

## A LONG-TERM RESPONSE TO THE NEED TO MAKE MODERN DEVELOPMENT AND THE PRESERVATION OF THE ARCHAEO-CULTURAL RECORD MUTUALLY COMPATIBLE OPERATIONS: THE GIS CONTRIBUTION

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#### ABSTRACT:

The paper discusses the definition of a framework of principles for the management of regions of archaeo-cultural value, which are destined to sustain modern development. Kouklia-Palaepaphos in SW Cyprus, where a three-year pilot project is taking place, is an extensive archaeological region, rich in sensitive anthropogenic data, which lacks a management plan that would render the preservation and enhancement of its archaeological resources, and its economic development, mutually compatible operations. The project combines, (a) geophysical surveys (extensive coverage) and excavations (small-scale in high risk plots); (b) production of a 3D digital land relief of the archaeological zone, with current property and land-use status; (c) development of a multidimensional digital platform using GIS, which will combine cartographic information with archaeological data, organised on a relational database. The final product is an electronic macro-scale management and planning tool for the region, which can be continuously annotated. As such, it is an invaluable policy- and decision-making tool for various state authorities. More importantly, development agencies will be able to consult it, and employ it as the basis for a micro-scale archaeological investigation of the area they plan to develop, which ought to become de facto the initial stage of any private or public project. What a developing agency will invest, in terms of time and money, by funding the archaeological investigation of the area that is meant to undergo development would be minimal compared to (a) the total investment budget and (b) the cost of unforeseen delays caused by rescue operations that may in the end lead to a demand for substantial modifications of final plans after the construction phase has begun. The above application is meant to heal an open wound caused by a clash of interests between modern development and the preservation of archaeo-cultural data. This clash has had negative repercussions on many socio-economic, industrial (construction and tourist industries), cultural and environmental issues. Cyprus is in need of a more effective preservation policy that will protect: (a) the archaeo-cultural record and (b) the taxpayer from a serious waste of public funds. It ought to be underlined that different versions of the proposed methodology have been the modus operandi of heritage management authorities in Europe and the United States for decades.

### 1. INTRODUCTION

#### 1.1 Background information on the Palaepaphos Pilot Project

Kouklia-Palaepaphos on the SW coast of Cyprus is an extensive yet insufficiently defined archaeological landscape. How this landscape was organised in antiquity, and especially how it was utilised by different urban components in the second and first millennia BC, is to this day poorly understood. Its few visible secular and sepulchral monuments and its famous open-air sanctuary to an aniconic deity, who was to become known as Aphrodite, are scattered over an area of two square kilometres. Since they are spatially isolated from each other, the temporal and institutional relationship and the physical communication of the secular and sepulchral monuments with the great sanctuary are issues requiring consideration (Fig. 1).

Palaepaphos continues to provide ample scope for the identification of its urban model in antiquity because it holds

untapped but endangered sources of archaeological information. One may still locate 'windows' that afford direct access to monuments of a period when the area held the administrative capital of an Iron Age kingdom. There is also evidence of Late Cypriote occupation, from the time when the same area had been chosen for the foundation of an *emporium* that facilitated the export of copper from the region of Paphos. It was from this gateway community that the coastal settlement of Paphos grew into one of the island's first regional polities around the 13<sup>th</sup> century BC.

The reason behind this rarely observed direct accessibility to settlement strata of the golden era of the Cypriote kingdoms (i.e. Cypro-Achaic and Cypro-Classical periods) is related to the move away of port facilities and administrative functions to Nea Paphos sometime in the fourth century BC. The urban landscape of Paphos, from then on referred to as Old Paphos (Palaepaphos) began to shrink as secular units of the kingdom's original capital were being abandoned. Only the sanctuary

continued to receive attention and, in fact, during the Hellenistic and Roman eras, its direct environs were heavily remodelled to accommodate the needs of pilgrims. Thus, the rest of the town appears to have been spared the kind of extensive public projects that have obliterated (with the construction of gymnasia and theatres) the better part of the Archaic and Classical landscape of other Cypriot urban centres (e.g. Salamis, Amathous and Kourion).



