

GIS Variations on a Cretan Theme: Minoan Peak Sanctuaries*

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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 (human and animal figurines, etc). 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 purpose of this project is the systematical investigation of these observations, the identification of further functionalities of the peak sanctuaries, the better understanding of 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. Geographical Information Systems (GIS) were 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

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

² A. A. D. Peatfield, "After the 'Big Bang' – What? Or Minoan Symbols and Shrines beyond Palatial Collapse", in *Placing the Gods, Sanctuaries and Sacred Space in Greece* (1994) 25.

³ A. B. Knapp, "Ideational and Industrial Landscape on Prehistoric Cyprus", in *Archaeologies of Landscape. Contemporary Perspectives* (1999) 232.

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.

DGPS receivers⁵ were used to collect the geographical coordinates of the peak sanctuaries, including all the certainly identified ones and some candidate sites⁶, 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, major sanctuaries and burial sites.

Topography, Geology, Land use, Land capability and Archaeological Survey maps of different scales were manually digitized in AutoCad 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. All resulting layers were referenced to the same geodetic projection⁷.

Several limitations exist in the constructed model, mainly originating in the availability of the data. The archaeological published data do not represent a complete spatial distribution of the Minoan settlement pattern, but rather the distribution of archaeological excavations and surveys. For a more complete image of the local distribution of sites and diachronic use of landscape, only an intensively surveyed area can be analyzed for optimal results. Secondly, due to the large size of the studied area, i.e. the whole of the island of Crete, the digitized maps and the DEM have a relatively low resolution, which leaves an error margin. Furthermore today’s land use and land capability have changed from the past⁸ and basically the proposed Minoan cultural landscape model is draped on a modern environmental background. Nevertheless, the constructed model is sufficiently accurate to analyze the visibility from and to the peak sanctuaries and their wider topographical and environmental characteristics.

⁴ A. B. Knapp & W. Ashmore, “Archaeological Landscapes; Constructed, Conceptualized, Ideational”, in *Archaeologies of Landscape. Contemporary Perspectives* (1999) 13-19.

⁵ Differential Global Positioning System Receivers, Ashtech Z12, with sub-cm accuracy.

⁶ 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). (B. Rutkowski, *The Cult Places of The Aegean* (1986) 72-98; B. Rutkowski, “Minoan Peak Sanctuaries: The Topography and Architecture”, in *AEAEUM* 2 (1988) 71-100; A. A. D. Peatfield, “Palace and Peak: The Political and Religious Relationship between Palaces and Peak Sanctuaries”, in *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; A. A. D. Peatfield, “Minoan Peak Sanctuaries: History and Society”, *Opuscula Atheniensi* 18 (1990) 117-132; K. Nowicki, “Some Remarks on the Pre- and Protopalatial Peak Sanctuaries in Crete”, *Aegean Archaeology* 1 (1994) 31-48.)

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. (P. Faure, “Nouvelles recherches sur trois sortes de sanctuaires crétois”, *BCH* 91, 1967, 114-150; P. Faure, “Sur trois sortes de sanctuaires crétois”, *BCH* 93, 1969, 174-213; P. Faure, “Cultes populaires dans la Crète antique”, *BCH* 96, 1972, 389-426; L. V. Watrous, “Some observations on Minoan Peak Sanctuaries”, in *AEAEUM* 12: *Politeia: Society and State in the Aegean Bronze Age. Proceedings of the 5th International Aegean Conference, University of Heidelberg, 10-13 April 1994*, II (1994) 393-403).

⁷ ΕΓΣΑ ’87 or HGRS 87 (Hellenic Geodetic Reference System 87)

⁸ K. Kvamme, “Ranters Corner: bringing the camps together: GIS AND ED”, *Archaeological Computing Newsletter (ACN)* (1997) 47, 1-5; O. Rackham & J. Moody, *The making of the Cretan landscape*, 1996, 39: The change to a “Mediterranean” climate seems to have developed gradually during the Bronze Age.

