DEFINING THE MINOAN CULTURAL LANDSCAPE BY THE USE OF GIS [*]

S. Soetens[1,2], A. Sarris[2], K. Vansteenhuyse[1,3]

(1) *Université Catholique de Louvain, Département d'histoire de l'art et d'archéologie, Place B. Pascal 1, B – 1348 Louvain-la-Neuve (Belgique), ssoetens@yahoo.com*
(2) *Institute of Mediterranean Studies, Laboratory of Geophysical and Satellite Remote Sensing & Archaeo-environment, Melissinou & N. Foka 130, P.O. Box119, GR-74100 Rethymnon, Crete (Greece), asaris@ret.forthnet.gr*
(3) *Temple University, Department of Art History, 3550 Market Street, Suite 100, Philadelphia (USA), klaas_vansteen@hotmail.com*

ABSTRACT

Minoan peak sanctuaries are located on or close to specific mountain peaks dispersed over the Cretan mountains. Their use as Bronze Age sanctuaries covers a period from ± 2300 B.C. to 1500 B.C., which corresponds more or less to the two main building phases of the 'palaces' (proto- and neopalatial periods).
Previous research has interpreted these sites as sanctuaries, based mainly on its finds. Further spatial characteristics, such as distance to the settlements, intervisibility with other sanctuaries and settlements have been explained mostly in terms of this sanctity. A suggestion was made that the intervisible peak sanctuaries were reflection of "zones" [1], and "*on a regional level the intervisibility of peak sanctuaries provides an opportunity for the expression of ritual unity may have transcended political boundaries*" [2].
The purposes of this project are to investigate these observations systematically, to identify further functionalities of the peak sanctuaries, to better understand how the whole landscape was perceived by the Minoans and all of this by the creation of models capable of spatial, statistical analysis and prediction. GIS was used to organize, analyze and visualize the combined information layers of archaeological, topographical, environmental, and statistical data.

1. INTRODUCTION

"One direct approach to conceptualizing past ideational landscape is to consider the ceremonial activities that took place within them. Rural sanctuaries are crucial for accessing the symbolic aspects of such landscapes" [3]. The Protopalatial peak sanctuaries have a definite rural character, and their particular topographical characteristics make them extremely sensitive to the further understanding of the Minoan landscape. Following contemporary theory on landscape archaeology, the presence of these sites can be interpreted as *"the materialization of memory, the mythical elements in the landscape, and these 'sites of memory' represent media that together with other landscape features help formulate a political identity"* [4].
The relation of the peak sanctuaries with the Minoan 'palaces' (or 'court compounds'), particular for the neopalatial period, is traditionally based on the rich, palatial artifact assemblages found at the peak sanctuaries. This relationship can be confirmed by the use of a selection of GIS spatial analyses. In this way it is possible to relate the socio-political identity of the court compounds to the peak sanctuaries, and to reflect this identity upon the landscape. We will present here the technical GIS procedures that are used to define the Minoan cultural landscape. Viewshed analysis from the peak sanctuaries was performed to identify the visibility qualities of these sites, to each other, the court compounds, and the further landscape. The territories of the Minoan centers were suggested by a comparison of three models, namely Thiessen polygons, Cost Surface Analysis and X-tent modeling.

2. COLLECTION AND ORGANIZATION OF DATA

Published archaeological data were organized in an Access database and linked to the GIS by SQL. Also in process is the creation of an interactive webpage with hot linked panoramic photos from the peak sanctuaries.
DGPS receivers (sub-cm accuracy) were used to collect the geographical coordinates of the peak sanctuaries, including all the certainly identified ones and some candidate sites [5], as well as a large number of the hierarchically important Minoan sites, such as the 'palaces', other court compound sites, the so-called villas, towns and major sanctuaries and burial sites.
Topography, Geology, Land use, Land capability and Archaeological Survey maps of different scales were manually digitized in AutoCad [6] and converted to ArcView feature themes. The Digital Elevation Model (DEM) is derived from stereoscopic SPOT images and has a resolution of 50 by 50m. Furthermore it gives information on the elevation of the studied surface (the

island of Crete), and by analysis can provide aspect, slope and viewshed rasters. This analysis was done by TNTmips, since its results were more accurate than the corresponding analysis in ArcView.

3. ANALYSIS AND MODELLING

3.1. Visibility from the peak sanctuaries

"The sanctuary should be seen from the region it served and it should 'see' that region" [7]. Viewshed analysis[8] thus seemed appropriate to investigate this ritual unity, which could even be transcended to a political territorialism (See endnote 2). The results of the viewshed analysis were compared to the panoramic photographs for verification. In this way it was discovered that for each peak the 'corrected' viewshed area was the result of an additive viewshed from the four corners of the highest pixel. Field experience allowed us to set a standard diameter of 50km, and an added height of 1.5m.