Figure 1. Visible Monuments of the Kouklia-Palaepaphos area

With the advent of Christianity, Palaepaphos also lost its religious significance. By the Frankish period, it had become an agricultural community within the feudal estate of the royal family of the Lusignan. The agricultural character of the community, known since as Kouklia, was retained virtually unchanged throughout the Venetian, Ottoman and British rule; nor did it change to any considerable degree during the first decade after Independence (1960).

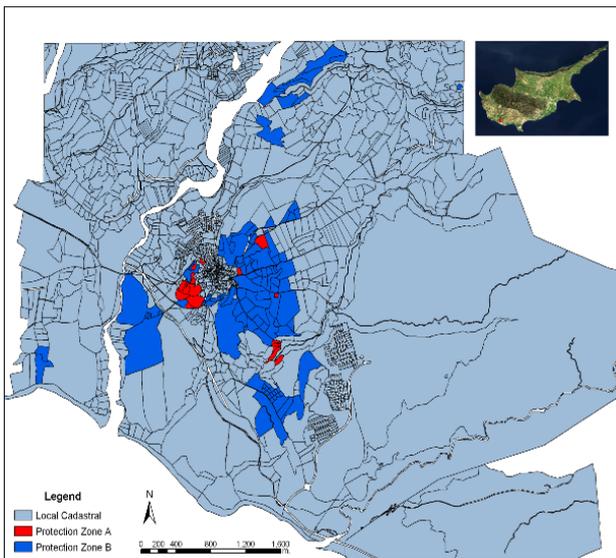


Figure 2. Protection Zones “A” (red colour) and “B” (blue colour) at the Kouklia-Palaepaphos area.

Since the 1970s, when agriculture ceased to be a sustainable way of life, the population of Kouklia could no longer survive on the cultivation of their land; nor were they allowed to make

any other use of it, since almost all the private parcels around the village have been listed by the Department of Antiquities (Fig. 2). They come under Protection zone “B”, which means that the Republic’s heritage manager has good reason to believe that these parcels have considerable archaeo-cultural value. Four decades later, the demands placed by the local community upon the government have become increasingly pressing - and they are justified: no excavation project has been carried out to prove or disprove the archaeological significance of all this private land. They therefore want to have the status of their land modified.

## 1.2 Motivation and aim of the study

The **Palaepaphos Pilot Project** is primarily concerned with the imminent reclassification of large parcels that lie over the ancient polity. A holistic management plan that would render the preservation and enhancement of the archaeological resources and the economic development of modern-day Kouklia-Palaepaphos mutually compatible operations will depend on the successful interaction and timely application of a combination of field methods - large-scale geophysical surveys and small-scale targeted excavations - and of a macro-scale analysis of the landscape with Geographical Information Systems, designed to enable us to define the most valuable archaeological zone and demonstrate its significance within the ancient state centre (cf. Iacovou 2007; 2008).

## 2. THE PALAEPAPHOS FIELD CAMPAIGNS

Palaepaphos was one of the first sites to draw the attention of the Cyprus Exploration Fund in 1888 - a decade after the island had been ceded to Great Britain. A second British mission, the British Kouklia Expedition, went out to Palaepaphos in the early 1950s under the epigraphist Terence Mitford of the University of Saint Andrews and J. H. Iliffe, Director of the Liverpool Museums (Catling 1979). In 1966 a Swiss-German Expedition took over and besides a thorough investigation of the sanctuary of Aphrodite, they also excavated a medieval cane sugar refinery at Kouklia-Stavros. The latter remains the finest industrial archaeology project to have been accomplished in Cyprus to this day (cf. Maier and Karageorghis 1984, 326-38; Maier 2004, 89-105). Meanwhile, ever since the 1960s, the Department of Antiquities of Cyprus has been conducting rescue digs, mostly of tombs but also of extra-urban sanctuaries, almost on a daily basis, but tomb robbing is still rampant in the area.

