SOCIAL AND ENVIRONMENTAL RISK AND THE DEVELOPMENT OF SOCIAL COMPLEXITY IN PRECOLUMBIAN MASAYA, NICARAGUA

by

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AB, Harvard University, 1996

Submitted to the Graduate Faculty of the

Kenneth P. Dietrich School of Arts and Sciences in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2013

UNIVERSITY OF PITTSBURGH

DIETRICH SCHOOL OF ARTS AND SCIENCES

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April 23, 2013

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This dissertation evaluates the applicability of three models that purport to describe and predict the development and establishment of social complexity based on the interplay between environmental setting and human communities. The three models are juxtaposed in terms of the conditions required to foment the development of and formalization of social complexity and the corresponding level of inequality, so that each model requires contrasting environmental risk conditions relative to the other two.

Considering the relative dearth of archaeological studies focused on understanding the development of social complexity in Nicaragua, and the abundance of readily accessible precolumbian ceramics and lithics available on soil surfaces, a full coverage, surface survey (172km^2) was conducted in the municipalities of Tisma and Ticuantepe in the vicinity of Masaya, Nicaragua in order to obtain the data necessary to test the suitability of each model. Relative synchronic and diachronic changes, including the tempo and pace were documented using the established and broadly accepted ceramic chronology, including the distribution over the municipal territories and the densities of occupation within each defined community. The results indicate very distinctive patterns for each region over an occupation sequence lasting at least two millennia.

Though this dissertation illustrates the limitations of each model using the data available, it also contributes to a clearer understanding of the configurations and trajectories of social

change may take in Pacific Nicaragua, thus adding to the growing corpus of comparable archaeological datasets that may bring forth increasingly sophisticated models explaining the development of inequality and its role in the development of increasingly complex social forms.

The complete settlement dataset is available in the University of Pittsburgh Comparative Archaeology Database (http://www.cadb.pitt.edu/).

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PREFACE

This project was only made possible through the collaboration and support of numerous individuals and institutions. I benefited from the generosity, goodwill and enthusiasm of all those involved. This final version required additional sacrifices on the part of my wife and family; it exists only because of their love and patience.

The Masaya Regional Survey Project was supported through NSF Dissertation Improvement Grant #023425. The Center for Latin American Studies (CLAS) at the University of Pittsburgh provided a Graduate Student Field Research Grant that for summer-long research that resulted in the project proposal in 2002.

Dr. Silvia Salgado has been a teacher, mentor and friend throughout; her data and our joint fieldwork allowed me to develop the focus reflected in this work. Luvy Pichardo, Jorge Zambrana, Don Luis Miranda, Don Carlos Ampié, Don José Aguilar, Henry Arauz, Juan Bosco Moroney, Marlon Obando, Manuel Gutierrez, Gabriela Ortega, Denis Guadamuz, Francisco Quant, Crisálida Cordero and Leonardo Lechado, were members of the survey teams in Tisma, Ticuantepe and Masatepe, who supported the project's objectives and collaborated with me on the ground and in the lab. They made it possible to collect all necessary data and information and for that I am grateful. Efforts were made on my behalf by personnel at Dirección de Patrimonio Cultural, Instituto Nicaragüense de Cultura, Universidad Nacional Autónoma de Nicaragua, Alcaldía Municipal de Tisma, Alcaldía Municipal de Ticuantepe, and Alcaldía Municipal de

Masatepe. Special thanks to Edgar Espinoza García, former Director of the Museo Nacional de Nicaragua for his assistance in ceramic type identifications. Phyllis Deasy, Graduate Secretary at the Department of Anthropology at the University of Pittsburgh, deserves a special mention for her friendship and help with administrative matters.

I would like to thank all of my committee, Dr. Marc Bermann, Dr. Olivier de Montmollin, Dr. Mark B. Abbott and Dr. Robert D. Drennan (supervisor). I was especially fortunate to count on the support and encouragement of Dr. Robert D. Drennan at every stage of this project, despite the extended period between the original defense in 2006 and final submission in 2013. He greatly improved the clarity of the resulting dissertation through his suggestions and cogent commentary.

1.0 INTRODUCTION

This research project was designed to better understand the role that social and environmental risk, environmental diversity and productivity, population pressure and external contacts play in the development of increasingly complex social and political organization. The project was conducted in the municipalities of Tisma and Ticuantepe in the Masaya region of Pacific Nicaragua (Figure 1.1, 1.2) because their municipal limits are within 12 km of each other and the environmental settings are different enough to make a meaningful comparison that would help answer questions central to the project. A systematic, full-coverage surface survey was used to gather the data necessary.

Though the development and evolution of social complexity (*sensu* Service 1962) has been the subject of much study and debate, the factors underlying social change have proven elusive. The development of increasingly complex social and political structures and inequality have been attributed to a multitude of causes, among them environmental change and diversity, demographic pressure, external contact, resource control, abundance and social and environmental risk. This project aims to document social and political changes taking place in the Masaya region during the prehistoric period encompassing from 1000 Before the Common Era (BCE) to 1500 Common Era (CE) and to evaluate the relative importance of factors to which such changes have previously been attributed.

Figure 1-1 Map of Nicaragua within Central America, including the department of Masaya.

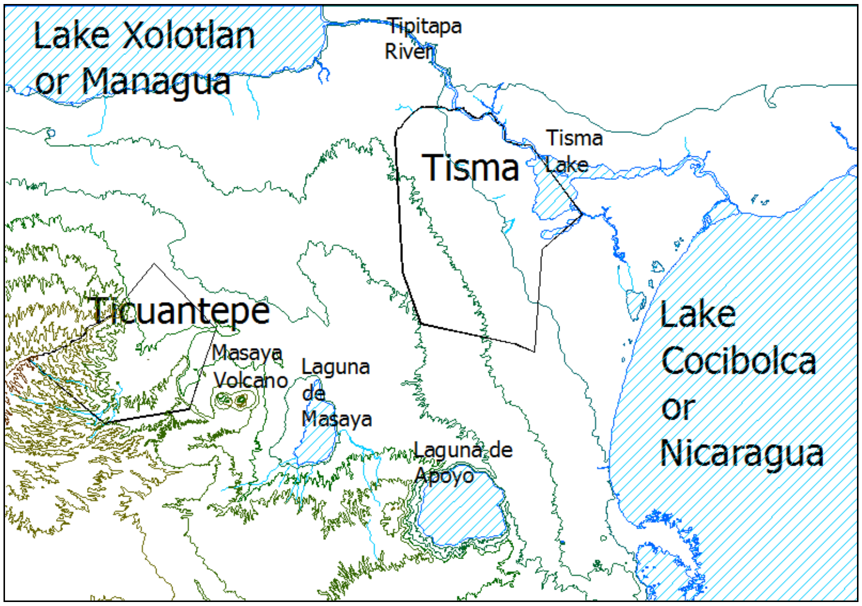

Figure 1-2 Map of Tisma and Ticuantepe within Masaya Region.

