

A Spatial Analysis of the Bronze Age Sites of the Region of Paphos in Southwest Cyprus with the Use of Geographical Information Systems

Agapiou, A.¹, Iacovou, M.¹, Sarris, A.²

¹ University of Cyprus, Archaeological Research Unit, Nicosia, Cyprus

² Laboratory of Geophysical – Satellite Remote Sensing and Archaeo-environment, Institute for Mediterranean Studies, Foundation for Research and Technology, Hellas (IMS-FORTH), Rethymno, Crete, Greece
athosagapiou@yahoo.gr

This paper presents the preliminary results of a spatial analysis of the Bronze Age sites of the Paphos region in Western Cyprus (3rd and 2nd millennia BC), with the use of Geographical Information Systems (GIS).

In the first part of the paper, the region of Paphos is defined based on geomorphological criteria. Secondly, the known Bronze Age sites of the Paphos region, found during excavations or foot surveys, have been recorded from published reports. Spatial and chronological coordinates of the sites as well as digital geomorphological data (e.g. digital elevation model, geological maps) were synthesized in order to investigate site patterns. The authors have also considered the relation of the sites to the copper ores of Western Cyprus in order to identify transportation routes from the mines to the ports using least cost path analysis (LCP).

Spatial analysis can assist in monitoring settlement patterns transformations. The analysis of the Paphos region settlement patterns in the Bronze Age has opened up a number of promising views concerning communication channels, transportation routes and the spatial relation between copper ores and settlement hierarchy.

Keywords: Spatial analysis, Cypriot Bronze Age, sites distribution.

1. Definition of the study area

The paper aims to study the Bronze Age site distribution in the region of Paphos in SW Cyprus in order to interpret site patterns. In the context of the Paphos pilot project, entitled, “A long-term response to the need to make modern development and the preservation of the archaeo-cultural record mutually compatible operations” (IACOVOU *et al.*, 2009), spatial analysis was performed, with the use of Geographic Information Systems (GIS), on sites of the Early, Middle and Late Cypriot period (3rd and 2nd millennium BC) that have been reported from the region to this date.

For the purposes of the above project, the boundaries of the Paphos region were *a priori* determined using a combination of geographical and geomorphologic data. Although a regional approach was done by Myres and Ohnefalsch-Richter as early as the ultimate years of the 19th century (MYRES and OHNEFALSCH- RICHTER, 1899), their definition of cultural regions was *a posteriori* determined. Since then, similar methodologies have been adopted by many archaeologists in their studies of the distribution of archaeological sites in the various

geo-cultural divisions of the island (e.g. GJERSTAD, 1926; CATLING, 1963; GEORGIU, 2006).

The authors have given serious consideration to the significance of topography. We have, therefore, proceeded to analyse in detail the topographic and geomorphologic criteria of the region of Paphos in order to correlate them with site trends in the Bronze Age period, using GIS spatial tools. The study area has been defined as the primary catchment area of Paphos (see Fig. 1). Catchment areas have been used in the past in the context of foot surveys (e.g. The Canadian Palaepaphos Survey Project - CPSP) in order to map the location of archaeological sites within the Paphos region.

The primary catchment area of Paphos is surrounded by hills and mountains with steep slopes and this renders it a topographically uniform area with well-defined natural boundaries.

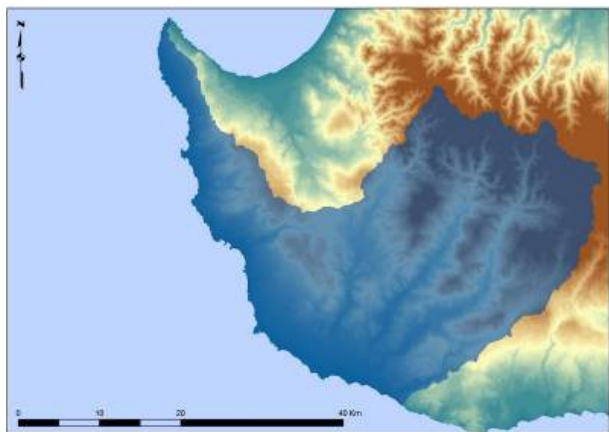


Figure 1: Paphos region. Study area in SW Cyprus.

