GIS approach to Iberian Iron Age landscape in central-south Valencia region (Spain)

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Abstract: This paper is an approach to landscape and territory in the central-south area of Valencia Region (Spain) through GIS techniques. Taking the information from the surveys and the revision of the known sites, an analysis of the settlement is made. We attend the dynamics of development of the Iberian oppida as the principal centres of population and political control.

Introduction

This paper shows some aspects of the recent research concerning Iberian landscapes, conduced by scholars from the Department of Archaeology of the University of Alicante (Spain). The archaeological research has been developed in the Alcoià-Comtat valleys (province of Alicante) in the central-south district of the Valencia region (Grau Mira, 1998). The aims of this research are to study aspects of settlement, landscape, and material culture among Iberian peoples.

In this region we explore the processes of spatial and societal transformations developed during the Iberian Iron Age, between the 7th and the 1st centuries BC. In Iberia this change is evidenced by the emergence of hillforts that are at the top of a hierarchical settlement pattern. These hillforts, traditionally referred to as *oppida* in Iberian research, are the principal centres of population and political control (Ruiz y Molinos, 1993). We analyse functional aspects of the Iberian hillforts and their role in regional settlement patterns using Geographic Information Systems.

Geographical background

The area of our study is L'Alcoià and El Comtat counties so-called Valls d'Alcoi, a mountainous area with peaks between the 300 and the 1200 meters, located in central Valencia Region, eastern Spain. The valleys consist of a series of folds oriented SW-NE, the typical orientation of the Betic reliefs, which define a landscape of calcareous mountains dominating narrow and irregular valleys that lead into small plains in the coast. This valleys are articulated by the river of Alcoi basin, the main valley of the area where are going to spill all the streams of the tributary valleys.

The orientation of these reliefs have a very important role in possible communication between this area and nearby region, that can only be achieved through a series of mountain corridors whose control is relevant to strategic pursuits.

The climate is classically Mediterranean with a summer drought, even temperatures in winter and maximum precipitation concentrated in the autumn months. However the broken topography modifies this general climatic pattern; for example, the northern exposed slopes will normally get more rain than southern exposed ones (Nebot *el al.*, 1993, 29).

The geological background, the climate and the broken topography have resulted in the existence of diverse types of soils in the area: in the top and slopes of the calcareous mountains we find rocket soil without agricultural possibilities. In the other hand, the better soils are located in the basins of the valleys, they are composed by alluvium and sediments deposited by the rivers in flat terrain. Middle capability soils can be found in contact areas between mountains and basin.

These natural features have led to the concentration of the settlement near the valleys, where we find the most important sites and the main ways of the area.

Procedures and methodology

We use GIS tools to analyse the structural relationships between hillforts and their surrounding area, including issues related to economic structures, control and visibility.

One of the most important points of procedure when applying GIS to landscape studies is to use the most homogeneous and precise cartography that is available. In this respect, the *Conselleria d'Obres Publiques i Urbanisme* of the Valencia Regional Government has edited many basic and thematic cartography in digital editions in the series *Sistema d'Informació Territorial.* This collection offers cartographic information in DXF and shape files for the *ArcView* program; this system allows the transfer of data with great precision.

The cartographic coverage that we used were 20 m and 100 m elevation contour lines, geology, rivers, modern roads and agriculture capability soils classification.

We produced a Digital Elevation Model of the study area generated from contour lines with a vertical interval of 20 m and covering an area of approximately 700 sq. km. With this DEM we explored cost surface analyses and viewsheds. We also examined tessellation of the landscape through Thiessen polygons.

The main analysis was carried out with GIS raster *Idrissi* and the resulting coverages were introduced into the *ArcView* program. This combination offers better possibilities of mapping, image processing and compatibility with other databases.

Settlement pattern and allocation

Different research groups have carried out excavations and intensive surveys in the study area and have uncovered the main archaeological remains. These surveys provided intensive information, which is translated into a high density of sites dating from various prehistorical periods, including those belonging to the Iberian Iron Age.

Archaeological fieldwork has provided evidence of seventy sites corresponding to the Iberian Period.

The settlement pattern in the area has two principal type of sites.