1.1 NICARAGUAN PREHISTORY

The predominant paradigm for the interpretation of the Nicaraguan precolumbian occupation sequence centers upon the developmental effect that migrations of Mesoamerican groups had. Nicaraguan precolumbian culture history is frequently no more than a re-telling of unverified ethnohistorical accounts (Abel-Vidor 1980) from the contact period (ca. 1522-1524 CE), scarcely delving any deeper. While there is no evidence supporting the existence of precolumbian state-level societies in Nicaragua, it is generally accepted that chiefly societies dominated the landscape in the Pacific coast by at least 1300 CE. Nevertheless, there have been few studies directed at gaining a better understanding of the political economy underlying such developments, or, for that matter, verifying the existence of chiefdom-level polities. An emphasis on in-migrating Pipil-Nicarao and Chorotega-Mangue groups after the year 800 CE has most often served to obscure the importance of local development of social complexity prior to their arrival (Healy 1993; Healy 1980). Pacific Nicaragua is conceptualized as a relative periphery (Schortman and Urban 1992), populated by simple societies until after the arrival of Mesoamerican groups, who overrun and replace the local population (Incer 1990; Fowler 1989).

Even in the best of cases, the effect of migrations on substantive aspects of social complexity is diffuse. Beekman and Christensen’s (2003) Nahua migration study includes a consideration of recent theoretical approaches to migration, using multiple lines of evidence. Their attempt at a reconstruction of events that span nearly 500 years is laudable as far as conjugating disparate sources of supporting information. The result is a suggestion of events likely from a lattice of facts that may not be so firmly related. As such, it highlights the limitations and interpretive shortcomings of similar migration studies. In the case of Lower Central America, and Nicaragua in particular, it is unclear when the Nahua-speaking Pipil

(Fowler 1989; Brinton 1883) arrived, in what quantities and with what effect. More importantly, how might we expect the results of such significant migrations will be reflected in the archaeological record?

McCafferty et al. (2008; McCafferty and McCafferty 2008; McCafferty and Steinbrenner 2005,) have pursued issues of identity and ethnicity, particularly as it pertains to the aforementioned Nahua migrations, since at least 2002. Leveraging data originating in area surveys conducted in Granada by Salgado (1996) and in Rivas by Niemel (2003), a great deal of attention and energy have been devoted to teasing out ethnicity and identity as markers and evidence of Nahua migrations and their effects throughout the southern and central pacific regions of Nicaragua. However, when contrasted with artifact complements from precolumbian Mexican Nahua settlements, there is clearly much less coincidence than might be expected. Dietary evidence (and the related artifact groups such as *comales* and grind stones) indicates significant differences in maize consumption, indicating, rather, rapid adaptations to local resources and staples. Beyond some chronological correspondence and broad stylistic elements, it is especially notable that artifact clusters within Nicaragua's Pacific region are most similar to each other, and quite unlike those beyond the archaeological cultural area better known as Greater Nicoya (after Norweb 1961, 1964; Lange et al.1992; Lange 1992a). Moreover, if there is any suite of relative differences within or among suspected Nicarao (Nahua) or Chorotega (Oto-Mangue) settlements, it is more subtle than archaeological analysis is capable of detecting thus far.

Based on the geographical distribution of ceramic types and varieties, (Norweb (1961; 1964) proposed that most of the Pacific coast of Nicaragua, east of lakes Xolotlán and Cocibolca, as well as Northwestern Costa Rica composed the Greater Nicoya Cultural area. Lange (1992a;

1984a; 1984b; Lange et al. 1992) further developed the model proposing that Greater Nicoya was a relatively autonomous, internally functional area subject to little external influence in precolumbian times. However, the dynamics underlying the development of a political economy that could give rise to the powerful chiefs mentioned in ethnohistorical records are scarcely developed and discussed only as a given, subject to a predictable, unilinear development.

The contact period (after 1522 CE) documentation relates merely the terminal point for the precolumbian sequence, even though it is the starting point for well-known and tacit models of the Nicaraguan past (Lothrop 1966). According to Spanish chronicles from the contact period (1522 CE) chiefdom-level societies had developed in precolumbian Nicaragua prior to the arrival of European colonists (Gil González Dávila 1883; Andrés de Cerezeda 1883; Peralta 1883; Carmack 1993; Incer 1990; Fowler 1989; León-Portilla 1972; Chapman 1960). In the Central Pacific area of Nicaragua, Mangue-speaking Chorotegas were the dominant group, while further south and in isolated pockets to the north, Nahua-speaking Nicarao chiefs dominated the surrounding landscape (Chapman 1960; Newson 1987; Brinton 1883). Based on the relatively scarce amount of writing devoted to Chorotegas, it is apparent that Spanish chroniclers were much more interested in the Nicarao. Even though Mangue-speaking groups were more numerous and occupied a vastly larger territory than Nicaraos, there is comparatively much less detailed information about them. According to Oviedo (1976), at the time of initial European contact in 1522 CE, Nicarao and Chorotega chiefdoms differed in the authority and decision-making power accorded to the chief. Chorotega paramount chiefs were elected by a regional council of elders. Similarly, the council of elders also elected a “general captain for war matters.” In turn, each community elected a representative elder. In times when a particular chief did not seem convenient for the aims of the polity, the Chorotega council of elders would either disown or kill the paramount chief. The Chorotega council of elders ruled in conjunction with the paramount chief, whose share of personal power they monitored, counseled and limited.

Nahua-speaking chiefs, on the other hand, are described in more detail. This may be because Nahua and Nahuatl are closely related, and by the time of the initial explorations of Nicaraguan territories, the Spanish had Nahuatl-speaking Mexican collaborators/interpreters. Nicarao chiefs (*teyte* or *calachuni*) also governed in conjunction with a council of elders (*nonexico*) (Oviedo 1976). However, the *teyte*, outranking all other nobles, was the supreme authority in the region and though his decisions were generally made in consultation with the *nonexico*, the *teyte* was the ultimate decision-maker. The *teyte* wore distinctive tattoos, which made him readily recognizable. One documented taboo surrounding the *teyte* was that he would never communicate directly or come into contact with low status people. Also, part of the *teyte*'s responsibility involved ritual functions. Each of the communities that integrated the Nicarao polity was ruled by a “capitán principal” who had some autonomy and a group of 10 to 12 warriors that accompanied him everywhere. In turn, each “capitán principal” responded to the *teyte* and the *nonexico*, which he could aspire to eventually join. Priests (*tamagest*) were a well-defined group within Nicarao society, as were “confessors,” elders from the *nonexico*, who were appointed for one year to counsel the young and all those who were not steadfast in “accomplishing their duties” whatever they were (Chapman 1960). All the above were nobles, apparently with ascribed, inherited status. Commoners with specially recognized functions included goldsmiths and craftsmen, “market officers,” nominated by the *nonexico* and charged with regulating and overseeing all market activities. Also, “war captains” (*tapaligue*) who were appointed amongst those warriors who demonstrated valor in the battlefield could achieve special status and privilege and later join the ranks of the nobility. Commoners included warrior/soldiers, artisans, market purveyors, hunters, fishermen, farmers, prostitutes, prisoners of war, beggars and slaves, whose status was lowest of all.

More recently, Carmack and Salgado (2006) have argued that much of western Nicaragua was actually part of the Mesoamerican World-System (*sensu* Wallerstein 1974; Frank & Gills 1992), functioning as a periphery, thus subject to unequal exchange relations with core regions. Similarly, Central American peoples south of Nicoya were part of the Chibchan Mesoamerican frontier (Kirchoff 1943), functioning within their own chiefly world-system while engaging in networks of trade and preciosity exchanges with the coastal Mesoamericans in Nicoya and Nicaragua.