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”⁹. Viewshed analysis¹⁰ thus seemed appropriate to investigate this ritual unity, which could even be transcended to a political territorialism (see footnote 2). The results of the viewshed analysis were compared to 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 radius of 50km, and an added height of 1.5m. The results of the viewsheds were compared to the distribution and hierarchy of the sanctuaries and settlements¹¹ (Fig.1). It followed that intervisibility indicates religious unity, but it is the hierarchy of the sanctuaries (in terms of ‘richness’ and architectural remains) 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 suggestions¹², 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 expected¹³.

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 (surface of centre, population, storage capacity, etc.) of its centers and the distance between them.

In Fig. 2 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.

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

⁹ A. A. D. Peatfield, “The Topography of Minoan Peak Sanctuaries”, *BSA* 78, 1983, 274-276.

¹⁰ S. Soetens, J. Driessen, A. Sarris, S. Topouzi, “The Minoan Peak Sanctuary Landscape through a GIS approach”, *Archeologia e Calcolatori* 13, 2002 (in press); S. Soetens, A. Sarris, S. Topouzi, “Peak Sanctuaries in the Minoan Cultural Landscape”, *Proceedings of the 9th International Congress of Cretan Studies* (in press).

¹¹ J. Driessen, “History and Hierarchy. Preliminary Observations on the Settlement Patterns in Minoan Crete” in *Urbanism in the Aegean Bronze Age* (2001), 51-71.

¹² 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* 23 (2002).

¹³ 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.

hypothetical territories were shaped (Fig. 3). The result resembles the Thiessen polygons, but respects much more the slope of the landscape.

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 the hypothetical path of the least effort (Fig. 3).

The X-tent model uses intra-site qualities for the size of its territory¹⁴. 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 model is based on the following equation:

$$I = C^a - K*d$$

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, 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.

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.

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 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 will also 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.

¹⁴ C. Renfrew & E. V. Level, “Exploring dominance: Predicting polities from centers”, in *Transformations: Mathematical Approaches to Culture Change* (1979) 145-167.

