

Counting the Stones: GIS as an Indispensable Tool for Intrasite Analysis at the Ancient Maya City of Chunchucmil (Yucatan, Mexico)

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Abstract. This paper seeks to show how GIS has become an essential tool for the recording, storing, processing and visualization of the archaeological data at the ancient Maya city of Chunchucmil (Yucatan, Mexico). In this paper I want to highlight the importance of GIS in the analysis of mesospacial contexts (in relation with the internal structure of sites) at Chunchucmil, where the dense urban landscape of Classic period Chunchucmil is filled with cultural features visible on the surface. GIS has facilitated the spatial analysis of the almost 6 km² map of dense urban settlement, consisting of stone platforms and residences encircled by stone walls and several other associated cultural features. The integration of spatial and non-spatial data has allowed the creation of new thematic maps and has facilitated the recognition, analysis, and visualization of spatial association between these mapped cultural features.

1. Introduction

In this paper, I want to show how GIS has become an indispensable tool for the recording, storage, processing, analysis, and visualization of the archaeological data collected by the Pakbeh Regional Economy Project at the ancient Maya city of Chunchucmil, Yucatan, Mexico. This report is preliminary since data are still being collected on the ground and in process of being entered in the GIS database. Intrasite GIS analysis has been limited in its use and practice, especially when compared to the more extensive regional and landscape studies that have benefited from the use of GIS technology. Efforts to use intrasite GIS have been hampered in part by the large initial costs for data entry (Biswell et al. 1995; D'Andrea et al. 2000; Hugget 2000).

Despite these time consuming efforts for the initial data entry, my paper tries to highlight how GIS is an essential and indispensable tool for intrasite analysis, especially for mesospacial contexts-in relation with the internal structure of sites-by allowing the understanding of the settlement pattern configurations through time, the analysis of spatial distributions and associations of mapped and excavated cultural features, the recognition and visualization of distributional patterns, and the creation of new thematic maps integrating spatial and non-spatial data.

2. The Archaeological Site of Chunchucmil

The site of Chunchucmil (Fig. 1), first occupied in the Middle Preclassic (500–250 B.C.) grew to become a sprawling urban center during the Classic Period (400–700A.D.).

At its maximum extent, the site may have covered an area of at least 25 km², as indicated by aerial photos and satellite imagery. At this time the city achieved one of the highest structural densities in the Maya area and we conservatively estimate that 34,000 to 39,000 people were living here



Fig. 1. Map of the Maya region showing the location of Chunchucmil.

(Ardren et al. 2003). This high population density in a marginal agricultural region may indicate that Chunchucmil was not agriculturally self-sufficient (Beach 1998) and may have had to import subsistence goods and relied on a market economy (Dahlin 2003).

Residential groups (Fig. 2) for the majority of the inhabitants consisted of two or more structures arranged around a common patio, similarly to other sites in the Maya area (Ashmore 1981). The distinctive characteristic of Chunchucmil's residential groups is that they were delimited and enclosed by stone walls (Magnoni 1995; Vlcek 1978) and that streets, created by parallel running walls, directed traffic in the crowded urban landscape. These stone walls, the bounded residential groups, and the streets that they created were not common features at most Maya sites (cf. Benavides Castillo 1981; Bullard 1954; Folan et al. 1983; Friedel and Sabloff 1984), but were ubiquitous elements of the urban landscape of Chunchucmil.