Hoopes (2005) coincides with this view, further adding that a Chibcha/Macro-Chibcha cultural area lay directly adjacent to the aforementioned Greater Nicoya (to the east and south). These neighboring regions of cultural influence have been discussed in similar terms since Kirchoff (1943; Lothrop 1966, 1926) proposed the limits of the Mesoamerican area (see also Fonseca 1994, Fonseca and Cooke 1993), indicated within Willey's (1984; Hoopes 1992) "Intermediate Area," and further reified by Constenla's (1991) linguistic studies using contact-period data. In essence, the differences in artifact varieties, construction and types of monumentality (Olsen-Bruhns 1992; Bovallius 1970) were the substrate upon which the boundaries were proposed, very early on. This construct still has enough traction that the remnants of the culture-history approach influence current discourse in Lower Central American archaeology, partly because of the relative lack of attention on the part of archaeologists aiming at social-evolutionary processes and explanations for change. Similarly, the lack of clarity and testable empirical evidence that seems to characterize countless "agent-centered," landscape

(Fisher 2009) or revisionist approaches further reinforces the need to utilize models that are testable, approachable and not yet exhausted in their explanatory power.

Hoopes points that just as precious metalwork and jade were relatively absent from Greater Nicoya, they were more prevalent in the Macro-Chibcha area (Bishop and Lange 1993; Braswell, Salgado and Glascock 1994). More importantly, as it pertains to the focus of this dissertation, he examines different models of social change and increasing complexity, reviewing the possible avenues such trajectories may have taken. In an attempt to simplify and distill the variability of a wide-ranging area characterized by diversity and heterogeneity, proposes that prestige goods were the fuel that allowed for self-aggrandizing chiefs to emerge, in a manner compatible with Helm's (1979) view of cosmopolitanism and the use of esoteric knowledge's role in the establishment of hierarchies, juxtaposing the important role that climatic change and environmental transformation during the period between 300 and 600 CE as a magnifying factor.

More recent work in Panamá contradicts Hoopes' proposal. Haller (2004), Menzies (2009), Palumbo (2009) and Locascio (2010) have conducted studies at different scales in the Rio Parita region (104km^2) and Volcán Barú in order to gain a more detailed understanding of the factors and milestones along the long-term trajectory of social change. Haller's (2004) regionally-focused work indicated that long-distance exchange networks were not essential to the development of local chiefdoms. This was further validated by the work of Menzies (2009) and Locascio (2010) in the same region of the Chibchan area, showing how local craft production stimulates internal exchange served to increase inequality, whether at the community or household level. Menzies' (2009) community-level work demonstrated how local craft production was also not a major factor in the development of inequality, as household-level differences were evident before there seemed to be any economic basis to fuel them. He illustrates how non-economic forms of social power, such as feasting, warfare and local trade accompany the development of social inequality and local craft production is not a relevant factor until the Parita period (1100-1300 CE). This variability within the same sequence is illustrative of the pitfalls that many synthetic models face when being compared to actual data. Locascio (2010) looked further into the differences between households work to better understand differences in activity spaces and materials. Palumbo (2009) focused on local craft production as it pertained to finely decorated ceramics and stone tool production in Volcán Barú, illustrating one path that higher status households may have taken to alter the local political economy for their benefit during the Parita period.

Murillo's (2009) work in Alajuela, Costa Rica compared the diversity of local trajectories of social change and concluded that even where long-distance exchange evidence was documented during periods of social change, it was not a constant influence over time. This recent work illustrates how relatively local processes are the substrate upon which local chiefdoms are established, very clearly contrasting with Hoopes' (2005) view. Nevertheless, the variability within each trajectory also shows how many different configurations communities occupying the same location over time may vary in significant ways, despite similarity of settings and their relative proximity.

The bulk of archaeological research in Nicaragua has been focused on documenting and constructing ceramic sequences and refining chronological control (Abel-Vidor et al. 1987; Lange et al. 1992, Salgado 1993; see Hoopes 2005 or McCafferty 2008 for summaries of significant work), or salvaging and registering archaeological sites. There are few studies overtly focused on documenting social change (Salgado 1996; Niemel 2003). Elsewhere in southern Central America, the situation is not very different, except where catastrophic historical events, volcanism in particular, are implied as primers for long term social change and collapse (Sheets and Grayson 1997; Sheets and McKee 1994; Dull, Southon and Sheets 2001; Orlove 2005). On the other hand, it is clear that on their own, reconstructions of ancient environments, geological events and palaeoclimatological studies (Stansell et al. 2013) are ever more useful when using archaeological data to understand the articulation between human social change and environmental factors.

1.2 MASAYA, NICARAGUA

Masaya is the smallest (610 km^2) and most densely populated department in Nicaragua (320,000 total population, or 524 inhabitants/km^2). Located in the Central Pacific region, its territory encompasses fertile valleys at elevations ranging from 32 to over 750 m above sea level (Figure 1). Much of the regional population aggregates along two of the largest fresh water lakes in the Pacific (Laguna Masaya and Laguna de Apoyo), both products of the 26,000 year-old Masaya Volcano caldera system. Lake Xolotlán (or Managua) and Lake Cocibolca (or Nicaragua), two lakes that rank among the largest in Latin America, are easily accessible along the flat eastern edge of the department, which is delimited by the Tipitapa River, a stream that historically connects the lakes. Though its natural course was interrupted by the construction of the Panamerican Highway in the 1950s, Hurricane Mitch’s rains rehabilitated it in 1998.

The Central Pacific region is characterized by its fertile soils and diversity of resources. The yearly rain cycle begins in May and continues frequently through the first few days of December. Masaya’s average annual precipitation is 1,320mm (AMICTLAN 2007). During a consistent rainy season as many as three crops of beans and corn are harvested, though two crops are more often the norm. In Masaya manioc is a very important staple crop that is less susceptible to seasonal fluctuations than beans or corn. Manioc, corn, beans, plantains, bananas and fruits including citrus, pineapple, mango and cashew comprise the subsistence compliment for local populations. Moreover, cash crops such as coffee, cotton, soybeans, sesame, sugar cane and rice are also produced in different areas of the department.

The Masaya volcano poses many risks for local populations. While tremors, and low intensity earthquakes are common occurrences with minor repercussions, less frequent, high intensity episodes have impacted the regions in significant ways. While, lava flows have covered populated areas periodically over at least the last five centuries, volcanic ash also serves to aerate and increase the mineral content of surrounding soils.

In July 2000 a series of earthquakes destroyed and heavily damaged 30% of the buildings in the city of Masaya. Moreover, because Nicaragua is located on a narrow isthmus between the Atlantic and Pacific Oceans it is significantly affected by El Niño fluctuations. Periodically, heavy rains and alternating winds conspire to turn the volcano’s smoke plume into a source of acid rain, severely affecting crop yields in the region. Nevertheless, the local environment in the Masaya area has been perceived to be quite favorable for many centuries and the city continues to thrive as a significant commercial and cultural center. El Niño/La Niña cycles may affect crop yields on the scale of once a decade, while seismic catastrophe may only impact large segments of the population once per century. In this sense, the department of Masaya is considered a low to moderate environmental risk area.

Masaya has been characterized by its relatively high population density for at least 500 years (Incer 1990; Fowler 1989; Chapman 1960). In geographical terms, Tisma and Ticuantepe, within the Masaya region, present opportunities for potential interactions ranging far beyond their confines and make it possible to further explore the connections between socioenvironmental risk, diversity, local resource abundance, external contacts and the development of socio-political complexity.