1. *Hillforts.* There are ten sites located on the hilltops. These cover approximately 2-3 hectares in area and are protected by defensive walls. These are the principal sites in the Iberian period, more commonly known as *oppida.*
2. *Farmsteads.* Sixty small sites are located at the base and on the low slopes of the valleys. Their size is typically less than a hectare, and frequently less than 5000 sq. m. These sites are interpreted as villages or farmsteads subordinate to *oppida.*

The *oppida* are generally located on summits on an approximate altitude of 800-900 m along the principal range of mountains that border the region, and around 200-300 m over the lower valleys. These locations offer defensive positions protected by the topography with good visibility of their surrounding areas. Thiessen polygons were used to assign territories to each *oppidum*, but they were first adjusted to conform to principal natural features like rivers and ridgelines (Van Leusen, 1993). We adapted the geometric lines of the theoretical Thiessen polygons to the irregular lines corresponding to natural boundaries in the proximity of these polygons. Through this approach the entire region was partitioned into territories corresponding to small valleys with boundaries recognisable in the landscape (Figure 2).

Cost surface and catchment analysis

Secondly, we employed cost surfaces analyses to define catchments encompassing to an hour's walking distance in order to explore the possibility of competition for resources. The cost surface derived catchment areas allow an examination of the economic possibilities of each *oppida* by relating the catchments with information about arable lands and soils quality. Through this analysis it is possible to quantify agricultural resources and the economic potential of each site within its theoretical territories (Figure 3).

We can conclude that it is not possible to observe similar economic strategies in relation to size and quality of land of these principal sites. However, we can detect that each *oppidum* controlled its surrounding land without frictions and competition with neighbours for land. There is an equal allocation and distribution of the *oppida* around the region. The principal interest of hillforts is oriented towards the control of medium quality soils. Land use is oriented to dry farming for cereal production, the characteristic agriculture in the Iberian period.

The large populations of the hillforts were the principal exploiters of the terrain in the region. Nevertheless the mountainous locations of the *oppida* made movement around the environment difficult, so their catchment areas were small. Therefore the exploitation of resources in these territories was completed by the subordinated farmsteads.

Communications and optimum corridor analysis

The communications between the settlements are of great importance in understanding the organisation of space. The existence of fixed pathways and communication axes were necessary to establish economic relations and to fulfill needs of political control.

In the mountainous area of study, the relief imposes some obstacles to circulation. We have carried out a GIS analysis employing the techniques of Cost Surface. These functions analyse the difficulties of travelling through a surface in relation to the characteristics of the terrain and the natural barriers. We take information to apply these techniques from a Digital Elevation Model.

We obtained optimum corridors, the routes of least resistance on wich to travel through the area. These pathways take advantage of the natural steps and the areas of lower slope. Secondly, we contrast the optimum corridors with the historically known roads in the region dating from the Middle Ages. The result shows that the traditional roads follow the same routes as natural corridors because these are the only possibilities of circulation in this mountainous region.

The layout of the natural corridors was contrasted subsequently with other layers of information about the location of the Iberian settlements. The purpose of this was to verify which of these corridors could have been used as pathways in the Iberian period. These were two principal conclusions:

1. The main pathway follows the North-South axis of the valley. Three of the most important *oppida* are located close to the road and control circulation.
2. Every *oppida* manages the secondary pathways that are present in their nearest valley. These pathways allow relations between the principal settlements.

Viewshed and intervisibility analysis

Viewshed analysis is very important to perceive territoriality and to investigate ideas about control over the landscape. We analysed the viewshed of each *oppida* through a DEM of the area as well as intervisibility between the *oppida*. Another fundamental feature of the landscape, the principal ways of travel, was also examined with respect to visibility. We developed some research similar to other GIS applications using similar technique to the analysis of Celtic roads in Burgundy (Madry and Rakos, 1996).

We can observe three principal focuses of visual control:

1. The view is oriented to the valleys below the *oppida* locations and the nearby small sites in the basin, much like GIS-based interpretations offered in other Iron Age landscapes (e.g., Lock and Harris, 1996).
2. Visibility is oriented to control the most important pathways in the area (e.g., Madry and Rakos, 1996), especially the mountain corridors. These points were very important places for achieving access to the Alcoià-Comtat Valleys.
3. Each hillfort has visual control over other *oppida*. Intervisibilty analysis allows the recognition of an important web of visual intercommunication between the *oppida* of the region. This visual connection is perhaps related to a common defensive strategy in case of incursion and war. Each *oppida* can issue the alert in case of danger.