Archaeologically we compared the results of the viewsheds to the distribution and hierarchy of the sanctuaries and settlements. It followed that intervisibility indicates religious unity, but it is the hierarchy of the sanctuaries (in terms of 'richness' and monumentality) that coincides with a hierarchy in intervisibility. The high intervisibility of early Protopalatial peak sanctuaries in east Crete may have served to unite the settlements in religious practice, but their non-hierarchical distribution corresponds to a landscape of many polities. Furthermore it seems that the prominent role of Knossos is mirrored in the peak sanctuary landscape by Iuktas. From the Protopalatial period and onwards, Central Crete seems to have a more stable distribution of sites than East or West Crete. The prominent character of Iuktas was accentuated by its high intervisibility with its "satellite peak sanctuaries". All of them are visible from Iuktas, but not so much amongst each other.

The visibility of the peak sanctuaries from the sea, analysed again by viewsheds, and the presence of thick ash layers at some of the sanctuaries, supports the idea that the sanctuaries were used as landmarks or even as beacons for travellers and especially for ships coming from the Cyclades.

3.2. Modeling of territories

In order to assign territories to Minoan sites of high hierarchy, it was first necessary to determine which these sites were. It was decided to work with different sets of sites, so that various theoretical suggestions [10], could be analyzed by modeling processes. Thus three sets were analyzed: the four generally accepted palaces (Knossos, Phaistos, Mallia, and Zakros), a group of 14 court compounds, and a hypothetical set of 18 sites, including the previous and some sites where a court compound is to be expected [11].

Three modeling processes were adapted, namely Thiessen polygons, based on Euclidean distance between the sites, Cost Surface Analysis, which is based on the effort needed to cross the landscape, and X-tent modeling, which is based on the idea that the extent of a territory is directly proportional to the size (and/or population, e. a.) of its centers and the distance between them.

In Fig. 1 Thiessen polygons show that the larger dataset creates a more even distribution of territories than the smaller dataset, but due to the dense distribution around the largest site, Knossos, a rather small territory is left for this major site.

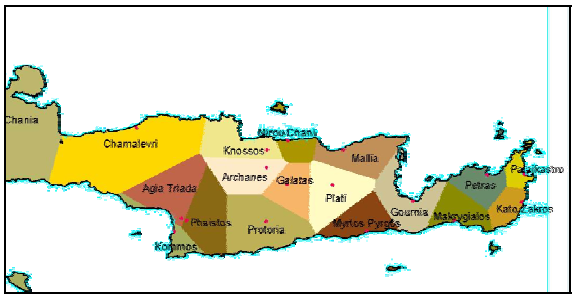

Fig. 1: Thiessen polygons for the set of all neopalatial court compounds and hypothetical sites

Cost Surface analysis can be an effective way to create areas of influence based on the relief of the landscape. The slope raster, as derived from the DEM was reclassified to a value of effort rather than a degree of slope. The sea was given the highest value so that our model would search its way over land and not over sea. The result displays a raster based on accumulative slope values starting at the court compounds. Where a steep slope is encountered, values will increase faster than on a flat area. Based on this result, each cell of the raster was then allocated to the easier reachable site, and hypothetical territories were shaped (Fig. 2). The result resembles the Thiessen polygons, but respects much more the slope of the landscape.

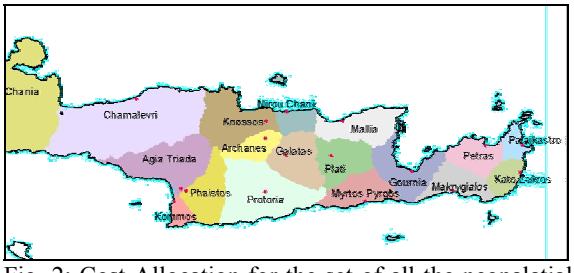

Fig. 2: Cost Allocation for the set of all the neopalatial court compounds and hypothetical sites

The analysis of the "cheapest" cost path between two points, such as peak sanctuaries and court compounds, visualizes and puts a value on the distance between both themes. The cost paths also detect which settlement or peak sanctuary is closer to which court compound. Peak sanctuaries and settlements are part of court compound networks, and here linked to the court compound with a hypothetical path (Fig. 3).