After more than a century of organised and emergency field projects the Late Bronze Age town, which housed the society that established the sanctuary and constructed some of the richest Late Cypriote tombs ever found on the island (cf. Catling 1968; Maier and Karageorghis 1984, 51) continues to defy spatial definition. Late Bronze Age Palaepaphos has been described as a settlement that extends over 144 hectares and, on other occasions, as a 65 hectare Late Cypriote urban centre (cf. Iacovou 2007). There is, however, no substantial evidence that would allow for a size measurement of the Late Cypriote town. Knowledge of the (invisible) Palaepaphos settlement relies on surmise from Late Cypriote wells in the localities Asproyi and Evreti, "filled with a large amount of storage vessels, animal bones, ivory waste, and household objects" (Maier and Wartburg 1985, 147), to which another well from Teratsoudhia (Karageorghis 1990, 71-73) has been added.

## 2.1 The lie of the land

A simple analysis of the natural topography of the area is necessary, as it will justify the targets of the micro-scale excavation projects. We may describe the area like the inside of a deep “bowl”. On the rim of this “bowl” we find the highest terraces of four plateaus. The lowest of the four plateaus (about 90 meters above sea level) carries the terrace on which the sanctuary was established, while its lower slopes are now occupied by the village of Koukليا. The topmost terraces of the other three plateaus, *Marchello* to the North-East, *Hadjiabdoulla* to the South-East and *Mantissa* wedged in between, share the same height, close to 115 meters above sea level, and command a superb view of the sanctuary and the coastline beyond it. All four terraces are sharply defined by fairly steep sides, which terminate below in deep valleys and/or dry lakes. In this respect, *Marchello* is completely separated from the *Mantissa* terrace. Likewise, the east side of *Mantissa* is separated from *Hadjiabdoulla* by the *Kaminia* depression. Thus, the four terraces are isolated from each other and each retains its own physical integrity and functional identity in the urban landscape of the ancient polity.

What is even more interesting to notice in this highly fragmented urban space is that the different low-lying strips of land between the terraces (*Xerolimni*, *Kaminia*, etc) slope gradually down towards the bottom of the “bowl” until they all come together to drain into *Loures*, presumably the silted-up inlet of the ancient port of Paphos.

## 2.2 Archaeological campaigns

In 2006, in view of the initiation of the Palaepaphos Pilot project, M. Iacovou decided to launch - under the auspices the Archaeological Research Unit of the University of Cyprus - the Palaepaphos Urban landscape project. The purpose of this complementary project was to undertake targeted micro-scale investigation of endangered plots around visible monuments. Lost in fields where only some wheat but mostly animal fodder is being cultivated, one may identify the localities of extensive cemeteries but will find only four visible monuments, in four different locations: a rampart on *Marchello*, an impressive secular building on *Hadjiabdoulla*, a peristyle house on *Evreti*, and a built tomb known as “*Spilaion tis Regainas*” on *Arkalon*. The choice of the 2006-2009 field targets was based on the degree of danger that certain parcels were facing as a result of rapidly progressing development plans.

Thus, from 2006-2008 we devoted three medium-length seasons on *Marchello* and in 2009 we initiated excavations on *Hadjiabdoulla*. Two impressive but only partially excavated monumental structures, which were constructed in the Cypro-Archaic period, no doubt by Paphian kings, stand on *Marchello* and *Hadjiabdoulla* respectively.

On both sites our excavations have increased the exposure of the two monuments and their surrounding ancient landscape. On *Marchello* we have added a rampart of solid stonework, 52 meters long and five metres wide, which is now adequately protected under a layer of mud-bricks, while the two plots in which it extends are being expropriated by the Department of Antiquities.

At *Hadjiabdoulla*, expropriation procedures have begun by the end of our first season, since we were able to show that the north side of the main wall and curtain wall of the citadel that

enclosed the palatial residence of the Classical Age, was being used as a dirt track and was eroded by the traffic of heavy agricultural machinery. Moreover, we proved that the SE area of the unprotected plot held significant material evidence of a settlement dating back to the 13<sup>th</sup> century BC, the heyday of Late Bronze Age urbanism.