2. Information on field projects in the region of Paphos

Despite the fact that the archaeological investigation conducted so far in SW Cyprus is not considered sufficient in terms of coverage (MALISZEWSKI, 1997; GEORGIU, 2006), regional survey projects have been progressing rapidly in recent years (Fig. 2). The Canadian Palaepaphos Survey Project-CPSP, which was initiated by Brock University, investigated large catchment areas of the Paphos region, such as the Ezouzas, Dhiazos and Chapotami drainage systems (cf. RUPP, 2004). HADJISAVVAS (2004) investigated the areas of Kissonerga and Souskiou and has reported 33 sites. A long-term program of excavations and surveys, which have been undertaken by the University of Edinburgh in the Kissonerga-Lempa area, are still in progress (BOLGER *et al.*, 2004).

As regards Kouklia-Palaepaphos, the main Late Cypriot (LC) site of the SW region, archaeological research was initiated in 1887-1888 by the "Cyprus Exploration Fund" (HOGARTH, 1889). Excavations continued in the 1950s with a second British mission under T. B. Mitford of the University of St. Andrews and J. H. Iliffe of the Liverpool Museums. In 1966, a Swiss-German mission, led by F. G. Maier, began to work in a number of important locations (in the Palaepaphos Sanctuary, at *Marcello, Evreti, Hadjiabdoulla and Stavros*) with im-

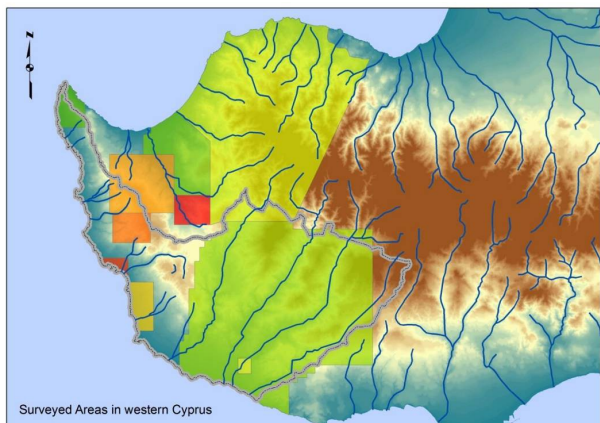


Figure 2: Surveyed areas in western part of Cyprus.

The Department of Antiquities of Cyprus has been conducting rescue excavations in the region since the 1960s. Two of these rescue projects resulted in the identification and publication of two important burial grounds. The first is the *Skales* Iron age cemetery (KARAGEORGHIS, 1983) and the second is the *Teratsoudia* and *Eliomylia* LC cemeteries (KARAGEORGHIS, 1990).

In 2006, the Archaeological Research Unit of the University of Cyprus initiated the "Palaepaphos Urban Landscape project", which includes, among other, geophysical surveys and small-scale excavations (IACOVOU, 2008). The purpose of this new project is to identify the structure of the urban nucleus -with micro-scale investigations concentrating within 2 Km² of the Sanctuary - and to understand the changing relation of the site of ancient Paphos to the region of Paphos in the Late Bronze and in the Iron Ages (macro-scale investigations).

Targeted short-term excavations of endangered plots around visible monuments, on the locality of *Marchello* (2006-2008) and, since 2009, on the area of *Hadjiabdoulla*, have increased significantly the exposure of two impressive and complex edifices that belong to the urban system of the ancient polity. Although preliminary, the results have led to a much better understanding of the surrounding ancient landscape (cf. IACOVOU, 2008; IACOVOU *et al.*, 2009).

3. Bronze Age sites and collection of data

For the aims of the study a combination of geographical and geomorphologic information, such as topographic and geological data, where used. First, the dataset regarding the archaeological sites of the Paphos region and their chronological attributes were collected from published reports (see Fig. 3). For the majority of the sites that date from EC the LC IA we have relied on the site corpus admirably presented by Georgiou in his recently completed doctoral thesis (2006). Information concerning sites dating from LC IA to LC IIIB, was collected from published reports.

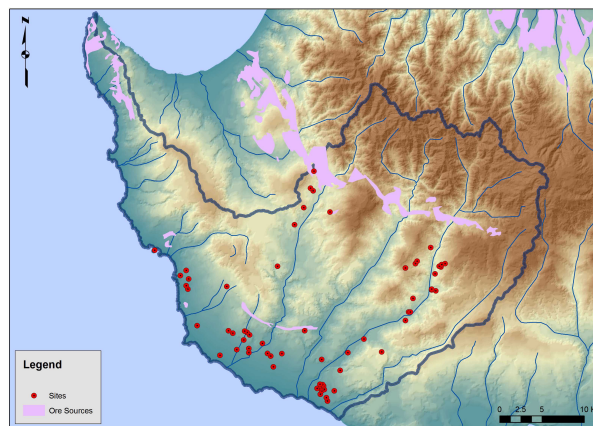


Figure 3: Archaeological sites of the 3rd and 2nd millennium BC in the Paphos region.