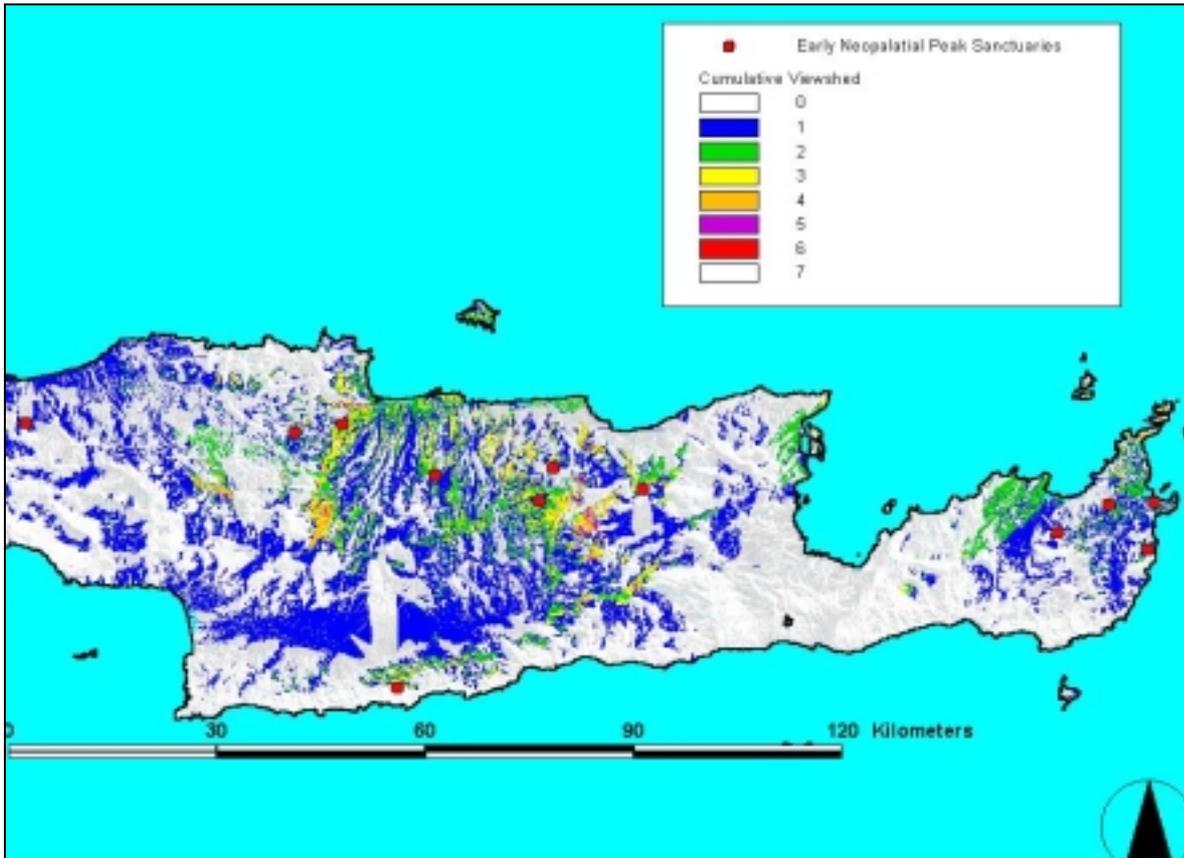


Figure 1: Early Neopalatial Peak Sanctuaries: Cumulative Viewshed

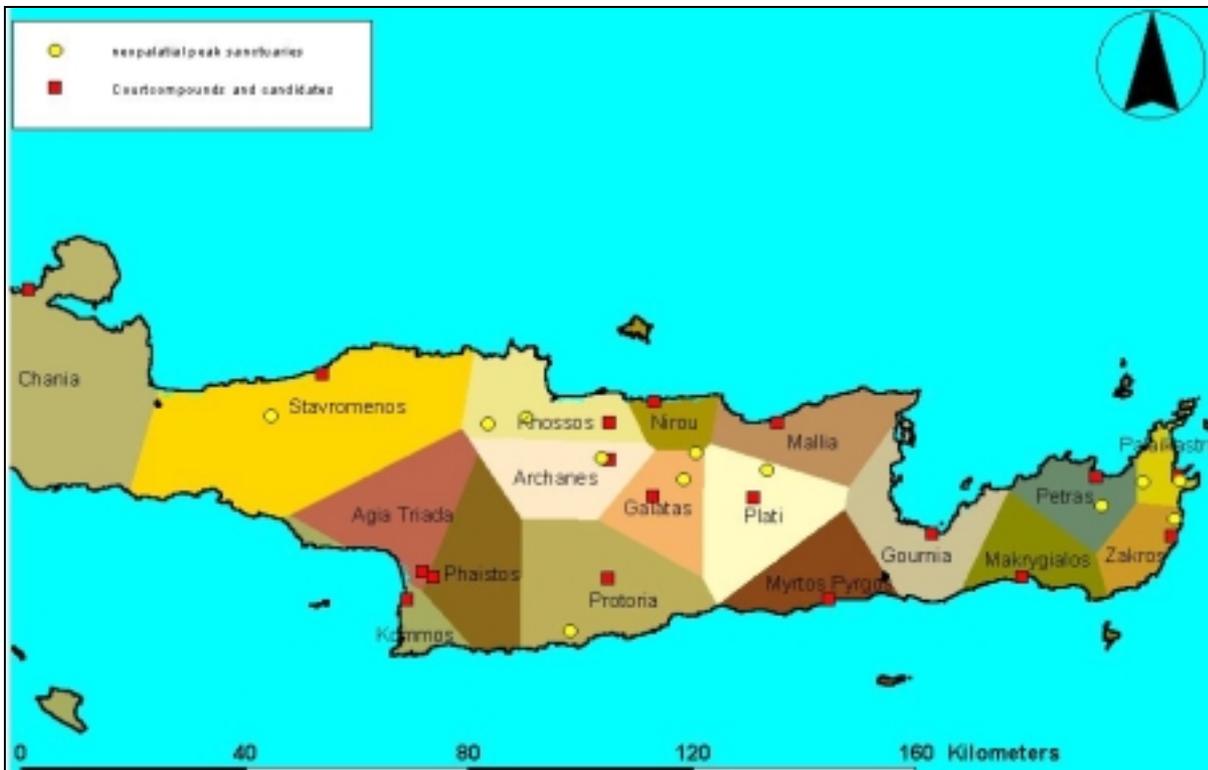