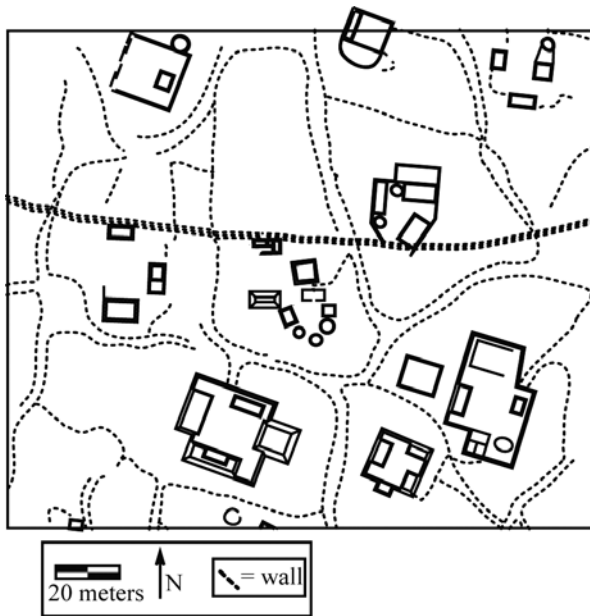


Fig. 2. Map of a residential neighborhood with bounded houselots and streets.

3. Chunchucmil's GIS database

In the almost 6 km² that have been mapped and digitized (Fig. 3) into the GIS database, we have recorded 136 km of walls, almost 5570 structures, 576 stone quarries, almost 1900 grinding stones, as well as several other archaeological features. In fact, almost one square kilometer (0.92 km²) of the mapped portion of the site (5.96 km²) is covered by cultural features. With such settlement characteristics, the use of GIS is crucial in facilitating the investigation of the mesospatial features at Chunchucmil.

I have designed the GIS database for the site of Chunchucmil in Geomedia Professional 5.1 (a vector GIS software produced by Intergraph). Georeferenced maps were imported into Geomedia, and archaeological features were digitized as separate feature classes with their corresponding attributes entered in attribute tables (e.g., the feature class structure has the following attributes: structure number, height, orientation, and architectural notes). More than 20 feature classes were used to enter the archaeological features alone. Other attribute data, like artifact databases from excavations, are being entered either in Excel or Access databases so that they can be attached as tables. Topographic and soil data from published maps, LANDSAT images acquired from NASA, and soil data collected in several parts of the site are also being integrated as separate layers in the GIS database.

4. Bounded Houselots at Chunchucmil

For this paper I will focus mainly on the most distinctive archaeological features of Chunchucmil, the residential groups that are enclosed by stone walls. While the total number of mapped residential groups is approximately 850, I only considered those houselots that were completely and unambiguously enclosed by stone walls. There are 206 of

these bounded houselots (Fig. 3). Ancient and modern occupation has in some cases disturbed the residential groups, making it difficult to distinguish to which houselot certain structures belonged and how much of the empty garden area pertained to a specific group. By selecting only houselots that are unequivocally delimited by stone walls, I could safely calculate the area enclosed by stone walls, the number of structures present in the enclosures, the total area and the total volume of all the structures within each bounded houselot, and compare the variation across the site.

The clear delineation of residential groups (Fig. 2) at Chunchucmil allows the identification of the basic co-residence units where activities were carried out by household members. Households have been defined as "task-oriented residence units" (Netting et al. 1984:xxvi), whose main functions are production, distribution, transmission, and reproduction (Wilk 1988; Wilk and Rathje 1982). In Mesoamerica, as in most parts of the world, households were the basic organizational units of society. Since households are the result of adaptive domestic strategies to meet the needs of its members (Wilk and Rathje 1982:618), they are measurable socioeconomic units of the larger community (Allison 1999; Blanton 1994; Santley and Hirth 1993). Research conducted by the Pakbeh Project at Chunchucmil has focused on these residential groups in order to understand social and economic processes operating at the domestic level as well as at the site level.

Nineteen of these residential groups have been tested while four have undergone extensive excavations and chemical soil sampling, providing us with a glimpse of the domestic life of Chunchucmil inhabitants (Hutson et al. 2004; Hutson et al. in press; Magnoni et al. 2004). Analysis of the ceramics recovered in these excavations indicate that all these groups were occupied during the latter part of the Early Classic and some continued in use during the first part of the Late Classic (ca. 400–700 A.D. The presence of walls shared by several houselots and streets connecting various residential groups corroborates the contemporaneity of occupation. The 206 bounded houselots analyzed in this paper are evenly distributed across the site (Fig. 3). These enclosed residential groups contain a total of 1240 structures, 105 quarries, and 433 grinding stones. These bounded houselots cover a cumulative area of 0.9 km² and contain 271,000 m³ of architectural features.