## 2.3 Geophysics campaigns (2003 and 2007)

A preliminary GPS topographic survey was carried out in 2002 aiming towards the topographic registration of the surface monuments of the site. The topographic survey was carried out using 2 Ashtech CGRS GPS receivers (Z12) in stop-and-go mode measuring at the local geodetic system (WGS '84 / Local Transverse Mercator System) of the Department of Land and Surveys, Republic of Cyprus. Based on the mapping of the surface monuments and the geomorphological settings of the site, a geophysical survey module was planned focusing on specific sections of the site (Fig. 3).



Figure 3. Outline of the geophysical grids that were explored during the 2003 and 2007 field season. A high degree of overlap existed among the different methodologies in order to enhance the interpretation of the data.

The geophysical campaign employed soil resistance, vertical magnetic gradient and GPR techniques and was conducted in two chronologically distinct phases: in 2003 (Stamatis *et al.* 2007) and in 2007 by the Institute for Mediterranean Studies of the Foundation for Research and Technology, Hellas (IMS-FORTH). An area of almost 100,000m<sup>2</sup> was covered during the two field seasons. Both surveys were exploratory in nature and they tried to locate subsurface features of potential archaeological significance. Processing of the geophysical data included creation of mosaics, grid and line equalization techniques, compression of dynamic range and the application of directional filters. GPR measurements were carried out along parallel transects 0.5m apart with 5cm sampling. The combined GPR data were processed through time and spatial filters and time-slicing techniques that gave rise to 10cm width horizontal sections with increasing depth. Laboratory measurements of the soil magnetic susceptibility were carried out at selected parts of the site in order to verify the results of the high resolution (0.5m) magnetic techniques. A number of promising targets were indicated and some of them exhibited good correlation with surface monuments. The results of the geophysical survey were implemented to GIS through rectification of the geophysical maps, for a further analysis of the landscape through spatial filtering techniques (viewshed analysis, least cost path, a.o.).

Specifically, the area close to the “House of Leda” in the vicinity of the Sanctuary of Aphrodite indicated a dense distribution of candidate targets in accordance to the visible architectural remains found in the surrounding region. Similar architectural relics that indicate a further extension of the excavated monuments were recognized in the regions of Evreti, Marchello and Hadji Abdullah. A few candidate anomalies that were suggested by all methods at Marchello proved to have been caused by geological processes (Fig. 4).

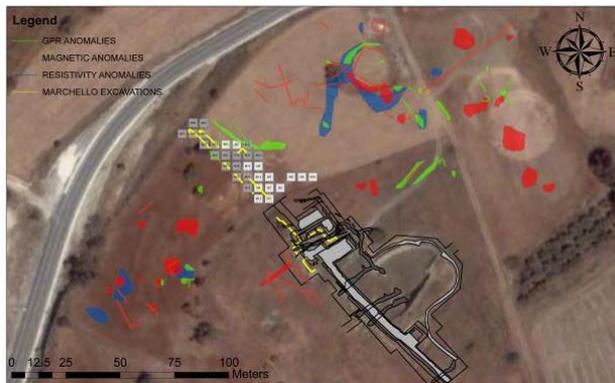


Figure 4. Marchello. Synthesis of the diagrammatic interpretation of geophysical data with the outline of the surface monuments and the excavation results. The semicircular feature (forming a small depression) to the central north region of the map proved to be of geological origin, resulting from the erosion of the carbonized bedrock. Excavations revealed a continuation of the wall of Marchello to the NW and similar features are suggested by the geophysical results.

Interesting enough were also a number of extreme magnetic anomalies ( $> \pm 3000 \text{ nT/m}$ ) that are of relatively large dimensions ( $\sim 5\text{-}10\text{m}$ ) and lack any kind of geometry (mainly diffused in various directions) and which were found in different sections of the site (mainly at Marchello, Mantissa and Hadji Abdullah). In order to study the nature of these anomalies (geological or anthropogenic), soil samples were collected and were subjected to measurements of the magnetic susceptibility, the analysis of which is still under progress. Wall sections were found by the soil resistance data to be projected in between the region of Marchello and Hadji Abdullah. These indications were reinforced through Least Cost Path analysis and they were consecutively confirmed through local inspection. At Evreti and Arkalon, architectural remnants seem to be better preserved. At Arkalon magnetic data revealed part of a large rectangular complex, extending for more than 70m in both directions. Burning residues were also located in the specific area (Fig. 5).