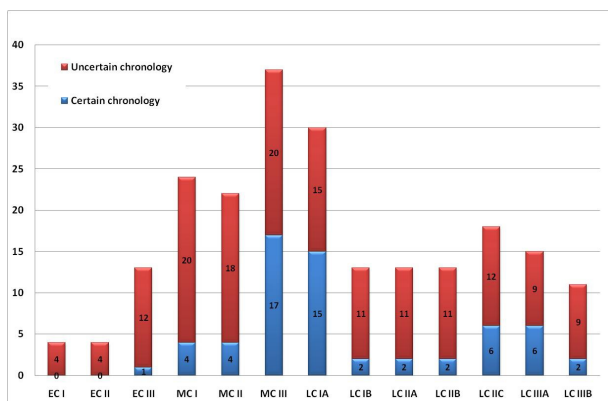


Figure 4: Number of sites per chronological horizon (uncertain chronology in red, certain chronology in blue).

Only a small number of sites dating to EC and MC have been located so far (Fig. 3). An increase of site numbers is observed during the transition from MC to LC. It must be stressed that, due to inadequate information, the chronology of the majority of Paphos region sites is uncertain (Fig.4, red columns)

Furthermore, the majority of the sites are located on slopes with south orientation. Perhaps, this is due to the fact that on this direction they have longer hours of sunshine (Fig. 5). It must be emphasized, however, that the accuracy of the geolocation of the sites is not uniform because the level of detail used for mapping each site varies.

4. Analysis

4.1. Spatial Distribution of the sites

The distribution of the sites according to the main sub-catchment areas is as follows from east to west:

- The Cha-Potami basin is the eastern part of the Paphos region. Only one archaeological site, Kouklia *Kokkinogia*, has been located so far in this basin. The site appears to have been in use only in one chronological period, which is assigned without certainty to MC III. The site is located on the southern part of the basin (Fig.

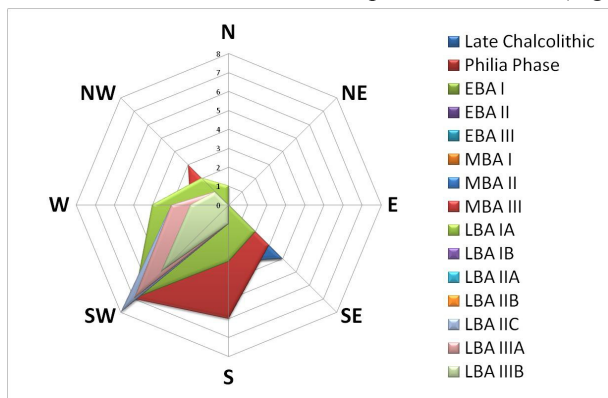


Figure 5: Orientation of sites of the 3rd and 2nd millennium BC.

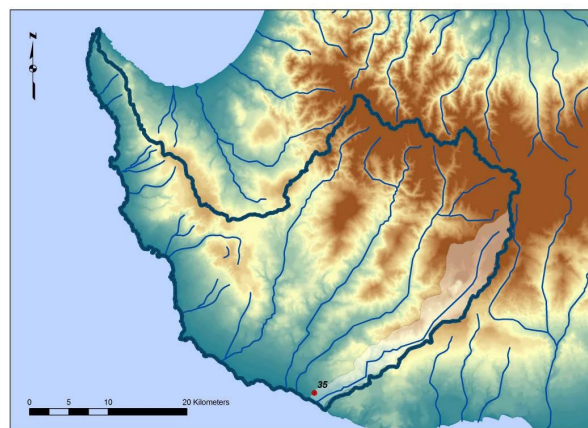


Figure 6: Archaeological site in the Cha-Potami basin.

6), fairly near the coastline, which would explain why the CPSP program has recorded it in the Diarizos's basin.

