From Iberian Oppidum to Roman Municipium
GIS Study of Ancient Landscape in Eastern Spain

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Abstract. This paper applies common GIS-techniques such as cost-surface and line-of-sight to study Ancient landscape. The creation of the roman hinterland in Eastern Spain is analyzed through a comparative study of the Iberian and Roman settlement patterns. For this pourpose, a GIS application of cost-surface techniques is developed to analyze the relationship between urban and rural components. As well, in order to understand the perceived environment, the strategic and symbolic changes are tested through GIS visibility analysis.

1. Introduction

The use of GIS techniques to understand the ancient landscape has an increasing role in the Spanish academia since the second half of the 90'. The monographic volumes dedicated to these methodologies (Baena et al 1997; Sande Lemos et al 2000) and the research developed in several universities have produced an important number of papers related to this topic. It is within this context that the current study, undertaken in the Department of Prehistory and Archaeology of the University of Alicante, must be situated.
The present paper is linked to other research developed by this author in Iberian Iron Age landscape carried out in recent years (Grau Mira 2001, 2002). The general aim of this research is to understand the Mediterranean landscape during Antiquity. This study addresses the socio-economic aspects related to the changes in the observable spatial patterns. These processes are characterized by the centralization and urbanization dynamics started by the Iberians which was culminated with the incorporation of Iberia to the Roman Empire. In this paper we address to this final process of transition from the Iberian to the Roman landscape.
This study applies common GIS-techniques such as cost-surface and line-of-sight analysis to the case study. In this sense, the contribution of the paper is the use of established methodologies to address specific problems in historical terms. This paper makes use of archaeological, historical and anthropological information within a GIS framework to understand this changing landscape. The study deals with the understanding of issues such as movement across the landscape and visibility to understand the structure of ancient territorium.

2. GIS Study of the Ancient Landscape in Hispania: the Case-study of Territorium Dianensis

This paper concentrates on the creation of the roman hinterland in Eastern Spain. The case study is the Late Iberian and Roman Imperial town of Dianium (Gisbert 1998, 2003), in Hispania Citerior (Valencia Region, Spain) (Fig. 1). This town was an important maritime port during 1st cent BC that developed an important role in the regional trade during the Late Iberian period. The town acquired the juridical status of municipium in Augustan period, beetwen 10–14 AD (Alföldy 2003, 47–48). The consolidation of the town as roman municipium was followed by major transformation both in the urban layout and in the hinterland. Dianium changes the physical aspect and the relationship with the hinterland to adapt the Iberian town to the new roman models.
In recent years, the development of fieldwalking projects and landscape archaeology in this area (Gisbert 2003; Grau 2000, 2002) has enlarged the scope of topics of research in Classical Antiquity, moving from the urban archaeology to spatial analysis and settlement patterns. The new research is also focused on the creation of roman landscapes, specially the formation of economic and political hinterland. In this paper we are going to deal with the transformation of Iberian landscape in the surrounding of the oppida towards the creation of landscapes in the hinterland of the Roman towns.

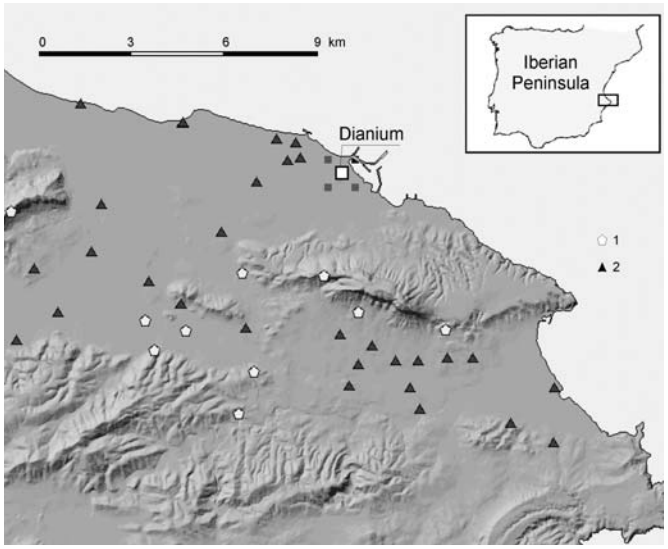

Fig. 1. Location map showing the Iberian (1) and Roman (2) Settlement.