This strategy is very important for the control of the principal North-South pathway that crosses the central part of the valley, allowing contact with other regions. This route is highly visible from the *oppida* as we can observe from the viewshed analysis. Figure 5 illustrates an example of visibility between two hillforts. The visual control of nearby valleys is clearly demonstrated, also the intervisibility with other hillforts. The control focuses on the central part of the region and the principal pathways. (Figure 5).

Final remarks

The procedures described are the basic GIS-techniques that we have employed throughout our study of the territory. This application allows us to analyse the relation between the most important Iberian settlements and their environment. Also, this system permits the management and transformation of an important volume of archaeological and geographical information.

GIS analysis illustrates the existence of early processes of proto-urbanisation and centralisation in the study area. This dynamic is shown in the emergence of several hillforts that assumed the main functions of control and exploitation of the resources in the landscape.

These hillforts or *oppida* control each one of the valleys of the region. The hill top sites manage the settlement of this environment composed of subordinate farmsteads. Also, these settlements exercise control over different roads and the defence of the territory. They provide refuge to dispersed settlements in case of danger.

This model is similar to other territorial structures in the Iberian Iron Age. These settlement patterns are characterised by the existence of hillforts controlling small territories consisting of farmsteads. These territorial structures are part of the socio-political organisation of the Iberians, characterised by the emergence of primary aristocracies and proto-state forms of development (Ruiz and Molinos, 1993).

During the Classical Iberian Period this settlement pattern changed to develop a more hierarchized model. The small valleys analysed formed part of a great territory corresponding to the complete region of L'Alcoià-El Comtat in the 3rd century BC. The Iberian town of La Serreta de Alcoi controlled this territorial structure (Olcina *et al*., 1998) and developed its power upon the other *oppida*. This town exercised the main political, economic and social functions in the landscape.

The new territorial structure established a network of common intervisibility allowing communication inside the region in case of a hostile incursion. This control permitted a rapid evacuation of the territory and the preparation of a possible assembled reply against the invader. This change is related to the historic circumstances of the period, principally at the end of 3rd century BC when the area was severely affected by the Second Punic War. As a result of this war, the Iberian structures of settlement were transformed and the process of Romanisation developed new models of organisation.

The area analized was in the core of a major region named *Contestania* by the ancient sources. In this region the most important strategic role of the settlement pattern was related to the possibilities of communication between the north and the south of *Contestania*. The important centres of *El Tossal de Manises* (Alicante) and *La Alcudia* (Elche, Alicante) was located around 30 km to the south and *Saiti* (Játiva, Valencia) was located 25 km to the north of the area of study. The region was well connected by the principal North-South road that crosses the Alcoià-Comtat valleys. This territorial integration allowed the very important development of *Contestania* in the Iberian Period that became one of the most important territories in *Iberia*.

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References

Lock, G and Harris, T.M. 1996. Danebury revisited: An English Iron Age hillfort in a digital landscape. In Aldenderf, M. and Maschner H.D.G. (eds.), *Anthropology, Space and Geographic Information Systems*. Oxfort University Press, New York, pp. 214-240.

Grau Mira, I. 1998. Aproximación al poblamiento de época

Plena Ibérica (ss. IV-III aC) en la región centro-meridional del País Valenciano *Arqueología Espacial XIX-XX.* Teruel. 309-321..

Nebot, J., Massanet, C., Torró, J. 1993. *L'Alcoià y El Comtat. Guia històrica i natural.* Alcoi.

Madry, S.L.H. and Rakos, L. 1996. Line-of-sight and cost-surface techniques for regional research in the Arroux Valley. In Maschner H.D.G. (ed.), *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*, Occasional Paper, N° 23, Southern Illinois University, Carbondale, pp.104-126.

Olcina Domenech, M., Grau Mira, I., Moltó Gisbert, S., Reig Seguí, C., Sala Sellés, F. y Segura Martí, J.M. 1998. Nuevas aportaciones a la evolución de la ciudad ibérica: el caso de La Serreta, In Aranegui, C (ed.), *Congreso Internacional Los Iberos, Príncipes de Occidente (Barcelona, marzo 1998).* Barcelona. pp. 35-46.

Ruiz A. and Molinos, M. 1993. *Los Iberos. Análisis arqueológico de un proceso histórico.* Barcelona.