- The Dhiarizos basin is located to the west of the Cha-Potami basin. The Dhiarizos is the largest basin in the western part of Cyprus. More than 34 sites have been identified so far in this basin. These sites are located in the southern and central part of the basin, near the Dhiarizos river (Fig. 7).

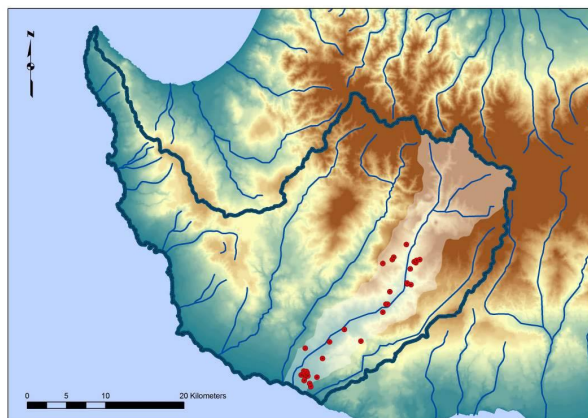


Figure 7: Archaeological site in the Dhiarizos basin.

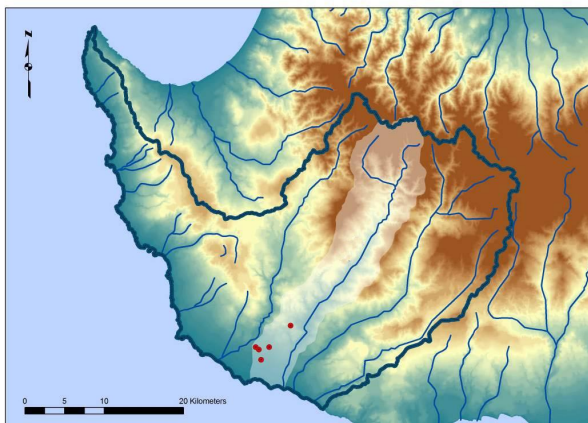


Figure 8: Archaeological site in the Xeros basin.

- The Xeros basin: only five sites have been identified to this date in the Xeros area. All five

of them are located in the southern part, and all of them appear to have been in use after the MC III period (Fig. 8)

- The Ezousa basin: 14 sites have been reported in the Ezousa basin (Fig. 9). All of them appear to have been in use after the EC II period. All but one are situated on the west bank of the river; only Lapithiou *Arkoklima* is located on the east side.

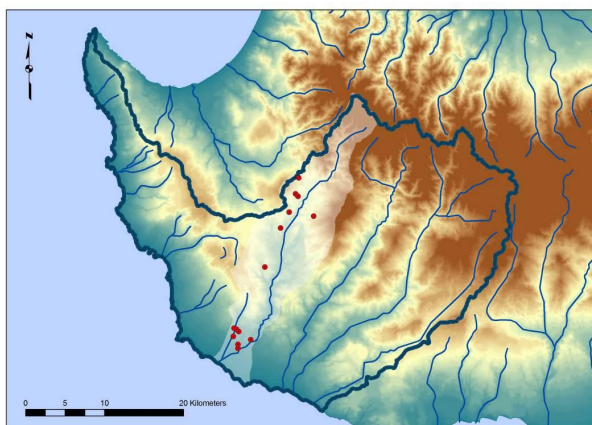


Figure 9: Archaeological site in the Ezousas basin.

- The Yeroskipou basin: 11 sites are known from the Yeroskipou basin and almost all of most are located in the southern part of the basin, near the coastline (Fig. 10).

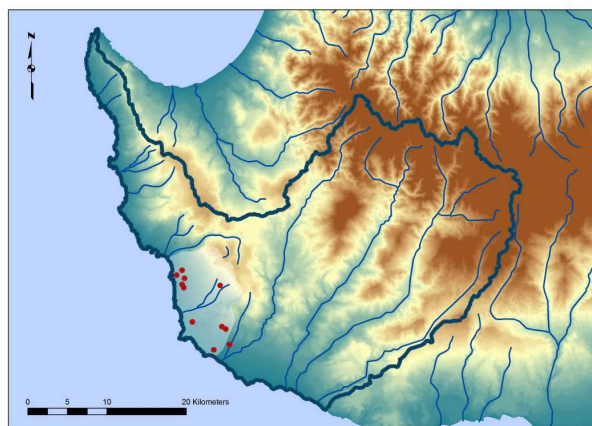


Figure 10: Archaeological site in the Yeroskipou basin.