2.1 Theoretical Proposals

The paper addresses to the development of Dianium according to the model of Roman town created by Ancient Historians and Archaeologists (Finley, 1973; Hopkins, 1982; Leveau, 1993). The roman settlement system is based in the relationship between urban centres and their rural surroundings. The Civitas, urban centre, and the Ager, rural hinterland, composed the roman territorium, the basic element of the roman structure. This settlement pattern supposes important transformations in the landscape in relation to previous Iberian Iron Age period to adapt to roman models.
The roman model of town needed a closest relationship with the hinterland than the previous Iberian town. Through a comparative study of settlement pattern the increase of the relationship between urban and rural components is studied. For this purpose, a GIS application of cost-surface techniques is developed. As well, in order to understand the perceived environment the strategic and symbolic changes are tested through GIS visibility analysis.
The study of movement across the landscape shows the possibilities of cover more terrain in similar cost (energy, time, etc...) and subsequently the extension of agricultural fields. At the same time, study of visibility shows several changes in the controlled landscape, related to a peaceful times in roman period and subsequently minor strategic needs. As well, the Iberian oppidum had a noticeable visual prominence becoming the symbolic reference in the landscape. During roman times the town changed the visual prominence in the landscape and constructed other spatial symbols focused in the urban layout such as the development of the forum and its monuments.
In the following lines are presented the GIS tools used to prove the changing in topographical and optical link during Iberian and Roman periods related to these theoretical proposals.

2.2 Cost Surface

One of the most frequent and common GIS techniques is the Cost surface analysis. In the scientific literature we found different approach on COST analysis, which allow us to understand the difficulties in de accessibility to some points on depending on the features in the landscape. At the same time allow the approach to the movement throughout the terrain in the least cost pathways (Llobera 2001; Wheatley and Gillings 2002: 151–158; Bell et al 2002).
This analysis has been developed in different way, especially in the algorithm to transform the slope to costs values expressed in time, energy terms... (Van Leusen 1998; Llobera 2001; Wheatley and Gillings 2002; Bell et al 2002).
For our analysis we are going to use the formula by Marble and Machovina (1997) that expresses the cost in metabolic rates. This formula is the following:

$$M=1.5W+2.0\ (W+L)(L/W)^2+N(W+L)\ ((1.5V^2+0.35V*abs(G))$$

where:
M=metabolic rate (in watts)
W=body weight
L=load weight
N= terrain factor
V= velocity
G= slope in percent

The purpose is comparing the cost values involved in the connection from the urban centre to the rural sites in both Iberian and Roman Periods. For this reason, the analysis needs values expressed in identical terms such as time, energy, etc... and the metabolic rates are useful for this purpose. The formula by Marble and Machovina permit incorporate detailed information about body weight, load weight and the terrain factor; for this reason it offer a more realistic and accurate approach.
The first step in the analysis was to create a DEM of the study area with a resolution of 10m that was transformed into the cost surface grid through the application of the above equation. The cost surface grid was then employed to evaluate the cost movement across the hinterland of Dianium. After that, the Iberian and Roman settlement was incorporated into the resultant grid (Fig. 2).
The second step was to tabulate the metabolic rates employed in connecting the urban nucleus with the Iberian and Roman sites. This comparison permits to observe the relationship between urban-rural components and its change across the time.
The assessment of the values of energy expenditure between both periods (Fig. 3) permits to observe some differences. Firstly, the rates of energy are lowest in the Roman sites than the Iberian ones; this point suggests that in Roman times the rural settlement are more intensively linked to the urban nucleus than in the previous period and the accessibility is more easy in general terms. Secondly, the 70 % of the Iberian sites offer similar rates of cost energy; meanwhile the roman sites offer more heterogeneous values of energy expenditure because they are spread over the entire landscape.
According to this data, we suggest that into the Iberian period the occupation of the land is circumscribed to a small portion of terrain while the rural Roman occupation was extended and it covered different areas of the hinterland.