The area of bounded residential groups ranges from 715 m² to 20,900 m², although only eight houselots have an area larger than 10,000 m² (Fig. 3). The average area is 4,233 m² with a standard deviation of 2,821 m², while the median area is 3,453 m². Even though structure density diminishes with increased distance from the site center, the size of these houselots does not correlate with distance from the site center. Small houselots can be located close to the densely occupied site center as well as in the more dispersed peripheral areas of the site. As one moves away from the site center, however, the space between walled houselots increases, therefore eliminating the need for streets in these less dense portions of the site.

The following step was to explore the correlation of the total size of the houselot, the number of structures included in each houselot and the area covered by all structures of each

houselot. Since different types of structures have been entered in the GIS database as separate feature classes, I had to combine these feature classes in order to obtain the cumulative area occupied by all architectural features within each bounded houselot. Using the aggregation, merge, and functional attributes tools in Geomedia, I was able to calculate the total area occupied by all types of structures included in each bounded houselot. At the end of this process, I ended up with a new feature class that contained the following attributes: the area and perimeter of the bounded houselot, the number of each type of structures present in the bounded houselot, the area occupied by all structures of one type as well as the total area occupied by all types of structures.

Using the spatial difference command I subtracted the total area covered by architectural features in each bounded residential group from the total bounded houselot area. I have called this the empty area of the bounded houselot. These empty areas or garden areas, similarly to modern bounded houselots in Yucatan could have been used for a variety of

activities such as gardening, crafts, and domestic activities (e.g., cooking, washing clothes, garbage disposal, etc...). According to ethnoarchaeological models, the variability in the size of the empty areas within houselots may correlate with the intensity of certain activities, such as agricultural tasks (e.g. infield and outfield cultivation intensity) or specialized craft activities (Killion 1990, 1992). In the case of Chunchucmil, where the Classic period landscape was densely occupied, land must have been a precious commodity and, thus, the size of the total bounded houselot and of the empty area within the houselot may be used as indicators of wealth.

The area covered by structures and the size of the empty area in houselots correlate significantly. Bounded residential groups with a large area covered by architecture also tend to include a larger empty area. Thus, the distribution of empty areas in houselots across the site does not differ considerably from the distribution based on total houselot area, indicating that it does not correlate with distance from the site center.

