

# Implementation of GIS Techniques for the Management and Graphic Representation of the al-Andalus City of Vascos (Navalmoralejo, Toledo)

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*The use of the GIS as a management and representation system is very useful on an archaeological site, especially when these data have been gathered after extensive excavation campaigns, as the case of Ciudad de Vascos, where several campaigns have been carried out since 1975. Amalgamating this information makes the creation of different intrasite analyses possible, and these allow us to form working hypotheses related to different implications about the probable structure of the Muslim city or the number of people who lived in this place. Other public buildings allow us to reconstruct the population of the Qasb site. So, in this way we are trying to use the archaeological data in a GIS as a tool to reach a post-procedural analysis.*

*Keywords:* GIS, Intrasite analysis, DEM, urban structure, “Mādina Vascos”.

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## 1. Introduction

The aim of this paper is to introduce the first applications of a more extensive project in what is called the City of “Vascos”, the remains of a 10th century al-Andalus city, situated in Navalmoralejo (Toledo). The archaeological remains are located within an 8-hectare walled area which forms an urban network with another wider area outside, with several excavation areas.

The large quantity of information from 35 years of archaeological campaigns (which has enabled us to undertake these analyses) called for the design of a data storage and management system to facilitate later studies and investigations in the city of Vascos. To this end, a GeoDataBase (GDB) that stores geographical and alphanumeric information has been developed with the help of GIS techniques (using software ArcGIS 9.2) which can subsequently be used to apply a whole range of analyses, that would form working hypotheses, with reference to different aspects of the city and its surroundings, thereby endeavouring to deepen our understanding of the city.

These applications have concentrated on the use of GIS techniques to analyze different aspects related to the internal structure of the site. Therefore, we ultimately use the different analytical tools of the GIS to clear up

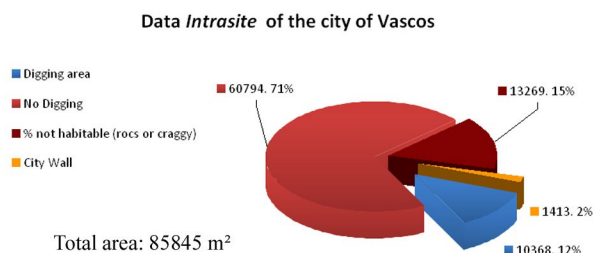
several doubts about this enigmatic site, the main ones being: What was the urban framework? How many people lived in the city? How many people had control over the population? In this article we will try to answer these questions, firstly we focus in the explanation of the analytical data, secondly we explain the working method that we have established for the analysis, and eventually we will check the results obtained.

## 2. Archaeological data

As we have mentioned, the archaeological study that has been carried out in the City of Vascos since 1975 has revealed a complex urban structure established within an enclosing defensive system, although there came a time when the city outgrew its limits and continued developing outside the walls (as in the example of evolution of cities in al-Andalus, proposed by JIMÉNEZ and NAVARRO, 2004).

So, if the wall is the boundary element of the population, at least until the time it outgrew its physical limits, the Qasb is the hierarchical element and in this place we can observe the remains from which a dominant group controlled the city. Thus, we have two almost completely enclosed spaces, which allow us to analyze different data of their population and structure.

It is very important to note the three key points for this study, which are the data and records management system that we have established in the GeoDataBase of the GIS, together with the numerous archaeological campaigns mentioned above, and also the fact that these have not focused on one exclusive area. With these data we have been able to discuss a significant number of probabilities that make our analysis go from a hypothesis to a probability study, based firmly on reality. We would therefore emphasize the importance of having this amount of data for analysis, as can be seen in Figure 1.



**Figure 1:** You can see in this graph the percentage of the excavation that has been unearthed, 12%, compared to 73%, unexcavated. In addition there is 2% that is formed by the walls and 15% of non-residential areas due to sloping terrain.

In the data from sites within the walls that have been archaeologically excavated up to the time of this publication, there is a total of 10,368 m<sup>2</sup>, as expressed in Figure 1. This is made up of different areas: the Citadel, fully excavated, with a total of 4,770.08m<sup>2</sup> (IZQUIERDO and DE JUAN, 2004), the area adjacent to the citadel with a total of 3723, 03 m<sup>2</sup>, the central zone or *Era* 489.50 m<sup>2</sup> (IZQUIERDO, 1983). Two neighbourhoods in front of two entrances, the West Gate zone with a total of 403.21 m<sup>2</sup>, and the eastern gate or *portillo* 6, with a total of 982.31 m<sup>2</sup> (IZQUIERDO, 1979, 1994).

The 12% excavated has revealed a complex urban plan which includes streets and housing as well as open spaces: squares, patios, which are used as a guideline for us to determine the organization of this city around the tenth century.