Only one site, that of Maa-Palaeokastro, has been indentified to the west of the Yeroskipou basin.

4.2. Chronological Distribution of the sites

Catchment analysis was used in order to analyze the chronological distribution of the sites known so far in the Paphos region. For this purpose, a simplified empirical friction surface was produced. Percentage of slope was reclassified according to a weight factor (0-10%: 1; 10-30%: 3; >30%: 5).

Our knowledge of the site pattern in the region of Paphos during EC I-II is extremely limited (Fig. 11), espe-

cially when compared to the central and northwestern part of the island (GEORGIU, 2006). Most of the sites were founded at low altitude and in close proximity to the coast (less than 1 hour walking distance). EC III - MC II sites were located mainly alongside the Dhiarizos and Ezousas rivers. They are situated from as low an altitude as 50 m to as high as 650 meters, which is the altitude near the copper deposits on the southern slopes of the Troodos mountains.

In the period that followed many MC II sites were abandoned and new sites were founded in MC III. Geor-

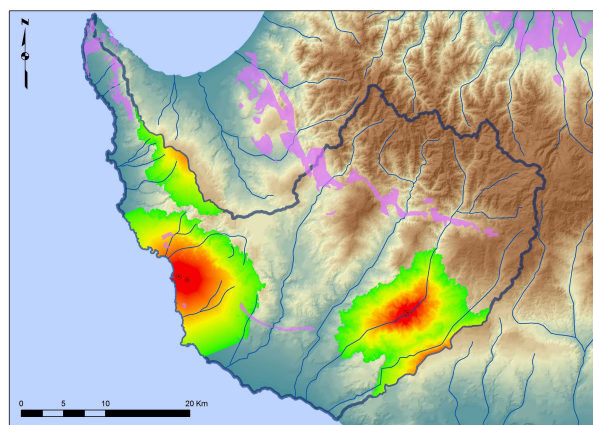


Figure 11: Site catchment analysis of EC I- II sites.

giou's analysis (2006) shows that this is not an isolated regional development of Paphos: a significant change of settlement patterns is observed all over the island in MC III and LC IA. MCIII/LCIA has been identified by many scholars (cf. KESWANI, 1996) as a period of constant change during which the export of copper begins to flourish due to the establishment of coastal settlements that undertook the role of ports of commerce.

The regions of Paphos to the SW and of Enkomi to the East are the two areas of the island where an increase of site numbers is evident from EC III to LC IA (GEORGIU, 2006), as is indicated in Fig. 12.

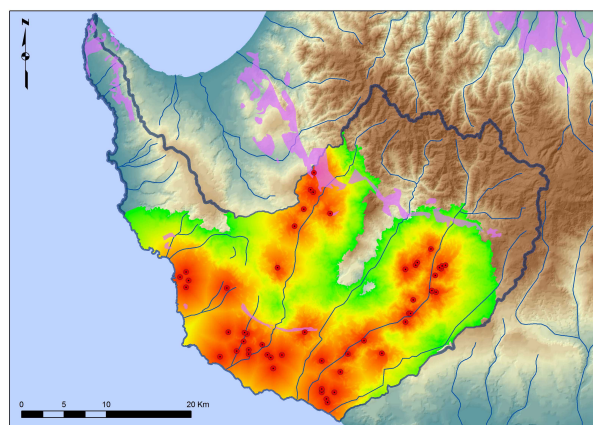


Figure 12: Site catchment analysis of ECIII to the LC IA.

Regarding the following periods, MC III to LC III, the majority of sites in the Paphos region were distributed alongside the rivers Dhiarizos and Ezousas (Fig. 13).

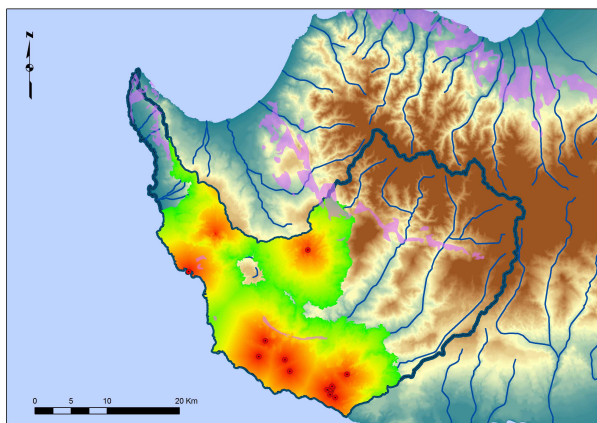


Figure 13: Site catchment analysis of the LC IIIA.