In general, most of the geophysical signals indicated increased level of noise originating mainly from the intense cultivation of the region. Very few architectural structures remain in good preservation within the disturbed layers. Geophysical results managed to pinpoint a few of these areas that deserve further investigation. In order to have a better image of the distribution of the suggested geophysical features in correlation to the surface monuments, all maps and their corresponding interpretation were registered to a GIS application that consists of aerial and satellite imagery and digital products of the land-use and its geology.



Figure 5. Details from the magnetic results at Arkalon. Linear anomalies that extend to the N-S and E-W directions suggest the existence of large structural complexes.

### 3. BUILDING A GIS

#### 3.1 Data

The data used for the aim of the Pilot Project can be categorized into four general thematic layers: a) the “excavation data” layer, b) the “archaeological - historical documentation” layer, c) the “geophysical survey” layer and finally d) the “geographical data” layer.

The “excavation data” is a time-stamped thematic layer which was created in order to monitor, collect and guide the small-scale excavations that took place in high risk plots. These data contain not only the archaeological squares but also geometric documentation of the monuments revealed during the excavation campaign seasons. This documentation was carried out using standard topographical equipment (Total Station and GPS) and hands-free plans.

“Archaeological - historical documentation” layer includes digitized plans from previous excavations of the visible monuments of the Palaepaphos area. The plans were firstly scanned and then geometrically corrected (1<sup>st</sup> polynomial order transformation), using ground control characteristic points measured with a GPS receiver. The position of the archaeological sites at the surrounding area of Palaepaphos, is also documented in this layer. The sites are represented with a symbol according to the period (e.g. Classical, Hellenistic). This layer represents and the toponymies of the area, mentioned either at the bibliography or at the excavations reports.

The third category of layer (“geophysical survey”) includes the final results of the two geophysical campaigns mentioned before.

The “geographical data” layer includes all the necessary topographical, geological, orthophotos data needed for this pilot project. The aim of this layer is to be used as a background information map, where all other data/ information can be overlapped. A Triangulated Irregular Network (TIN) model was created, using topographical data and afterwards, we produced a uniform rectangular grid model (DEM), which was used as the 3D digital terrain for our study. Grayscale orthophotos (taken in 1963, and in 1993), with accuracy of 1 m, were used in order to create a realistic digital terrain. These orthophotos cover an area of 5Km x 5Km (25 Km<sup>2</sup>) (see figure 6). Furthermore this layer includes hydrological data and the parcels of the Palaepaphos area. The detail geological map, which was also added in this layer (scale 1:250 000) was found very helpful.

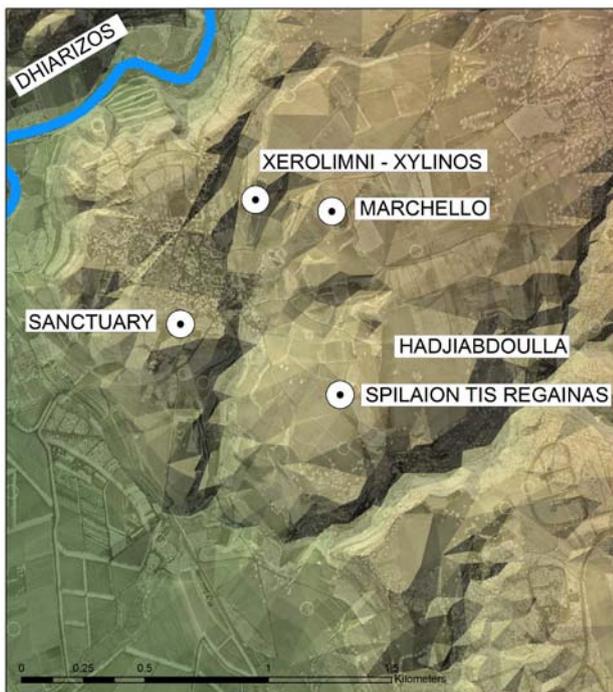


Figure 6. 3-D reconstruction of the terrain using orthophotos and TIN

It must be emphasized that all these data were georeferenced in a common geodetic system, and the data were supplemented with the no-spatial information.