Figure 2: Thiessen polygons for all court compounds and hypothetical sites

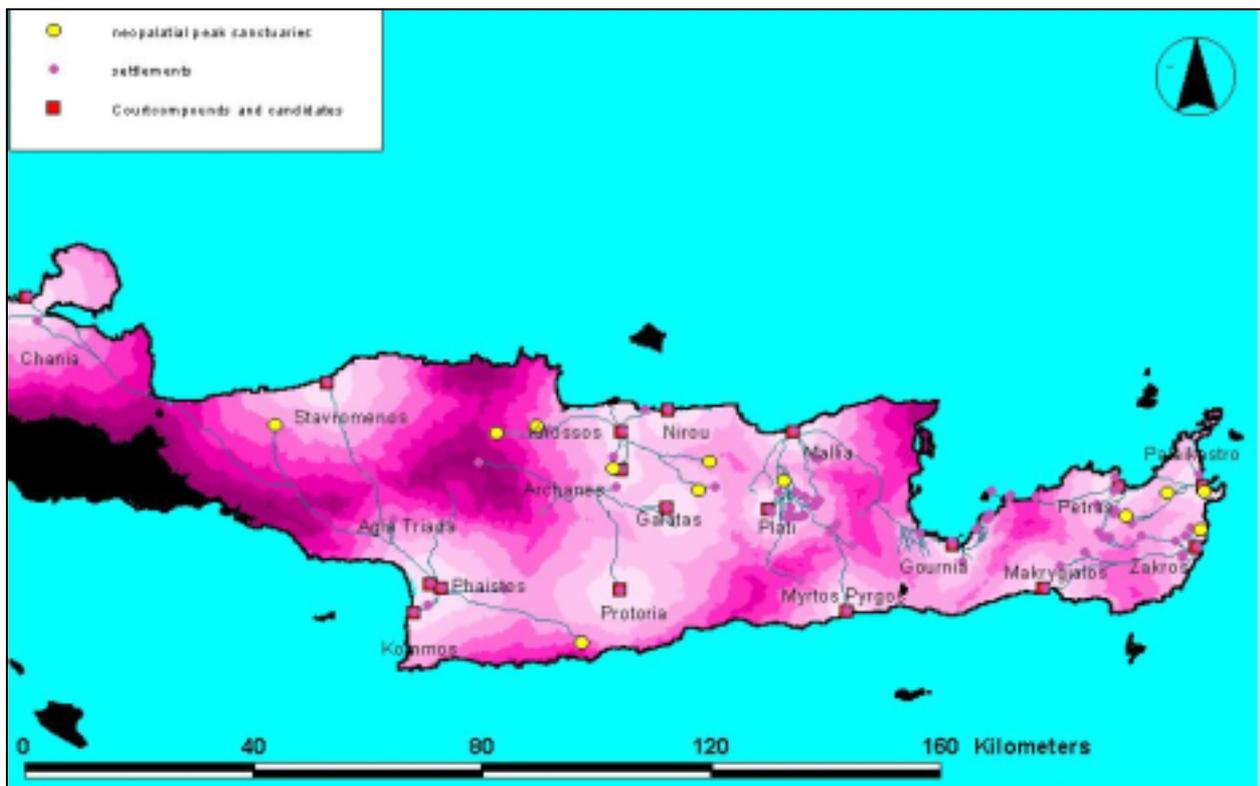


Figure 3: Cost Distance for all