Van Leusen, P.M. 1993. Cartographic modelling in a cell-based GIS. In Andresen, J., Madsen, T. and Scollar, I. (eds.), *Computing the Past: Computer Applications and Quantitative Methods in Archeology, CAA92*, Aarhus University Press. Aarhus. pp. 105-122.

Legends

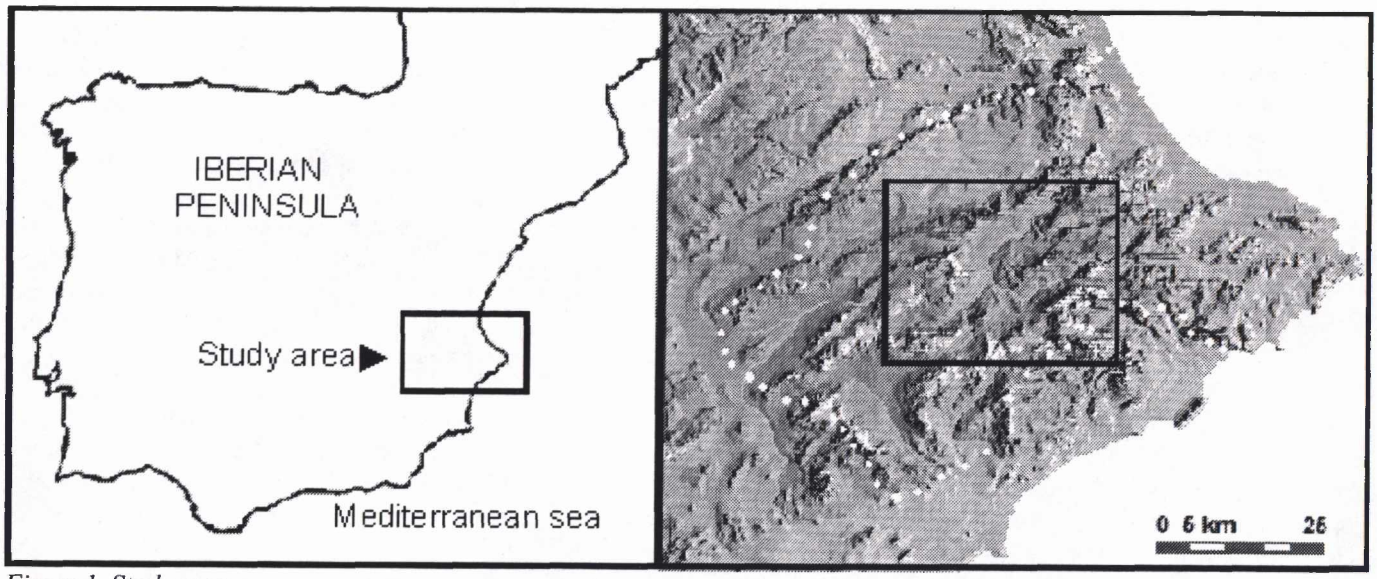

Figure 1. Study area.

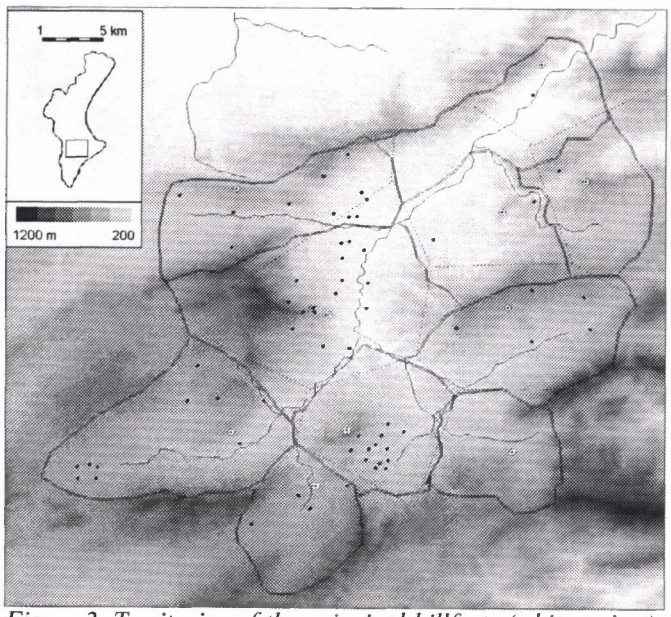

Figure 2. Territories of the principal hillforts (white points) achieved through modified Thiessen polygons conforming to landscape features