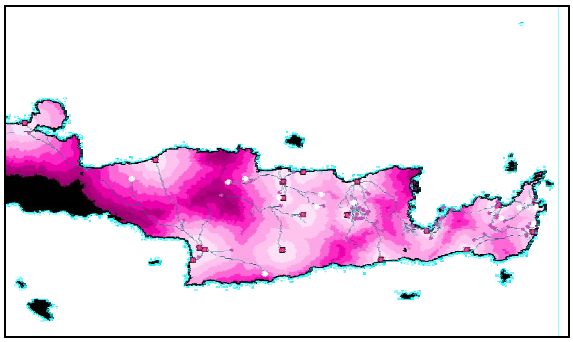

Fig. 3: Cost Path from all court compounds and hypothetical sites (squares) to neopalatial peak sanctuaries (in white) and settlements (purple circles) on Cost Distance Grid (black is more than a day's walk)

The X-tent model uses intra-site qualities for the size of its territory [12]. Its value was tested with the current district capitals of Crete, for which we know the modern day boundaries. This model argues that the extent of a territory is directly proportional to the size of the main settlements and the distance between them. The equation is:

$I = C^a - K*d$

where I = influence, C is the size of the settlement, d is the distance from the site, and a and K are experimental variables. In our case C was expressed in sq m and d in m. A total of six runs was executed for each of the sets (a=0.75 & K=0.5; a=0.8 & K=0.5, a=0.85 & K=0.5; a=0.75 & K=1; a=0.8 & K=1; a=0.85 & K=1).

As can be seen in Fig. 4 and Fig. 5, Knossos not only gained enormously in surface, but its size is impressive enough to completely subdue any influence of the smaller court compounds. In case of the court compound set, only five of fourteen sites exert any influence at all.

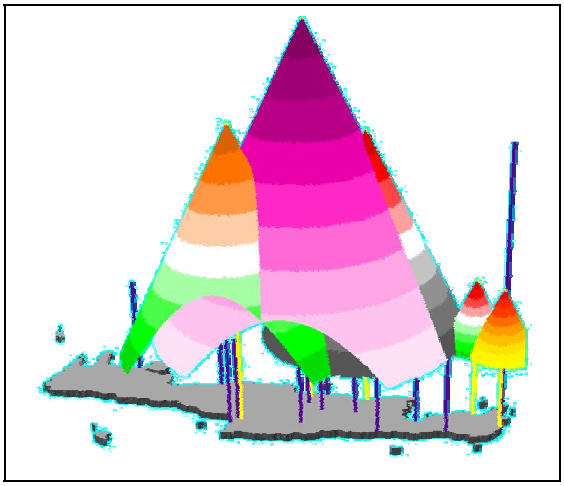

Fig. 4: 3D representation of the X-tent model of all court compounds. The radius of circle is C^a and represents the size of the X-tent territory, while K*d is the slope of the cone (Run a=0.85 & K=1) and represents how fast the territory loses influence.

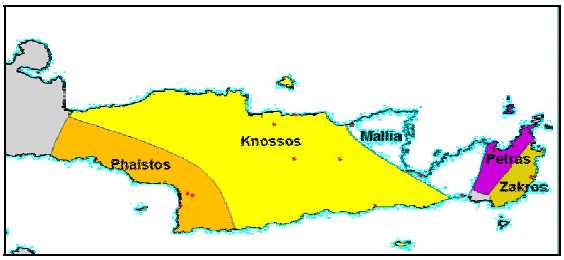

Fig. 5: Xtent model of all court compounds, without their influence on the sea (Run a=0.85 & K=1)

4. RESULTS - FUTURE

To come to a proper archaeological interpretation on the perception of the ideational landscape, on the Minoan topography of power and on its relation to the peak sanctuaries, it is obvious that the results of these models cannot be analyzed separately.

All of the models were compared by charting the non-sea surface for each site in each different set.

Thiessen polygons simply distribute the available terrain into territories of power sites as if the landscape was flat and dry. It is for this reason not a very useful method for the dramatic landscape of Crete. However territories resulting from Cost Surface Analysis respect very much the topography and characteristics of the Cretan landscape. Cost Allocation suggests the shape of the territory. X-tent modeling uses a quality (size of site, population, stock capacity, etc.) of the power site and its distance to the investigated terrain. The experimental variables make this model slightly unstable, but X-tent modeling suggests the size of the territory.

Spatial relationships between the court compounds and the peak sanctuaries were confirmed by viewshed analysis and the study of site distribution and hierarchy.
We hope in the future to develop a combined model of X-tent and Cost Surface to suggest simultaneously shape and size of hypothetical territories.
The next phase of this project will on one hand compare more systematically the court compounds models with the peak sanctuaries' viewsheds to define more accurately the spatial relation between these sites, and propose a better interpretation of their common ideational relationship with the landscape. Multivariate statistics on the other hand will be deployed to group the peak sanctuaries based on topographical and environmental characteristics. The results here are hoped to further define the peak sanctuary and provide a useful tool of prediction.