court compounds and hypothetical sites

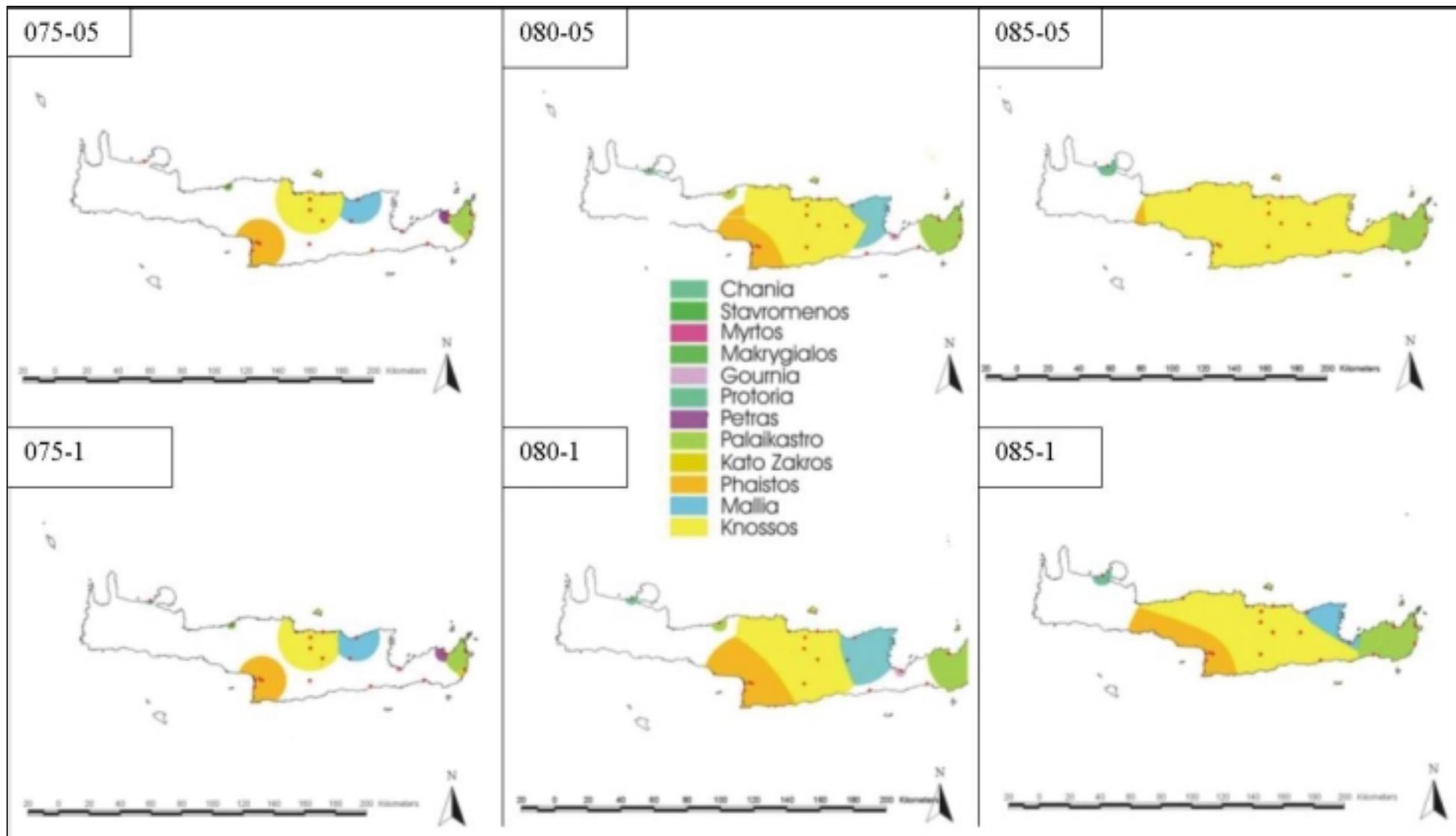


Figure 4: Xtent model for all court compounds and hypothetical sites