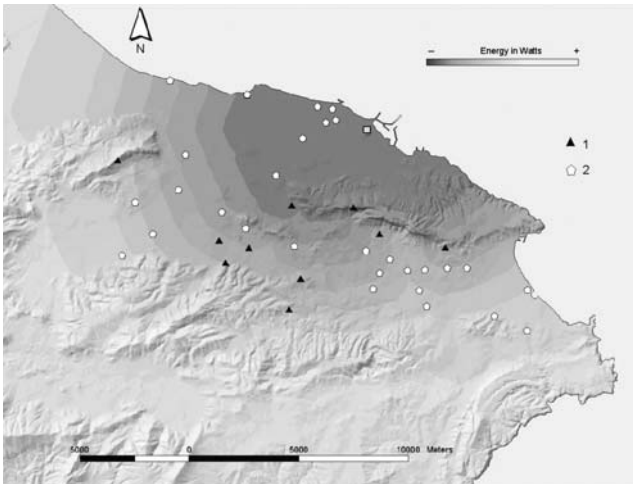

Fig. 2. Cost Surface map showing the Iberian (1) and Roman (2) settlement.

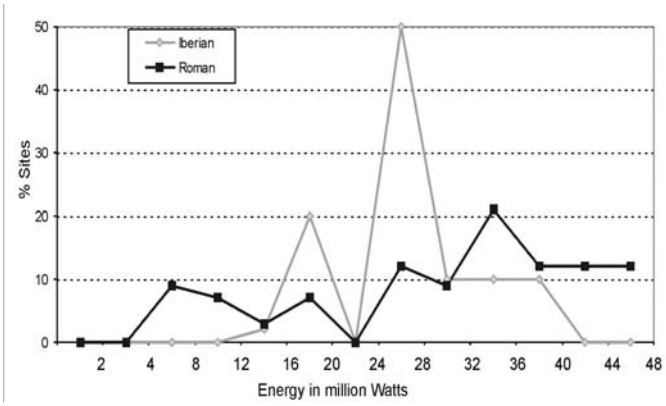

Fig. 3. Energy expediture in connecting urban and rural sites during Iberian and Roman times.

2.3. Visibility

The visibility analysis is another common technique applied in GIS studies (Van Leusen 1998; Wheatley and Gillings 2002, 201–216). There are different approaches of visual analysis in GIS framework described in the scientific literature (Llobera 2003), such as the cumulative viewsheds (Wheatley 1995) employed in other studies on roman landscapes in Hispania (Keay et al 2001). In our study case, we are using simple viewsheds to address the visual relationship town-hinterland.

During the Iberian period the Hilltop location of the Urban centre permitted a large visual control over the entire surrounding landscape, as well as the coastal line. The oppidum was very prominent in the territory and created a visual network with the minor sites in the area.

During Roman times it is possible observe large changes in the visual structure. The general viewshed was transformed into a more reduced an unidirectional visual focus (Fig. 4). This modification is clearly related to the change in the location of the urban nucleus from the hilltop to the flat area. This relocation produced the changes in the visual pattern from the general viewshed towards an oriented control.

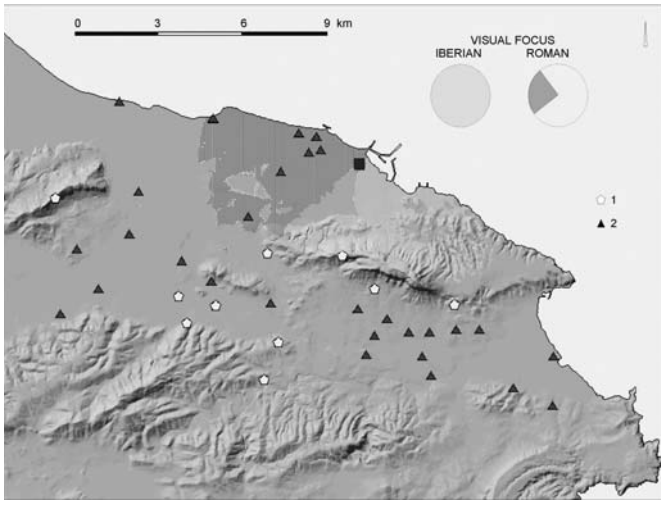

Fig. 4. Viewsheds map showing the Iberian (1) and Roman (2) Settlement.