Although some of the diagnostic types commonly utilized as chronological indicators in the Pacific are found in areas such as Chontales (Rigat 1992; Gorin 1990), the Atlantic watershed (Magnus 1978, 1976) and Segovias (Espinoza, García and Román-Lacayo 2000; Fletcher, Salgado and Espinoza 1993), the material culture on the eastern side of the Cocibolca and Xolotlán lakes is noticeably different from that found in the Pacific. Pacific region diagnostics typically compose less than 0.5 % of the total identifiable sherd count (Román-Lacayo 2001). The balance is made up of ceramic types that are scarce to non-existent in the Pacific. This may indicate that over time Tisma served as either a land bridge for apparently different groups to interact or as a buffer zone. Also, Tisma and Ticuantepe's location along the central corridor of the Pacific coast would be quite advantageous for the acquisition of trade items originating in the north or south. Masaya's location makes it a region where one might expect many opportunities for social, political and economic contact to develop over time, allowing ready access to extra-regional information or trade networks.

Fowler (1989) proposes that Nicaraos in Rivas, west of Lake Cocibolca, along the southern Pacific coast of Nicaragua, had achieved a "terminal chiefdom". Using the traditional, unilineal, cultural evolution model, this meant that Nicaraos were on the verge of statehood in the early years of the 16th century. Based on contact period chronicles, Masaya was a Chorotega-dominated region. Silvia Salgado (1996) conducted a regional survey in the neighboring Granada area, also purportedly occupied by Chorotegas, and focused upon aspects of social change through the 2,500 years preceding the contact period. Indicators of increasing social complexity are apparent in Salgado’s data. There are clear site-size hierarchies (Figure 3) during the Bagaces period (300 – 800 CE) and a substantial increase in the number of sites between Bagaces and Sapoá (800 – 1350 CE), the period when Chorotega-Mangue groups are said to migrate to the area. While the number of sites increases substantially during the Sapoá period in Granada, the Bagaces period shows site nucleation, albeit with a smaller regional population. A similar pattern occurs in nearby Northwestern Costa Rica (Guerrero and Solís 1997).

1.2.1 Municipality of Tisma

The municipality of Tisma, in east Masaya (Figure 4), is a low to moderate risk, low diversity area. It covers 124 km^2, ranging in elevation from 32 to 34 m in the plains near Tisma lake in the northeast increasing gradually to 188 m in the southwestern edge. The municipalities of Tipitapa, and Granada lie along Tisma’s north and east; Nindirí lies to its west and Masaya to its south. In the north The Tipitapa River system defines the northern municipal limit. Tisma Lake is part of the Tipitapa system, is an overfilled oxbow depression that fluctuates in size and depth depending on seasonal precipitation cycles. The dry season (December through May) lake depth is normally no more than 2 m, allowing fishermen to wade in with their nets hundreds of meters from the shore. At the height of the rainy season (May to December), lake levels may increase by 1 to 2 m, reaching a maximum depth of 5 m. A significant area of the Tisma plains are seasonally flooded, thus land usage in these areas is limited to cattle farming and seasonal fishing camps. Wells are a readily available and widespread water source as the areas where population aggregates are within easy reach of the water table. Numerous springs are also found throughout the lower elevations, though most seem to be utilized for livestock.

Presently Tisma produces corn, tomatoes, melons, watermelons, sugar cane, plantains, bananas, manioc, beans, soy, cabbage, sorghum, sesame, wheat, pork, cattle, beef, milk, chickens and different varieties of squash,mostly for consumption outside of Tisma. Many of the inhabitants depend on subsistence agriculture, based on staple crops (beans, corn) complemented with the variety of locally produced fruits, vegetables and an assortment of autochthonous fauna such as reptiles, fish, birds and small mammals, in addition to the more common beef, chicken, pork, turkey and, to lesser degree, goat. Though fish are readily available in Lake Tisma, and the Tipitapa River they are decidedly not a staple in the local diet.

For well over two decades Tisma has been one of the principal sources of looted precolumbian ceramics, gold, jade, obsidian, and fancy local and exotic ceramics in Pacific Nicaragua. Nevertheless, Lydia Wyckoff's (1971) study of a museum collection originating in Tisma is the only published documentation of precolumbian evidence within the municipal borders.

1.2.2 Municipality of Ticuantepe.

The municipality of Ticuantepe covers 65 km^2 and the elevation ranges 229m along its northeast border and nearly 900m at its highest point in the southwestern limits. In 1991 Ticuantepe was annexed by the department of Managua because of the capital city's urban growth and the need to broaden its tax base. However, it had previously been part of the department of Masaya and it is still widely considered to relate more closely to neighboring Masaya municipalities than to the city of Managua.

The interesting environmental contrasts found within the municipality make Ticuantepe an attractive area for pursuing research questions relevant to this project. It is a low to moderate risk, low to moderate diversity area. Nearly two thirds of the municipal territory lies in valleys and the valley-piedmont transition. Close to 3km^2 are within the Masaya-Santiago Volcano System caldera. Though the caldera floor is accessible, the escarpment constrains entry through all but two paths as there is a difference of 150 to 450m between escarpment top and caldera floor. Besides being visible from most of the municipal territories, low intensity tremors are a constant reminder of the volcano's proximity. The Ticuantepe aquifer is currently the main source of drinking water for the city of Managua (1,600,000 inhabitants), and despite Ticuantepe's ever more urban character, drinking water is available without much difficulty from the numerous rivers, springs and wells.

Altogether, fewer than 400 people reside in 30% (19.5 km^2) of Ticuantepe's territory. The slopes on the south and west are quite steep and heavily forested, limiting settlement in those areas. The slopes and higher elevations are currently being used as either coffee farms, natural reserves, vacation homes or communication antennae stations, thus the low population numbers. Urban development resulting from Managua's growth has fostered a move towards the city, in search for salaried jobs. Thus, Ticuantepe's urban area is growing as people from Managua seek the comfort and proximity of Ticuantepe and rural residents settle in the city.

The Masaya volcano's constant sulfuric smoke plume has dealt a serious blow to large scale coffee production in the area in the last 60 years. On the other hand, pineapple cultivation has benefited from the same conditions, becoming the cash crop of choice in the area because the local soils present an ideal pH balance. Most of the pineapples consumed in Nicaragua grow in the Ticuantepe Valley, while an increasing number are also exported. Although most of Ticuantepe's population no longer depends on subsistence agriculture, staple crops are still grown in a much smaller scale than in Tisma. Corn, beans, bananas and plantains, chickens, pigs and a few head of cattle are still to be found in hamlets and other rural areas. Wild fauna includes deer, coyotes, a few monkeys and a wide variety of reptiles.

Gordon Willey and Albert Norweb conducted excavations at the site of La Borgoña, in the heart of Ticuantepe in 1961. The resulting collections have never been formally analyzed and only field notes and unpublished manuscripts survive.

Using nearby lake sediment cores, Stansell et al. (2013) documented a consistently wetter (higher precipitation) period mostly coinciding with Bagaces and the beginning of Sapoá (and the Medieval Climate Anomaly/MCA), followed by at least 150 years of consistently more arid conditions matching the Ometepe period, close to the onset of the Little Ice Age (LIA) after 1,400CE. A higher lake and river level would make flooding more common, and reduce the inhabitable area in Tisma. Even though Tisma and Ticuantepe are both low to moderate risk areas, Tisma is riskier, less diverse and more productive than Ticuantepe.