4.3. Proximity of the sites in copper-based zones and coastline

Spatial analysis reached significant results regarding the proximity of sites to the Paphos region copper deposits and the coastline. Site location from MC III to LC III appears to correspond to the *chaîne opératoire* of copper processing, from the mining stage in the SW

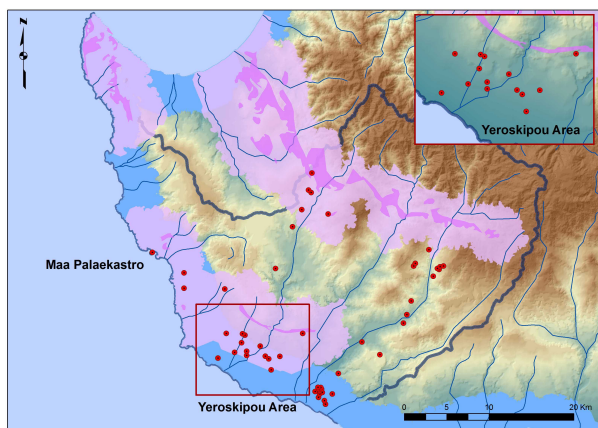


Figure 14: Proximity of MC III to LC III sites to the copper deposits (in purple) and the coastline (in blue).

Troodos foothills to the transportation of metal along the rivers until it reached a gateway, which served as a port of export (Fig. 14).

As regards the allocation of sites in the study area, no sites have been reported from the northern part of the Paphos region, which corresponds with the raggedy areas of the Troodos mountains at an altitude that exceeds 650 m. and well beyond the location of copper deposits.

Another observation concerns the sites of the *Yeroskipou* area, which are located between the coast and a narrow strip of copper deposits found at a walking distance of less than an hour from the sites (see detail in Fig. 8).

This appears to suggest that the establishment of the *Yeroskipou* sites was not at all random.

Likewise, the location of the LC III *Maa Palaekastro* site is situated within a walking distance (<1.5 km) from a small copper deposit (see Fig. 14).

4.4. Communication Systems

For the transportation of ore from the mines to the ports, natural routes were chosen. When established circa MC III/LC IA, these routes became the economic communication channels of the region. In order to identify possible routes, least cost-path analysis was performed in various sections of the region.

Based on this analysis, two main routes were identified from the ore sources: the first, via the Ezousas river channel; the second, via the Dhiarizos river channel. Although our knowledge of how the Ezousas communication system operated is still limited, the Dhiarizos communication channel appears to be well documented.

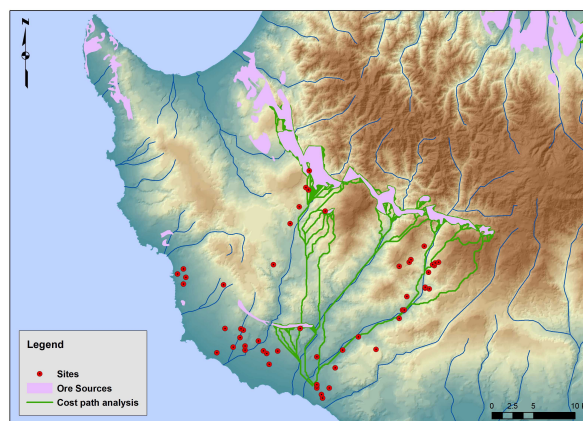


Figure 15: Suggested Communication systems of the Middle Cypriot III and Late Cypriot IA period, from the metallurgical zones of the Troodos to Palaepaphos.

According to IACOVOU (2008) the location of the site of Palaepaphos was specifically selected for the establishment of a port dedicated to export goods (emporium). The subsequent development of Palaepaphos as the region's central place and administrative capital is in accord with the "minimum spatial requirement" needed for the establishment of an urban polity in the island environment of Cyprus (IACOVOU, 2007). The rich LC II-III tombs discovered at Palaepaphos suggest that the site had developed from a MC III- LC IA terminal point (gateway) to an urban capital of the region in the context of copper economy.

Viewshed analysis from Palaepaphos has shown that from this site one could have an unhindered view of the sea and the coastline mostly to the west (Fig. 16). Visibility from Palaepaphos to the west extends as far as the site of Maa-Palaekastro, which is the westernmost site in the study area.