3. Discussion: Socio-economic Aspects of the Spatial Change

The main Iberian towns, usually named oppida, were the spatial representation of an economic and socio-politic model of control of aristocratic elite over an extensive base of peasants. The landscape of the oppida was the territorial expression of the Iberian aristocracies defined by Ruiz and Molinos (1993). The leading groups of the oppida established their control through ties of clienteles that permitted the economic exploitation of the rural subordinated groups. The leaders controlled the land, the access to prestige goods and assumed the military power.

The model described was linked to a structure of landscape in which the organizing guidelines was the exploitation of the land based on the household peasant production. The Iberian farmers surpassed the levels of subsistence to generate a surplus that circulated in form of tribute or taxation toward the elite.

The spatial organization of this landscape shows the rural settlements distributed in the territory over the visual control of the oppidum but to a certain distance. It is possible to interpret equilibrium between the rural and the urban settlement. The rural farmsteads are in the proximity of the oppidum due to the need of defense provided by the fortified oppidum. At the same time, the payment of tributes to the elites of the lineage and other social practices associates to the ties of clienteles would require of the proximity among the groups subordinates and leading.

Through GIS techniques it is possible to evaluate the spatial patterning of this Iberian model. The strategic necessities and the political control are evidenced in the visual control of the oppidum that is expressed in GIS viewsheds. In turn, the rural sites are located to certain distances to avoid the competence for the agricultural land. For that reason, the urban-rural connectivity remains in a small level and within similar rates in energy expenditure, as the GIS-cost analysis shows.

In comparison to this patterning, the Roman concept of territorial structure was built on different bases. The Roman landscape was constituted by the territorium in which was integrated the civitas, urban nucleus, and the ager, agricultural hinterland. This basic cellulle was constituted by the binomial city-field, civitas-ager, the town and the rural nuclei or villae. This landscape was based on the specialized agriculture of plantation oriented to the commercial productions. The base of this model was found in the villae system that exploited slave labour in extensive rural properties that produce for the market.

The spatial pattern of this landscape was quite different to the Iberian one, described previously. The relationship between the rural landscape and the city was more intense due to the economic need. The system of villae required of a close located market to exchange merchandise, to provide labour force and foreign products, to collect tributes and taxes, etc..

The intensity of urban-rural links was expressed in terms of more accessibility; that means less energy expenditure as is evaluated in the GIS-cost analysis.

The economic role of the city is accompanied of social and political functions. The roman town is the arena for the political competition; as well it is the space of promotion of the elite, which is involved in the local administration and the financing of public building through the evergetism. The towns become cultural centres (Keay, 1993) and its symbols are the public buildings and spaces. In this sense, The roman town abandoned the symbolic and strategic imposition in the landscape, which was the characteristic features of the Iberian oppidum. The large visibility over the landscape was not a necessity neither in defensive nor symbolic purposes.

4 Concluding Remarks

The Iberian landscape was characterized by the intense imposition over the hinterland in visual control, favoring the political domination over the territory while the integration of the rural hinterland remained in low level. On the other hand, the roman urban model was expressed in more physical integration, related to the economic management of the surrounding environment, but the visual imposition over the surrounding land was weak. The symbols of political and social order were translated into other expressions, such as the public buildings or the centuriated order of the rural space (Witcher, 1999).

These economic, political and social functions are expressed in spatial patterns that we could study within the GIS framework. At the present time, the use of GIS techniques to model archaeological landscape has a large amount of literature and current research mainly related to Prehistoric studies. Disappointingly this methodology is less used in some historical periods, as the Classical Greco-Roman times, in which the academic traditions develop very different approaches.

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