2.0 MODELS FOR THE DEVELOPMENT OF COMPLEX SOCIETY

2.1 THREE MODELS – FIVE FACTORS

Charles S. Spencer (1993) proposes a model such that high risk conditions are most propitious for social complexity to develop. In his model the development of social complexity is predicated upon the successful management of social and environmental risk for a long enough term as to allow for its permanent establishment. Social complexity, inequality and hierarchy develop in settings that pose increasing levels of *socioenvironmental* risk for human groups. Since Spencer takes human ambition for granted, he lists resource scarcity, whether due to relative demographic change or environmental degradation (circumscription *sensu* Carneiro 1970, 1981), as the springboard that ambitious individuals can use to establish their dominance over a group.

Spencer (1993) utilizes the term socioenvironmental risk to include both the social and environmental impetus for change and to establish a single mechanism that averts environmental determinism. On the one hand, social risk may be affected by either internal or external social forces such that added competition resulting from local population pressure increases risk just as the threat of added competition from external groups will, through conflict or warfare. It may then be that the environmental context does not change but the social context does. Conversely, significant, potentially life-threatening environmental change will cause pressure and increase risk among stable populations, even in the absence of extra-local social threats, as scarcity will increase competition at the local level. Interestingly, though the proximate mechanism is apparently different, social or environmental, the ultimate effect is the same, increased, perceived risk is the consequence of socioenvironmental change.

Demonstrated success in the management of risk can result in the regularization of hierarchical social systems, so long as the goals of potential leaders seem to be compatible or can be reconciled with those of their likely followers. Normally transient inequality, exalted or influential positions of leadership and prestige would be perpetuated as long as the perceived risk remains and the leaders' strategies prove effective in stemming the deleterious effects of the threat. Decisive interventions that result in successful risk management strategies provide the opportunity for inequality to become instituted.

External contacts can also contribute to the institutionalization of inequality so that those individuals who possess or can readily acquire information about contexts outside the immediate local setting would be in a better position to take advantage of rapidly changing social and environmental conditions. Per Spencer (1993:44-45), an important characteristic that differentiates chiefdoms from "uncentralized societies" is that chiefs are able to expand their authority along an external dimension, beyond their immediate surroundings. Through extended domains a chief may maintain contact with or increase his knowledge about distant elites, potentially gaining useful information otherwise unavailable. Broadly speaking, this may include new technologies, cultivation and subsistence techniques, ideologies (*sensu* Helms 1979 and 1994, 1993, 1991), and leadership strategies. Long-distance contacts also have a material component when exotic items are procured to reward selected followers.

Although Clark and Blake (1994) see similar human dynamics at play in the development of social complexity; ambition and self-interest in the search for power and influence, they postulate that hereditary inequality develops as a result of “aggrandizers” able to leverage resource abundance environments to propel them towards their aims. Relative, habitual, social inequality can only be established where resources are abundant. Thus, individuals seeking prestige can only leverage and ascend in social status where naturally productive environments or where “intensifiable habitats” (*sensu* Price 1984:225; Erickson 2006) exist. Resources must be “accessible, productive and relatively immune to normal environmental perturbations” (Clark and Blake 1994:18). A relatively low risk, predictable environmental, productive setting allows the local, ambitious “big man” or chief to collect surplus from subjects because it adds relatively little hardship to those from whom tribute is exacted. Consequently, the predictability and availability of resources would allow for the situation to be perpetuated. The resulting political economy would benefit a reduced segment of that group relatively more than those financing the status differentiation. Nevertheless, the costs to tributaries are expected to be low. Clark and Blake see competitive generosity as the token of reciprocity ambitious individuals would offer to supporters. Clark and Blake propose feasting as a prevalent feature signaling future aims and creating bonds of reciprocity, much the same way Hayden and Villeneuve (2010; Hayden 1995) see feasts as a way to reiterate, create debts fueling the creation of new configurations and sociopolitical structures.

Notwithstanding the fact that Spencer (1993; 1994) and Clark and Blake (1994) have the same starting point in the development of complexity, the socioenvironmental settings they deem essential lie on opposite ends of the spectrum. Spencer conceives high risk or relatively resource-scarce settings as ideal for the establishment of inequality, while Clark and Blake (1994) propose the opposite to be true. Holding the human factor constant, one would expect to see very different trajectories of social development depending on the model adopted, with the socioenvironmental substrate accounting for most of the difference.

While giving less room in their discussion to human factors assumed to be similar in all societies than the above authors, Sanders and Webster (1978) focused on apparent differences in a model that deals more explicitly with environmental factors as determinant in the development and trajectory of social complexity. Societies are organized, and utilize more or less efficient alternative paths, to cope with the consequences of the local environmental variation such that environmental variation is the principal thrust and substrate that constrains and determines collective actions. Social change is seen as an almost inevitable response in a feedback mechanism. The resulting trajectories differ, as do the environmental settings. The conjugation of agricultural risk, environmental diversity and productivity produces different levels of social complexity and inequality. In this sense the factors to which human societies react and adapt through different sociopolitical organizations and institutions are largely outside their control. However, unlike Spencer (1993) or Clark and Blake (1994), Sanders and Webster see a more varied and nuanced palette of trajectories possible depending on the environmental variables that provide the impetus for social change, taking population growth as a constant. Though the research that yielded this influential publication was conducted four decades ago, the consideration of four trajectory variations using two variables, risk and diversity, provides one of the most thoughtful considerations of the role of environmental variables in the development of social complexity and varying degrees of inequality, not to mention long-term trajectories. Whatever the shortcomings, the predictive aspect of the Sanders and Webster model makes it particularly appealing for the aims of this study.

Sanders and Webster's (1978) multilineal model includes four types of environmental situations resulting in four possible trajectories. In all four trajectories population growth is a given, which seems to be unilineal in its course, on the path larger populations.

Trajectory 1 occurs in low risk, low diversity environments such as humid regions like those found in the Gulf Coast, Maya Lowlands and Highland Guatemala. Soil fertility is the major obstacle to overcome in order to increase demographic capacity and technological innovation has little effect on productivity and yields. This trajectory would follow a constant decrease in the input-output ratio and would be characterized by a rapid development in complexity, reaching the chiefdom level, concomitant with specialized crafts such as obsidian and ceramic specialization relatively early on, followed by little subsequent political evolution (Sanders and Webster 1978:284) and or a relatively quick decline. Should state-like formations be found in such environments, they would be characterized by the features of a secondary state (*sensu* Fried 1967), which would result as the consequence of diffusion from a nearby Trajectory 2 area. Over time a decreasing input-output ratio would require a higher labor investment and eventually agriculture might no longer be sustainable.

While it is clear that agricultural diversity is low for Trajectory 1 areas, Sanders and Webster (1978) also mention how diversity can include items that are not just subsistence goods. Obsidian is mentioned among those that might extend technological capacity, as are other potentially valuable trade and sumptuary goods. Higher populations, external contact and trade and the economic activities stimulated by non-subsistence goods would add to the original setting's diversity. At that point a low risk-low diversity environment could be considered low risk-high diversity, or Trajectory 3. Over time, productivity and potential abundance depend more on the level of risk than diversity.

