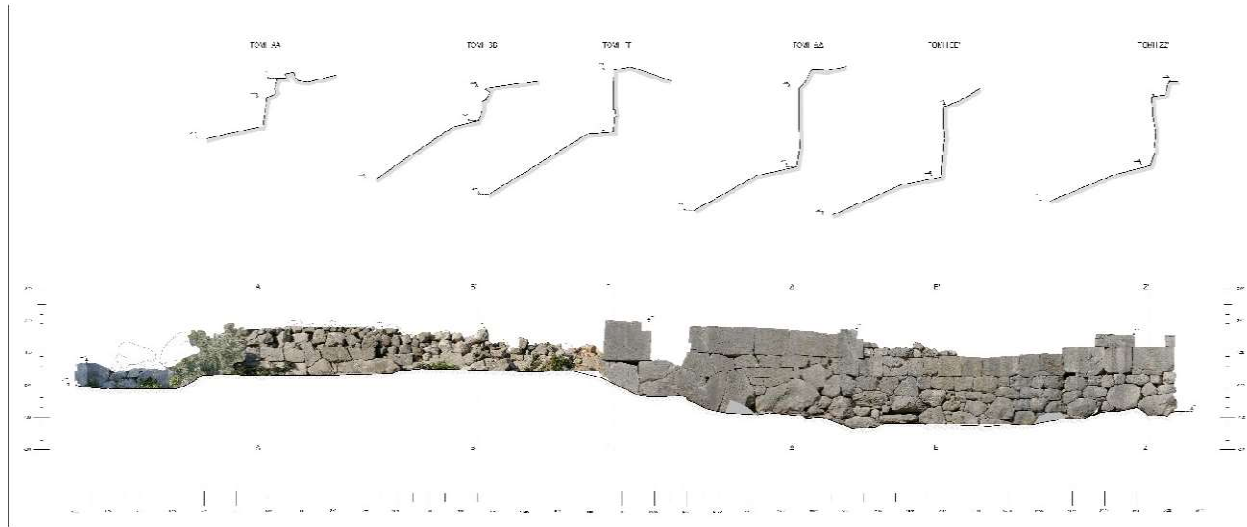


Fig.4– The Wall of the Acropolis of St. Phokas

The area of the Vassilika is a destroyed settlement, where one may easily recognize the urban network in the form of house footprints and vague street borders. All this area is covered with stones of any size and for its excavation, a detailed record at a large scale (1:50) is of utmost importance. For seven consecutive campaigns, vertical photography using a specially developed mega-tripod was acquired from a height of 7.50 m using a normal DSLR digital camera. In addition, in 2013 an Erasmus IP was organized in the area by NTUA¹¹ and images from two UAV's were also obtained at a small scale, able to produce orthophotos at scales of 1:200. Finally, in our Lab's last year of involvement, a thorough aerial photographic coverage from an octocopter lifting a full frame DSLR was carried out. All these data were processed accordingly

¹¹(Acevedo Pardo *et al.*, 2013).

and the products in the form of orthophotos at scales 1:2000 and 1:50 were given to the archaeologists in charge (Fig.5).



Fig.5– The orthophoto mosaic of the road network in the Vassilika area overlaid on the 1:200 orthophotos

The examples presented above were all compiled by 4th year surveying students of the NTUA. Within the framework of their practical exercise, they elect a summer course called Photogrammetric Summer Practice. Within the framework of the cooperation with the University of the Aegean, 10-15 students are hosted in the Kymissala area every year with the indispensable support of the local Authorities of Rhodes. They work for about 2 weeks in situ acquiring data for the implementation of contemporary topographic techniques, to document the archaeological area. In this way, they are given the opportunity to exercise under real working conditions and contribute to the production of the necessary base products for the continuation of the archaeological research on this site.

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List of Figures

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Fig.3– Vassilika, settlement (KARP).

Fig.4– The Wall of the Acropolis of Hagios Phokas.

Fig.5– The orthophoto mosaic of the road network in the Vassilika area overlayed on the 1:200 orthophotos.

ICOA908: MÉTHODES INNOVANTES POUR LE PATRIMOINE NUMÉRIQUE DOCUMENTATION: LE SITE ARCHÉOLOGIQUE DE KYMISSALA A RHODES

Sous-thème 03: Protéger et interpréter le patrimoine culturel à l'ère de l'autonomisation numérique

Session 1: Pertinence des outils numériques et de la technologie dans la documentation, la conservation et la sauvegarde du patrimoine et l'engagement communautaire

Lieu: Silver Oak 2, India Habitat Centre

Date et heure: 13 Décembre, 2017, 14:30 – 14:45

Auteur: A. Georgopoulos, S. Tapinaki, M.I. Stefanakis

Le professeur Andreas Georgopoulos enseigne la photogrammétrie et la documentation des monuments depuis 1980 à NTUA et comme professeur invité à la KULeuven (RLICC), à la CUT et à l'Université Egée. Il est membre du Conseil exécutif, secrétaire général (2010-2014) et actuellement président de la documentation CIPA-Heritage. Il a participé à de nombreux projets de recherche sur la photogrammétrie numérique et la documentation des monuments. Vice-président du comité de recherche de NTUA. Il a publié plus de 250 articles scientifiques dans des revues internationales et des actes de conférences sur la modélisation 3D du patrimoine culturel, l'automatisation et les techniques numériques contemporaines.

Résumé: L'évolution des technologies contemporaines de l'information et de la communication (TIC) a marqué des progrès spectaculaires dans le domaine de la documentation numérique du patrimoine culturel, matériel ou immatériel. Ces progrès technologiques ont grandement contribué à combler le fossé entre les experts et le public. Les possibilités actuelles d'acquisition de données numériques, mais aussi l'approche interdisciplinaire sur le sujet très important de la conservation de notre patrimoine culturel, conduisent à la production de données de base numériques attractifs en deux ou trois dimensions qui fournissent la précision et le détail nécessaires.

La zone de 10 kilomètres carrés de l'ancienne Demos de Kymissala avec une histoire continue de 1300 ans, se trouve à environ 70 km au sud-ouest de la ville de Rhodes, dans un environnement sauvage et montagneux, couvert de forêts denses qui la rendent difficile d'accès et qui la caractérisent comme un paysage rural protégé NATURA 2000. Pour que la communauté locale et les visiteurs puissent connaître le site, des visites spéciales sont organisées, car la zone n'est pas encore

Cette présentation explore l'utilisation de méthodes contemporaines et des outils innovants pour aider à combler ce fossé. Elles sont brièvement présentées et évaluées de manière critique, sur la base d'une expérience pratique d'une décennie de la documentation géométrique numérique détaillée de l'acropole, de la nécropole et d'un établissement important à Kymissala, soutenant la recherche archéologique dans le secteur par l'Université de l'Egée et l'Ephorie des Antiquités.

Outre les produits habituels de documentation 2D et 3D, une tentative de développement d'un environnement 3D virtuel est en cours pour servir de multiples façons. Premièrement, pour contribuer à l'éducation des jeunes générations et se familiariser avec le site. Deuxièmement, pour permettre aux

visiteurs intéressés d'admirer les beautés culturelles et naturelles avant de visiter réellement Kymissala. Ces produits sont présentés et évalués de manière critique.

Mots-clés: *ressources numériques, interprétation, diffusion, accessibilité*