Endnotes:

[*] Acknowledgments: The authors would like to thank the Institute of Aegean Prehistory for their continuous support. This poster is a combined effort of two individual research projects ("Building a cultural landscape model of Minoan peak sanctuaries through a GIS approach" and "A Study of Political Structures in Neopalatial Crete"), and is part of the wider framework project: "A Topography of Power. Studies on the Political Structures of Minoan Crete and Etruria". (http://www.fltr.ucl.ac.be/FLTR/ARKE/Arka/accueil/fsr.html)

[1] Nowicki K., Some Remarks on the Distribution of Peak Sanctuaries in Middle Minoan Crete, *ArcheologiaWar (Warsaw)*, XLII, 1991, 143-145..

[2] Peatfield A. A. D., After the 'Big Bang' – What? Or Minoan Symbols and Shrines beyond Palatial Collapse, in Alcock S. E. & Osborne R. (eds), *Placing the Gods, Sanctuaries and Sacred Space in Greece*, Oxford, 1994, 25.

[3] Knapp A. B., Ideational and Industrial Landscape on Prehistoric Cyprus, Ideational, in Ashmore W. & Knapp A. B. (eds), *Archaeologies of Landscape. Contemporary Perspectives*, Blackwell Publishers, Oxford 1999, 232.

[4]Knapp A. B. & Ashmore W., Archaeological Landscapes; Constructed, Conceptualized, Ideational, in Ashmore W. & Knapp A. B. (eds), *Archaeologies of Landscape. Contemporary Perspectives*, Blackwell Publishers, Oxford 1999, 13-19.

[5] Proper criteria for identification were defined by Peatfield, Rutkowski and Nowicki. About 25 sites respond positively to their criteria. These criteria are the site's closeness to peak, intervisibility between sites, proximity to contemporary settlements, and the presence of a specific artefact assemblage (figurines, pottery, and pebbles from the river or sea).

Before these criteria were defined, more sites were identified as peak sanctuaries. They are either located near mountain peaks with unpublished, wrongly dated or not further specified archaeological evidence or have no relation with a mountain peak, but just produced many figurines. (Rutkowski, B., *The Cult Places of The Aegean*, New Haven & London, 1986, 72-98; Rutkowski, B., Minoan Peak Sanctuaries: The Topography and Architecture, in Laffineur, R., (ed.), *AEGAEUM* 2, 1988, 71-100; Peatfield A. A. D., Palace and Peak: The Political and Religious Relationship between Palaces and Peak Sanctuaries, in R. Hägg and N. Marinatos (eds.), *The Function of the Minoan Palaces. Proceedings of the Fourth International Symposium at the Swedish Institute in Athens, 10-16 June, 1984*, 1987, 89-93; Peatfield A. A. D., Minoan Peak Sanctuaries: History and Society, *Opuscula Atheniensia*, 18, 1990, 117-132; Nowicki K., Some Remarks on the Pre- and Protopalatial Peak Sanctuaries in Crete, *Aegean Archaeology (AEA)*, 1, 1994, 31-48)

[6] With many thanks to S. Topouzi

[7] Peatfield A. A. D., "The Topography of Minoan Peak Sanctuaries", *BSA* 78, 1983, 274-276.

[8] Soetens S., Driessen, Sarris A., Topouzi S., "The Minoan Peak Sanctuary Landscape through a GIS approach", *Archeologia e Calcolatori* 13, 2002 (in press); Soetens S., Sarris A., Topouzi S., Peak Sanctuaries in the Minoan Cultural Landscape, *Proceedings of the 9th International Congress of Cretan Studies* (in press).

[10] This question was the main theme of an International Workshop "Crete of the 100 'Palaces'? Variety and Levels in the Minoan Political Landscape" organized by the project: A Topography of Power, and will be published in J. Driessen, I. Schoep and R. Laffineur (eds), *Monuments of Minos.Variety and Levels in the Minoan Political Landscape,* Aegaeum 24).

[11] Some of these sites are so substantial in size that the absence of the court compound building is explained as "not found yet". The presence of 'palatial' architectural features and a gap in the Cretan terrain very often reinforce these assumptions.

[12] Renfrew C. & Level E V, Exploring dominance: Predicting polities from centers, in Renfrew C. & Cooke K. L. (eds), *Transformations: Mathematical Approaches to Culture Change*, Academic Press, New York, 145-167, 1979.