Trajectory 2, the “most important” in Sanders and Webster’s opinion (1978:281), occurs in high risk, high diversity areas like the Basin of Mexico and the Oaxaca Highlands, where the predominant environmental setting is arid and semi-arid. The areas where agriculture is possible without intensification strategies such as irrigation and terracing are relatively few. Trajectory 2 occurs concomitantly with technological innovation, and yield and crop security results in an increasing input-output ratio. In turn demographic capacity increases. It is thus expected that given enough time, human groups living in high risk, high diversity environments will develop the technology necessary to intensify agricultural production and sustain larger populations. Yet, as the population grows, risk increases since the land available for cultivation is essentially the same. Agricultural intensification strategies palliate risk, but only to a certain point and competition for resources inevitably increases, even as more labor is available for production. The trajectory is relatively continuous and sustained, but accelerates as it reaches state-level organization. In contrast to the three trajectory 1 areas, state formation would have all the characteristics of a pristine or primary state.

Sanders and Webster present us with a perplexing juxtaposition when describing their Trajectory 3 examples from Mesoamerica as they are the same as their Trajectory 1 examples, with the added consideration of non-subsistence goods as part of the spectrum of resources to be utilized by human societies. In other words, Trajectory 3 occurs in low risk, high diversity environments which may in all ways be the same as Trajectory 1 contexts except for either the presence or utilization of some non-subsistence goods. Trajectory 3 low risk, high diversity environments tend to follow a relatively steady pace through egalitarian societies, to chiefdoms to states. Once again, as populations increase, risk increases as well.

High risk, low diversity environments, such as those in desert regions, characterize the type 4 Trajectory. They cite Polynesian chiefdoms as potential examples of trajectory 4 (Sanders and Webster 1978: 282) because of the relatively homogenous, small regions contained within islands and archipelagos in the Pacific, while no Mesoamerican examples are given for Trajectory 4, where an initial increase in carrying capacity is followed by a rapid decline, generally because the technological innovation that increases the input-output ratio results in salinization of the soils and a rapid collapse. Causal factors lie outside the realm of social dynamics, which can then be interpreted as epiphenomenal. Nevertheless, as populations grow, increased demand can add to the risk, thus affecting the pace or tempo at which societies move through different levels of hierarchy and inequality. Trajectory 4 may result in chiefdoms as the highest level of social complexity, only after a previous transition from egalitarian society to stratified society.

Sanders and Webster (1978) and Spencer (1993) explicitly deal with aspects of demography that may be particularly important factors when conjugated with environmental conditions. Clark and Blake (1994:21) place less emphasis on population changes, though in their model it is clear that it would be more difficult for social complexity to develop in areas where socioenvironmental stress is exacerbated by higher populations than an area can comfortably support. Scarcity would increase the premium on the tribute potential elites might exact, thus subverting a scenario where abundance would allow them to establish preferential status. Demographic capacity and growth play a dynamic role, where increasing populations can add to the risk factors especially in areas of high diversity. Thus, population aggregations result as aggrandizers successfully attract followers through their generosity. Sanders and Webster (1978) add nuance to a low-risk scenario by predicting that chiefdoms and states would only develop through added labor, as populations increase and require added productivity, as long as agriculture is possible. Spencer (1993) would see relative or absolute population aggregation adding to the risk factor, creating opportunities for potential leaders to surface. In this sense, all three models consider growing regional populations, especially in terms of relative concentrations, to indicate increasing social complexity. Nevertheless, Clark and Blake see it as a consequence of increasing complexity, while Spencer and Sanders and Webster consider it a stimulus.

In spite of their overt focus on individual action as the impetus for social change over time, Spencer (1993) and Clark and Blake provide models where the environmental conditions determine a self-aggrandizing agent’s available opportunities. Similarly, for Sanders and Webster (1978) the independent variables are environmental, even as they place little emphasis on individual agency. Nevertheless, when the model is operationalized, Sanders and Webster (1978:281) present a detailed, cogent model that predicts different outcomes, variations and trajectories and the sequence of increasing social complexity for each of four possible types of environments. The four trajectories vary in terms of terminal social organization level, tempo of change and in the organizational forms through which each trajectory passes. In this respect, Sanders and Webster’s (1978) multi-lineal model compares favorably to more recent work (See Kohler et al. 2007), despite the absence of individual agents, especially because of the comparative and predictive nature of their model. The multi-lineal, comparative approach matches recent calls for additional comparative work (Smith 2012; Drennan and Peterson 2006; Drennan, Peterson and Fox 2010) in order to better understand the actual dynamics underlying social change as it pertains the establishment of hereditary inequality and the reasons why trajectories of change diverge over time.

The models involve variables that are dynamically interwoven and the particular combination of these will determine the unique trajectory that a society follows along the path to increasing social complexity. In all the models social and environmental risk, environmental diversity, population pressure, environmental productivity and external contacts appear to be relevant and potentially testable factors. A productive way to test the applicability of the models would be to use these dimensions to contrast differences in pacing, tempo and character for long-term sequences.

2.1.1 Social and Environmental Risk

The presence or absence of socioenvironmental risk is a major factor influencing the development of social complexity in the three models discussed. For Spencer (1993), risk is high where productive activities are highly likely to fail unless effective coordination is employed and where warfare is frequent and unpredictable. Risk, in turn, stimulates development as risky environments provide opportunities for aggrandizers to propose and execute strategies that, if effective, could bestow higher status upon them. For Clark and Blake (1994) it is the absence of such risks that allows for an aggrandizer to develop a following. The surplus necessary for competitive generosity to take place results from resource abundant or highly productive environments.

For Sanders and Webster (1978) the level of risk is relative to the likelihood of crop failure due to, for example, changes in rainfall or unpredictable environmental variables. However, they also consider other environmental variables in the four trajectories they propose. The relative distribution, size and diversity of productive soils, and the products potentially obtained there, whether subsistence or non-subsistence, define the diversity aspect of their equation. Abundance, although environmentally set, also depends on the extractive technology utilized and will vary within one setting and over time. Thus, the conjugation of different levels of risk, varying diversity and productive potential may result in abundance or scarcity. Human groups are at the mercy of the environment, save for the capacity to develop and utilize intensification techniques or technological advancement to improve their efficiency in extracting resources.

Changes in moisture and temperature, soils and topography affect the relative productivity and dependability. A low-risk area would be one where resources are more dependable, but not necessarily more abundant or less diverse. Technological innovation is most likely to improve reliability of a particular resource, rather than the variety available or long-term viability. Improvements in extractive technology generally palliate risk, for at least the short term, increasing the demographic capacity due to increased agricultural output. On the other hand, technological innovation can also accelerate imminent processes such as soil salinization, resulting in a much-reduced input-output ratio, eventually requiring more labor to produce the same yield. Whenever output decreases relative to the labor input, resulting in a relatively lower demographic capacity decline it adds to the environment’s risk. Thus, just as risks can be palliated through technological innovations that add to the dependability of the environment, they also increase risk during particularly bad years resulting in calamitous effects for the larger population dependent on the agricultural yield. It may be that the documented multi-century fluctuations that make Tisma a higher environmental risk area (Stansell et al. 2013).

2.1.2 Environmental Diversity

Sanders and Webster (1978) present the only model that explicitly deals with environmental diversity as part of the dynamic of change in social complexity. As they see it, environmental diversity generally tends to increase where more environmental zones and their concomitant products and productive potential are accessible within the regions they study, independent of the level of risk. This is in contrast to the idea that diversity is reflected in the number of species found within a particular biome or setting. Thus, uniformity of setting would curtail diversity, such that a region with a uniform distribution of a multitude of species would be considered less diverse than a similarly sized region containing distinct biomes, even if, when added, the actual number of distinct species is smaller. Diversity, in Sanders and Webster's view is mostly dependent on topography, although soil packets and their distribution throughout a region are the proximate correlate.