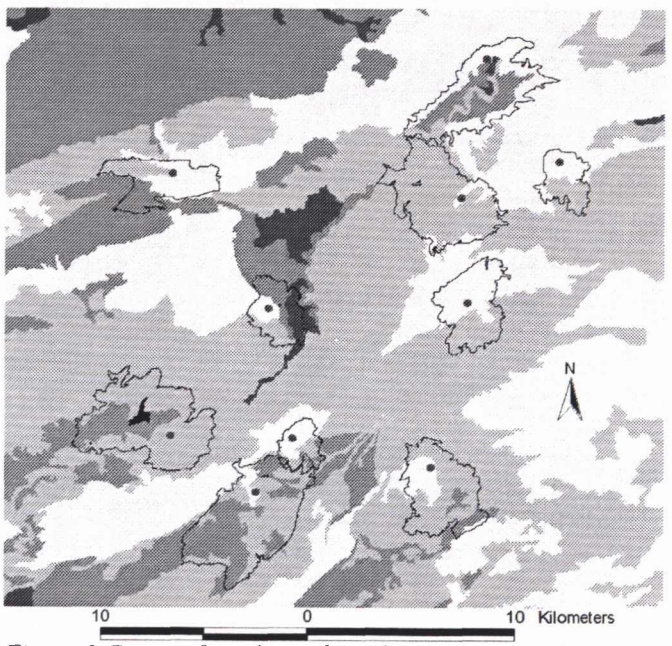

Figure 3.Cost surface derived catchment areas of the hillforts (white points) plotted over soil productivity. Dark colours are good soils; clear colours are poor soils.

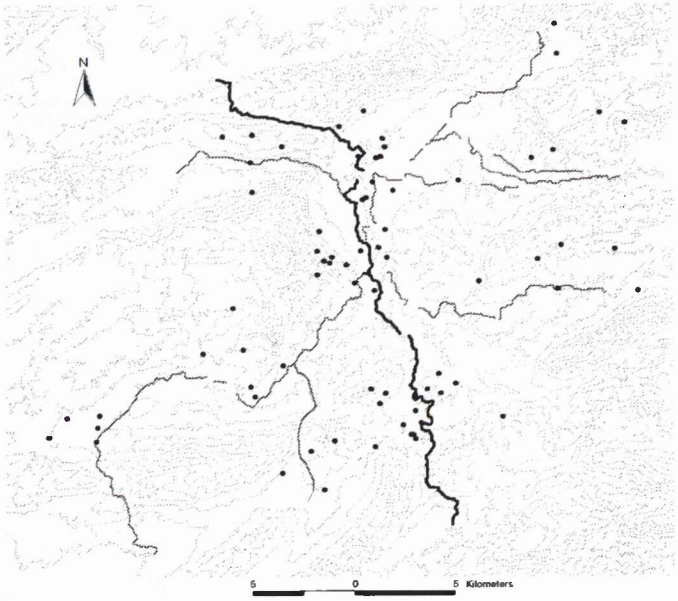

Figure 4. Settlement distribution inrelation to the principal pathways in the area.

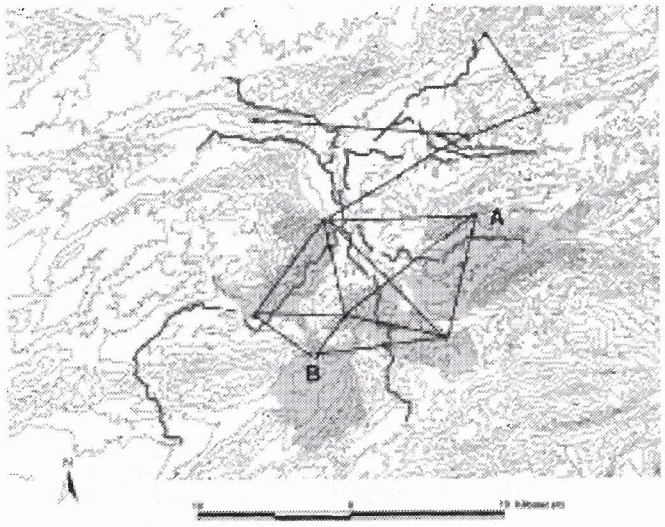

Figure 5. Visibility between two example hillforts (A and B) and the intervisibility relation of the principal hillforts. In dark grey we illustrate the principal pathways.