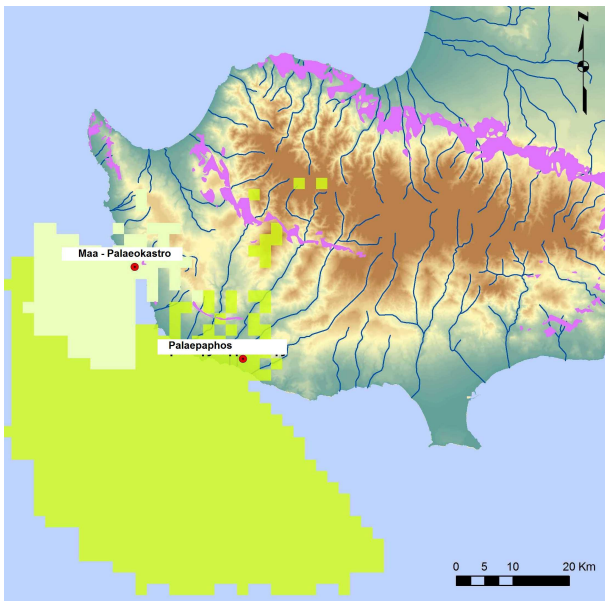


Figure 16: Visible areas from the Palaepaphos and Maa-Palaekastro site.

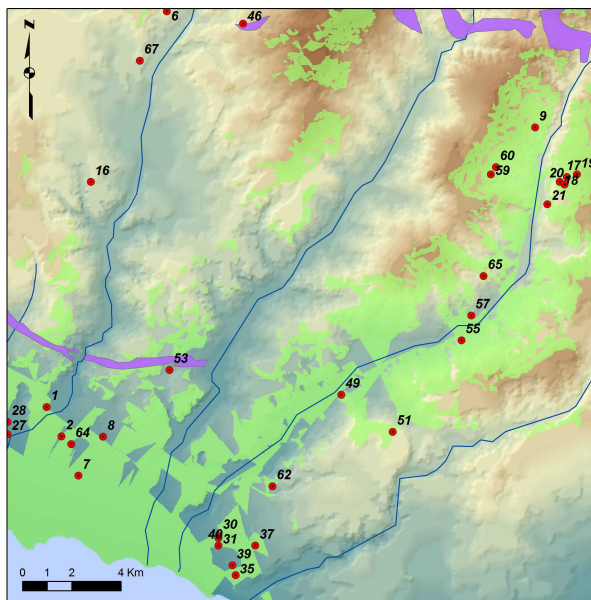


Figure 17: Visible areas from the Dhiarizos sites.

We also performed viewshed analysis as well as line-of-site analysis and we established an important parameter with respect to the location of MC III/LC IA sites: although they had no visibility with one another, each site could have visual control of one of the three communication systems (Fig. 17 and Fig. 18).

Conclusions

This paper attempted to analyze and highlight the spatial attributes of the Bronze Age archaeological sites (3rd and 2nd millennium B.C.) in the SW of Cyprus. For this purpose, all known sites were mapped on a GIS environ-

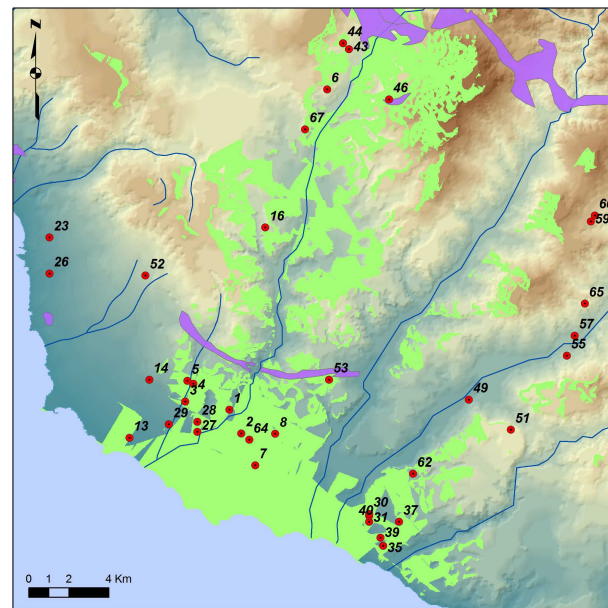


Figure 18: Visible areas from the Ezousas sites.

ment. For the spatial analysis, geomorphological, geological, and hydrologic data were used.