Clark and Blake (1994) do not mention diversity as such, but it is implied, though conflated, as part of the abundant resources they see as necessary for social complexity to develop. For Spencer (1993) diversity is implied as well, though it is clearer that should diversity be curtailed, for social or environmental reasons, risk would increase, thus decreasing diversity would promote and accentuate the unequal distribution of resources and the development of social complexity. For Clark and Blake (1994), more environmental diversity promotes social complexity; just as for Spencer (1993) the opposite is true. For Sanders and Webster (1978) high environmental diversity, when combined with high risk contributes to increasing social complexity over time, though not necessarily in a unidirectional manner. When combined with low risk, high diversity also fuels social complexity, but the nature of the trajectory of change is different, so that it is the conjugation of the two factors that actually determines the tempo and result, given enough time. It is the trade and exchange dynamics that could result from the diversity of products available to the human groups within a given region, or in contact with one another, that facilitates the development of inequality.

2.1.3 Population Pressure

Sanders and Webster (1978) assume relatively continuous population growth as part of each of their trajectories. In essence, population only increases over time and it seems to be a factor that once it is set in motion, no further consideration needs to be accorded to it. Increasing demographic capacity is sometimes the result of technological innovations. Although technological innovations can also be seen as a successful response to increasing demographic needs, diminishing input-output ratios may also result despite technological adaptation, depending on the diversity and risk level of the setting. In this perspective, population growth can thus be seen as an impetus fomenting innovation and as the result of increased demographic capacity.

Spencer (1993) sees relative demographic change primarily as a stimulus for increasing social complexity. Whether populations are circumscribed by unstable or violent social situations or decreasing environmental capacity, the relative scarcity thus created provides the opportunity for aggrandizers to assume leadership and, if successful, consolidate their exalted position beyond the immediate situation. Demographic change could then be the result of absolute or relative population increases.

Clark and Blake (1994) see populations increasing as aggrandizers attract ever more followers. Though the mechanisms are not explicitly examined, it is assumed that competitive generosity would attract migrations and foment autochthonous population growth even as social complexity increases. In this sense, relative population concentration, not necessarily growth, would be an indicator of increasing social complexity.

2.1.4 Productivity

The three models focus on the relationship between local productivity and demographic capacity. Productivity provides the potential for aggrandizers to engage in competitive generosity, an elemental requirement for the Clark and Blake (1994) model. Conversely, it is at the point where resources become relatively scarce that increasing complexity would result in Spencer’s model (1993).

For Sanders and Webster (1978:250) the productivity of local resources is a “second-order factor.” They focus much more strongly on risk and diversity. Nevertheless, low productivity relative to population size would retard a society’s trajectory, and increasing levels of complexity may only be reached after a comparatively protracted period of time, never reaching state-level complexity. Such developments would not necessarily be unidirectional.

2.1.5 External Contacts

For Clark and Blake (1994: 29) “effective competition” in the local setting requires that aggrandizers establish “enduring ties” and traffic outside their communities, though it is never clear how far “outside” needs to be and how such external contacts contribute to the development of complexity in a functional way. It may be that external contacts matter more to the extent that different leaders are able to attract more followers through competitive generosity, and can further cement bonds of debt and/or reciprocity. Sanders and Webster (1978) talk about the importance of “secondary states,” achieving that level of social organization because of external influence, not necessarily because it was autonomously nascent. However, external contacts are not detailed in a useful way and their role is subordinate to local environmental, social and demographic factors. Much like Clark and Blake (1994), Spencer (1993) considers external contacts to be critical links in the search for exalted positions and higher status. Long distance relations between elites may make accessible information otherwise unavailable, enhancing the potential leader’s chances of mounting a successful strategy to widen the extent of their influence. In this sense, information may be knowledge about new strategies, technologies and ideologies, as well as actual ties of affinity, alliance and support. Long-distance contacts may also be instrumental in the acquisition of rare goods to bestow upon collaborators and allies. Esoteric, highly idiosyncratic or distinctive objects may signify not only a leader’s reach and contact with powerful distant or mythical allies, but may, on the part of the subordinate recipient of such goods, be used to express relative proximity to a local leader.

The three models assume that once certain social structures are in place, the only alternative is to continue on the path to increasing social complexity, though Sanders and Webster provide four potential trajectories dependent on environmental risk and diversity and they mention the potential for collapse, though it is unclear where in the complexity trajectory collapsed societies would fall thereafter.

The three models that frame this research effort were chosen precisely because they are clear in their interpretation of the development of social inequality and complexity, especially as they become relatively stable features once chiefdom-level societies are established. Since all three models present clear contrasts in the forces that cause the same social transformation phenomenon, they are deemed especially suitable to testing them using empirical evidence and make a valuable comparison.

2.2 ENVIRONMENTAL RISK, DIVERSITY, RESOURCE ABUNDANCE, AND LOCATION IN TISMA AND TICUANTEPE

2.2.1 Environmental Risk

Although there are pockets of higher risk within the region, in general, Tisma is a low to medium risk area. The municipality lies in a relatively flat, low-lying area, with highly productive soils. The highest elevation within the municipal borders is 173 m above sea level, in the southwestern corner of the municipality. Concomitantly, the elevation contours decrease generally in a northeastern direction, reaching a year-round, readily accessible source of water at 34 m above sea level: the Tipitapa river/Tisma lake system. This stream defines the northern and northeastern municipal borders.

Because the areas near the river and the springs are generally inhabitable only during the dry season, permanent settlements in the floodplain are only likely during longer-term dry cycles. Conversely, during periods when the precipitation-evaporation balance changes and rain is more plentiful, permanent settlements would be feasible only in elevations safely beyond the flood levels, where the present-day ephemeral streambeds would be more likely to have water available longer or perhaps even year-round.

Although there is some regularity to the yearly rain cycles, droughts are not uncommon and river-level fluctuations are not quite predictable because they depend on the Xolotlán and

Cocibolca lakes' drainage basin, equivalent to an area of more than 30,000 km^2 (Montenegro-Guillén 2004). In the absence of efficient irrigation and water-storage techniques, this makes it more difficult to choose the optimal placement for planting and successful crops.

Two important consequences of this added risk are that crop success or failure and access to water sources other than springs, are intricately and strongly tied to the yearly fluctuations of the water table. There is the potential that crops could be planted in areas that may be readily flooded and water source location could change significantly relative to settlements. The five to six-month long rainy season regularly causes an increase of one meter in the river level, thus flooding much of Tisma and increasing the level of the water table throughout. Average annual rainfall in Tisma is 1000 mm (INETER 2003a). During El Niño events, rainfall decreases by 40% to an annual average of 600 mm in Tisma (INETER 2003b). The floodplain retains much moisture, making movement on foot on wet clay soils extremely difficult. There are also springs which emanate year-round. These sources are currently used to irrigate nearby crops and for drinking water for humans and livestock. Other than the springs and river/lake system, surface water is available only during the rainy season, and most abundant after heavy rains in the larger Masaya region. At present there are also numerous ephemeral streams that follow the southwest-to-northeast trend.