Finally, I calculated the total volume of all structure types in

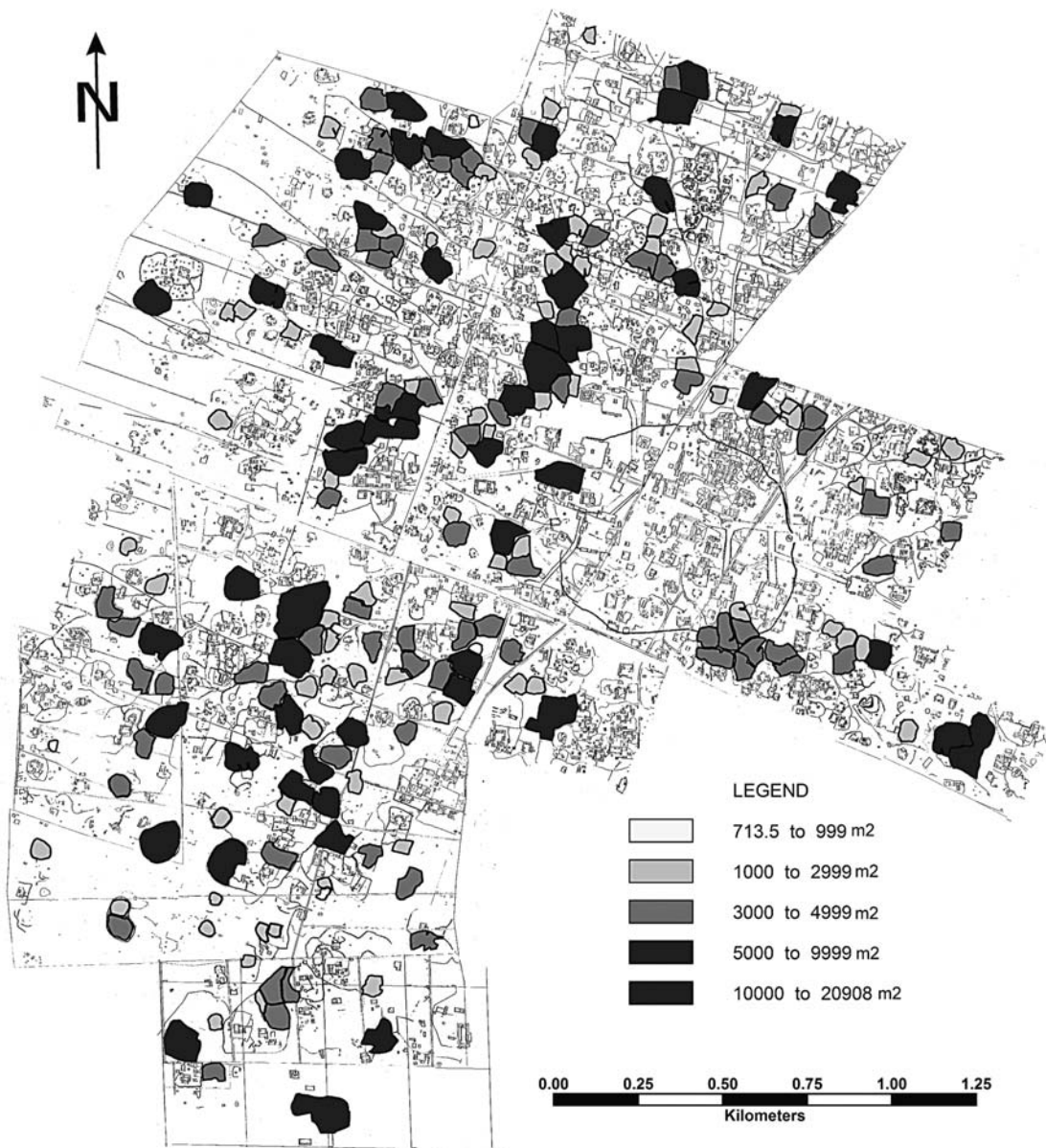


Fig. 3. Map of Chunchucmil (5.96km²) showing the distribution of the 206 completely bounded houselots sorted by their total enclosed area.

each bounded houselot. Volume of architecture has often been used to reflect the scale of power and control of labor and resources that a particular group could command (e.g., Abrams 1989). In our case, it could reflect the labor and resource control that each household in the bounded houselots had. To obtain the total volume of architecture per bounded houselot, I performed the same calculations used above for obtaining the total area of all structure types within a bounded houselot, using the aggregation, merge and functional attributes tools. The volume of architecture contained in bounded residential groups does not correlate with the empty area of houselots. This suggests that size of the garden area and the total volume of architecture are independent variables. Volume of architecture may not be a good indicator of wealth in these residential groups since the final architectural volume may be the result of small sequential increases in construction over several generations of each houselot's inhabitants. Moreover, we know from excavations in some of these bounded houselots that even small residential groups with modest architecture may have an abundance of precious portable goods.

5. Conclusion

This preliminary analysis of the configuration, characteristics, and variation of bounded houselots at Chunchucmil has been extremely facilitated by the use of GIS. The costs of excavating all of these residential groups would be prohibitive. Thus, to understand and explain this densely inhabited Classic period urban center we have to focus on the abundant surface remains left behind by its previous residents. GIS provides us with unsurpassed tools to investigate the mesospatial characteristics of the site by manipulating and visualizing archaeological data, creating new thematic maps, and deriving spatial associations between the different cultural and natural features. Because of time constraints, this paper has focused solely on a particular investigation that can be carried out with the help of GIS, but the integration of excavation and artifact databases, chemical soil analyses, satellite imagery, aerial photographs, which is still in process, will allow a wealth of other in-depth analyses.

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