This analysis has, on the one hand, confirmed or strengthened current archaeological interpretations; while, on the other, it has opened up a number of promising views concerning communication channels, transportation routes, and the spatial relation between copper ores and sites.

The authors will continue to investigate the region, through small-scale excavations and large-scale geophysical surveys, whose data will continue to be analysed with the use of Geographical Information Systems.

Acknowledgements

The authors would like to thank the Geological Survey Department of Cyprus for providing geomorphological, geological and hydrologic data. For permission to carry out field work, surveys and excavations, in the area of Kouklia-Palaepaphos, we express our thanks to the Director of the Department of Antiquities of Cyprus.

References

- BOLGER D. L., McCARTNEY C., PELTENBURG E., 2004. Regional interaction in the prehistoric west: Lemba Archaeological Project Western Cyprus Survey. In IACOVOU(ed.) *Archaeological field survey in Cyprus. Past history, future potentials*, pp. 105-123. British School at Athens Studies II.
- CATLING H. W., 1963. Patterns of Settlements in Bronze Age Cyprus. *OpAth* IV, pp. 129-69.
- GEORGIU G. A., 2006: *Topography of Human settlement in Early and Middle Cypriote* (in Greek). Unpublished Ph.D. dissertation, University of Cyprus.

- GJERSTAD E., 1926. *Studies of Prehistoric Cyprus*. Uppsala.
- HADJISAVVAS S., 2004: Surveying after Catling: the work of the Department of Antiquities Survey Branch since 1960. In IACOVOU (ed.) *Archaeological field survey in Cyprus. Past history, future potentials*, pp. 37-41. British School at Athens Studies II.
- HOGARTH D. G., 1889. *Devia Cypria. Notes of an Archaeological Journey in Cyprus in 1888*. London.
- IACOVOU, M., 2007: Site size estimates and the diversity factor in Late Cypriote settlement histories. *Bulletin of the American Schools of Oriental Research*, 348: 1-23.
- IACOVOU M., 2008. The Palaepaphos Urban Landscape Project: Theoretical Background and Preliminary Report 2006-2007. In *RDAC* (2008), pp. 263-289.
- IACOVOU M., STYLIANIDIS E., SARRIS A., AGAPIOU A., 2009. 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. In *Proc. CIPA 2009*.
- KARAGEORGHIS V., 1983. Palaepaphos-Skales. An Iron Age cemetery in Cyprus, Nicosia.
- KARAGEORGHIS V., 1990. *Tombs at Palaepaphos. 1. Teratsoudhia. 2. Eliomylia*. Nicosia
- KESWANI P. S., 1996. Hierarchies, Heterarchies and Urbanization Processes: The view from Bronze Age Cyprus, In *JMA* 9.2, pp. 211-250.
- MAIER, F.-G., 1985. *Alt-Paphos auf Cypern: Ausgrabungen zur Geschichte von Stadt und Heiligtum 1966-1984*. Trierer Winkelmannsprogramme 6.
- MAIER, F.-G., 2004. *Guide to Palaipaphos (Kouklia)*. Nicosia: Bank of Cyprus Cultural Foundation.
- MAIER F. G., 2008. *Nordost-tor und Persische Belagerungsrampe in Alt-Paphos*. Deutsches Archäologisches Institut.
- MAIER, F.-G., WARTBURG, M.-L. Von, 1985. Reconstructing History from the Earth, c. 2800 B.C.-1600 A.D.: Archaeology at Palaepaphos, 1966-1984. In Karageorghis V. (ed.), *Archaeology in Cyprus 1960-1985*, pp. 142-72. Nicosia: Leventis Foundation.
- MALISZEWSKI D., 1997. Notes of the Bronze Age settlement patterns of Western Cyprus c. 2500-c. 1050 BC. In *RDAC* (1997), pp. 65-84.
- MYRES J.L., OHNEFALSCH-RICHTER M., 1899. *A Catalogue of the Cyprus Museum*. Oxford.
- RUPP D.W., 2004. Evolving strategies for investigating an extensive *terra incognita* in the Paphos District by the Canadian Palaipaphos Survey Project and the Western Cyprus Project. In IACOVOU (ed.) *Archaeological field survey in Cyprus. Past history, future potentials*, pp. 63-76. British School at Athens Studies II.