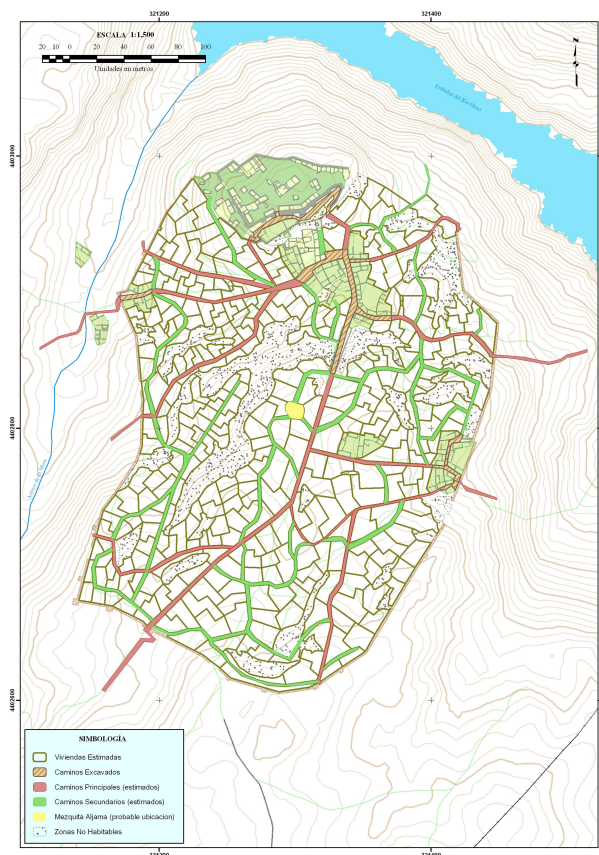
### 3. The analysis

Using this information we have wanted to examine more deeply the different data from the Medina, which can be established in two general categories, but which include different internal analyses which could go on to generate individual studies of each of them. But to aid understanding we have divided them into: the studies of the Medina (madina) and the populace, and the studies of the Kasbah (Qasb) and the ruling elite.

#### 3.1. The studies of the madina and the populace

The principal aim of the first category, established as a study of the city's populace, was to come up with an

estimated figure for the number of city residents, based on the archaeological data. For this purpose we had to establish the possible urban network, and for that it was essential to analyze two elements: the streets and dwellings that existed in Ciudad de Vascos (Figure 2).



**Figure 2:** Hypothetical reconstruction of the Medina Vascos.

**Streets:** To carry out this study we followed the guidelines laid down by three factors; the existing excavations (housing, shaded in light green, and the streets, marked with lines); the doors and gates, and the data obtained from a high-quality DEM. Therefore, we established two types of routes: major roads (in red), all those which come from a principal entrance, e.g. doors and Gates; and secondary streets or alleys (in green) including in this category all those streets which served to link the streets within the medina. With this, we did not wish to state that some of the streets that, for practical reasons, we consider secondary were not important, such as the access to the area we established as the location of the mosque *Aljama*.

#### Housing

Once the road network was established, we created a "model" house with an average area of 138 m<sup>2</sup>, calculated from all the excavated areas with housing<sup>1</sup>.

To calculate the total number of houses, we wanted to compare the numerical information with the graphic information. Regarding the first, we assumed that if our

<sup>1</sup> These data are not very different from those calculated by T. Balbas, who estimated the surface of the muslim houses in 172 square metres (TORRES, 1985: 103).

city has a total usable area of 66,393 m<sup>2</sup> and we subtract the street area, 8,961.29 m<sup>2</sup>, this gives us a total of 57,432 m<sup>2</sup> usable floor area (100%)<sup>2</sup>. If we apply the average size of houses that have been excavated to this area, it gives us a total of 435 homes throughout the city.

The treatment using the graphic information was a little different, as the housing had to be drawn on the site map, and the space is consequently less theoretical and more real. Following the gradual division of the area, using the average home as a model, a total of 478 dwellings was established. The result can be seen in figure 3. We should point out that many homes were entered via small alleys or passages (IZQUIERDO, 1990) and in some cases by common patios (especially in houses in which inhabitants had close family ties).

### Population

This has been one of the most subjective factors in the study because we had to start from different population studies made by linking historical facts and archaeological data.

According to studies by linguists and historians using Arabic sources and name data analysis, a low reproductive rate has been determined. In this way the analysis establishes a number of three children per family in the majority of cases, although it is true that there is evidence of cases, such as the *Banu Hayyaay* of Seville, of up to seven children (ÁVILA, 1995).

These data have been supported by archaeological excavations in different cemeteries, which show a high rate of infant mortality, leading us to speak of greater procreation but, in turn, a lower chance of survival. (VIGUERA, 1995: 82).