### 3.2 Building a geodatabase

In order to handle and organized this amount of information, which includes spatial and no-spatial information Geographical Information System (GIS) software was used (©ArcGIS 9.3).

At this stage a web database was created, using an Entity – Relations (ER) data structure, for the recording of the available no-spatial data. The database includes six main entities (toponymies, parcels, monuments, finds, references and reports) which allows a full and correct documentation. A friendly interface created for this purpose (shown in Fig. 7), combines both quick registration of the data (which is related to the documentation of the Palaepaphos area) and also allows the export of valuable reports. The web database is easy searchable

through key – words, that allows the user to isolate a monument and see all the information which is related with it (fig. 8).



Figure 7. Detail from the web database

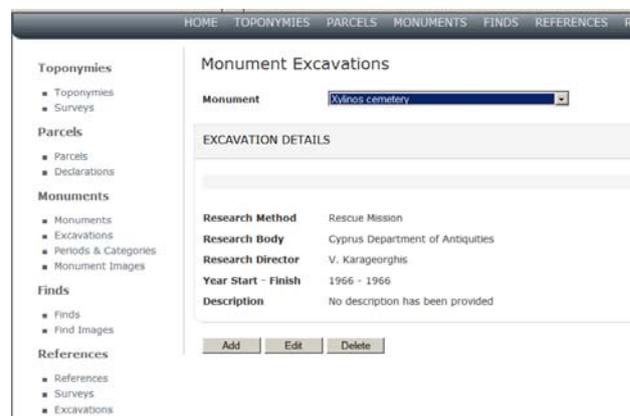


Figure 8. Searching the web database for excavations details at a specific monument

The spatial information is stored –at this stage of the project- in personal geodatabases, using the ©ArcGIS 9.3 software. These geodatabases can access, the web database and synchronized.

### 3.3 Results & thematic maps

The final result of this implementation was a development of a specific GIS for the Kouklia-Palaepaphos area. The GIS provides all the necessary data and information not only for a tourist- visitor but also for archaeologists as a digital tool. This GIS was operated during the last three excavation campaigns seasons (2006-2009), where it has a significant contribution. GIS users can export any thematic map or create useful reports using the data provided.

GIS, as a digital heritage tool, managed to bring, under one digital roof a vast amount of cultural information.

#### 4. A METHODOLOGY FOR ARCHAEO-CULTURE ENVIRONMENT MANAGEMENT

##### 4.1 An integrated framework

The Palaepaphos project aims at developing balanced, interrelated policies with an integrated framework for the management of the Palaepaphos archaeo-environment. By analysing the existing information, it is expected that the project will propose an interdisciplinary research aiming at improving the sustainable development of archaeological sites. The project also aims to enable land-owners and land-users of to improve their relationship with the archaeo-environment. At the moment, it is not feasible to outline such a framework.

#### 5. CONCLUSIONS AND FUTURE WORK

The project has both short-term and long-term plans. The short term plan is, to fulfil the obligations that will lead to a successful implementation of the project, and to deliver all the necessary products. The main product is the compilation of the integrated framework for the management of the Palaepaphos archaeo-environment as well as the policy guidelines for the public stakeholders. In addition, the development of the Geographical Information System and the web-based database management system will give the opportunity for further research and analysis of the area.

In the long-term, the research team aspires to stimulate the government to concentrate more efficiently in the successful enhancement of archaeo-environments. Cyprus, as tourist destination, is suffering from the pressures of intensive real estate development. The government has the obligation to formulate a legal framework that will sustain the archaeo-environment.

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