With these two premises we consider it interesting to make three appraisals<sup>3</sup>:

- On the one hand, if we pay strict attention to the data extrapolated from the sources, showing the presence of a father and a mother and at least two or three children, we have a family unit of four or five individuals.
- On the other hand, we can do another analysis, closer to the number of children of the *Banu Hayyaay* of Seville, where we would have a father and a mother, plus four sons and three daughters, making a total of nine individuals in the household.

<sup>2</sup> Total area, 85,845 m<sup>2</sup>, minus the wall area, 1,413 m<sup>2</sup>, minus the uninhabitable area, 13,269 m<sup>2</sup>, minus the citadel area, 4770 m<sup>2</sup>.

<sup>3</sup> We would like to indicate that in our study we do not take into account polygamy, without denying that it existed, as the very M. L. Ávila states "... direct evidence of polygamy is extremely rare, the demographic study of the information... it could not have been common in Andalusian urban society ..." (ÁVILA, 1995:35); so we believe that its existence would be minority in the percentage of population. We do not take into account the possible number of slaves or servants there would have been in every home, counting only the number of individuals of each family.

- Finally, we can do an intermediate calculation by counting the father, the mother and five children, making a total of seven individuals.

We think it interesting to set out the table 1, that shows an approximate average number of inhabitants, taken from the central data, stipulating an average of between 2200 and 3200 inhabitants in the city at the moment of maximum occupancy within the aforementioned Medina.

Rangos Población Vascos				
	Población Baja		Población Alta	
Individuos/Vivienda	4	5	7	9
Nº Viviendas Numéricas	435			
Población Estimada	1740	2175	3045	3915
Nº Viviendas Gráficas	478			
Población Estimada	1912	2390	3346	4302

Table 1: Population ranges at Vascos.

### 3.2. The studies of the *Qasb* and the ruling elite

The analysis of the *Qasb* proved problematic because, after excavation, large areas of the main space of the Kasbah experienced a reduction in their living space, which led to the formation of many hypotheses about population size, based on the habitable areas emphasizing further, that many of them would not be used for habitation but as public spaces, such as the audience chamber or used by the military.

Therefore, and to corroborate a relative population figure, we wanted to use one of the key elements of the Citadel (*Alcazaba*), its mosque, based on the assumption of its exclusive use by the resident population. Thus, by calculating the number of users, we could establish a figure quite close to the demographic reality in the citadel.

#### The mosque

To establish an occupancy rate of the mosque, we based our calculations on Muslim ritual and its prayer system, which has five positions, the fourth being the most interesting for us, as they kneel down "...with the knees, hands, nose and forehead on the ground" (BADIA, 2001: 68). So, we have established that an individual between 1.60 and 1.70 m. tall would occupy a space 1.40 m. long and 0.50 m. wide in the fourth prayer position. These individuals would be shoulder to shoulder, facing the *qibla* wall, presumably leaving a respectful space in front of the *mihrab* that is known as *maqsura*.





**Figure 3:** Diagram of the distribution of individuals in the Mosque of the Qasb in the fourth prayer position.

In this way the number of individuals who could gather in this space would be 132, and may be assumed to reside in the Qasb.

#### Habitable areas

We did not want to discard the analysis of existing inhabitable areas and we wanted to establish an average by analyzing each structure of the citadel. To do this we calculated that there was "a total of 867.98 square meters compared with 4770 m<sup>2</sup>" in this large space with relatively few structures, and then matched the number of people which the mosque could hold to this figure. Thus we have found that, for a total of 134 individuals, each of them would have had an area of occupation of 6.5 m<sup>2</sup>. Assuming that the function of the space would be military and that many of the open spaces show signs of occupation with post holes, we can state that this figure is indicative of a base number of individuals which could be increased by as much as 50%.

#### Social relationships

If we compare the data obtained both from the Medina and the Qasb, we can draw some interesting comparisons. If we have established that between 2200 and 3200 inhabitants occupied the Medina and between 134 and 201 (50% more) occupied the Qasb, this leads to the conclusion that, in the first case, 6.09% of the population and, in the second case, 6.28%, of the population ruled over the rest. These results are very surprising, as they are very similar to the data of individuals who ruled Andalusian society since their arrival in the Peninsula.

#### Conclusions

In this paper we have analyzed a first approximation to the use of these tools within our archaeological site. We believe that their use is very important, because with a few simple analyses of relations very surprising results can be produced, like the estimated population ratio in different areas of the city.

We believe that the development of these tools has an importance and a projection far greater than their use as a simple quantification tool and illustrative element for the archaeologist (though this too is important). As different authors point out (LOCK, 2001), these tools allow us to delve into post-procedural studies, through which we try to get closer to the behaviour of individuals and reflect some of their links to physical reality.

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