The average annual rainfall in Ticuantepe is 1200 mm (INETER 2003a). However, in contrast to Tisma there is only a modest decrease of 17% in the annual average rainfall during El Niño years, to 1000 mm (INETER 2003b). There are numerous springs and year-round streams in Ticuantepe and they are located throughout rather than concentrated in one area. The elevation differential within the region makes for very marked contrasts in vegetation, soil productivity and temperature. On the other hand, most of Ticuantepe's soils are suitable for the same suite of crops as Tisma. Non-subsistence resources are more localized, though the distances within Ticuantepe could not be construed to pose an obstacle for the acquisition and processing of igneous stone or a variety of hardwoods, fruit and fauna. In light of its permanent nearby water sources, Ticuantepe is less susceptible to annual precipitation fluctuations and crop failure is less likely than Tisma. During drier, less productive years, lacustrine resources could be more intensively utilized in Tisma, but staple crop-scarcity might only be mitigated through storage. Ticuantepe is less prone to suffer from crop failure, while the irregular terrain would lower the yield per labor ratio.

Although the Masaya volcano system is very nearby, it has been proposed (Incer et al. 1999) that the most destructive, explosive volcanic events took place as many as 16,000 years before the Orosí and Tempisque periods, the earliest time frame to be dealt with in this project. Instead, numerous lava flows impacted areas well below Ticuantepe’s elevation, and the relatively low-level volcanic activity, coupled with seismic activity have not deterred populations from settling there. While, some of the higher elevations beyond Las Cuchillas, to the south west of Ticuantepe, have been noticeably affected by the sulfur content of the Masaya volcano’s continuous gas expulsions, especially in the last fifty years, the minor ash eruptions that sometimes occur, on the scale of every three to four decades, serve to enrich the soils with minerals. This makes the highest elevations in Ticuantepe the least productive and riskier area within the municipality. Concomitantly, there is a dearth of settlement evidence at elevations beyond 550 m. Because of the plentiful productive soils, increased diversity and more predictable water sources, Ticuantepe is an area of lower risk than Tisma.

Ultimately, Tisma is a slightly riskier area overall, though the difference is in the range of that found within some of the regions Sanders and Webster (1978) described (see for example the contrast between the northern and southern Basin of Mexico [1978:286-288]).

2.2.2 Environmental Diversity

Approximately one third of Tisma’s territory lies between 34 and 40 m in elevation. A gently sloping, continuous elevation increase makes for a relatively homogenous area in terms of vegetation and productivity. Lacustrine resources are easily accessible, especially close to the shores of Tisma Lake, which is a shallow (one to three meters deep) open basin through which the Tipitapa River system flows. The Tipitapa River connects the two largest lakes in Nicaragua, Lake Cocibolca (also known as Nicaragua or Granada) and Lake Xolotlán (also known as Managua), and the shores of Lake Cocibolca lie 6 km from the edge of the Tisma Municipal boundary. Although modified igneous rocks are readily found in archaeological contexts, the nearest sources for basalt or andesite are 12 to 15 km away from Tisma proper, though not rare by any means. There is a relative homogeneity of non-subsistence resources in the area, although clay for adobe and ceramics is localized near the river/lake shore.

Ticuantepe’s northern edge follows the same general contours, in the same general direction as Tisma. However, the terrain and vegetation elsewhere are noticeably different. Excluding the Masaya volcano’s lava-covered crater area, the lowest point within the municipal borders is around 193 m above sea level in the northeastern corner, while the highest elevation measured is nearly 900m in the southwestern corner. Most of the area between the relatively level northeastern plain, (generally between 200 and 250 m) and piedmont (between 450 and 600 m) is undulating, less than compact soils, cut-through by drainage channels and ephemeral streams. The escarpments and very marked slopes make for land profiles that are less than ideal for cultivation, especially when contrasted with the relatively level or gently undulating Ticuantepe valley areas only a few kilometers away.

The availability of water during the dry season becomes a mitigating factor for those areas further away from wells, springs and surface water sources. In Ticuantepe the variety of terrains available make for a noticeably higher diversity of resources when compared to Tisma. This makes location within the region an important consideration for future agricultural production. Subsistence agriculture could easily be complemented with the relatively higher diversity of available resources. On the other hand, Tisma’s broad, flat plains and fertile soils have the potential to produce a higher yield per labor input ratio.

Ticuantepe offers moderately greater resource diversity, despite its smaller relative size when compared to Tisma. There is a noticeable difference in terms of elevation, vegetation, fauna and availability of surface water, not to mention the rich and periodically replenished volcanic soils. Also, the El Niño cycle fluctuation in Ticuantepe is more moderate, palliating long-term effects.

2.2.3 Productivity

As demonstrated by Tisma’s present-day agricultural potential and productivity, the level, and gently sloping trend coupled with the highly productive soils and relatively homogenous setting make it quite convenient to plant crops at any scale throughout the municipality. Even without intensive agriculture, yields are abundant and the yield per labor input ratio is high. Productivity is high even in the absence of agricultural intensification techniques. Similarly, Ticuantepe is highly productive because of the rich, volcanic soils predominant throughout.

Tisma has a slightly higher productive potential than Ticuantepe because of its generally level terrain and homogeneity. However, both municipalities are similarly productive.

2.2.4 Location and External Contacts

Tisma's location, on a broad, relatively flat, fertile plain along the edge of the Tipitapa River, between the lakes Xolotlán and Cocibolca makes it a particularly advantageous location for trade and external contacts. The Tisma plains are central to only land crossing between the two lakes for nearly 200 km. The area is a natural choice for passage between the east and west, as well as the north and south, a potential *entrepôt*. Tisma would seem to have a particularly privileged location in the Pacific coast region of Nicaragua. Thus, if location is primordial for external contacts, Tisma should be especially privileged in this regard.

Ticuantepe's location is strategically advantageous since there is only one flank that is completely exposed, the plains on the eastern edge. The south and west are demarcated by the Masaya Volcano system's escarpments and vesicular basalt fields; access from the north is constrained by the very sudden change in elevation between the undulating plains and Las Cuchillas. At the same time, the constraints make Ticuantepe the most accessible area for travel to the nearby "*Meseta de los Pueblos*," a region documented to have had a good portion of Masaya's precolumbian population (Incer 1994).

Although both Ticuantepe and Tisma have the potential to serve as passages to and from different areas, Tisma's location has more potential to either serve as a passage or as a long distance trade and exchange node.

2.3 ENVIRONMENTAL COMPARISON OF TISMA AND TICUANTEPE TO OTHER REGIONS

Sanders and Webster (1978) proposed that the conjugation of environmental factors such as diversity, risk and productivity resulted in four different likely trajectories for the development of complexity. The models used as their particular referents the Basin of Mexico, Highland Oaxaca, Maya Lowlands, Highland Guatemala and the Olmec Gulf Coast, all areas both authors were quite familiar with and for which enough quality data was available for comparisons of the sort they envisioned.

Among the regions utilized in their risk/diversity/productivity model, the Olmec Gulf Coast provides the most useful comparative framework for evaluating Tisma and Ticuantepe's place in a broader context because of the low risk, low diversity denomination. However, because Spencer (1993) uses Tehuacán and Barinas in his model and Clark and Blake (1994) set their model in Soconusco, these will also be considered, along with the Basin of Mexico, an area that will provide a clear contrast.

Sanders and Webster (1978:288) describe the Olmec Gulf Coast in Tabasco and Veracruz, Mexico low risk, low diversity area. Rains are predictable and abundant, averaging between 1500 mm and 4000 mm, depending on the region (CEC 2006), and with the exception of floods, "risk is virtually non-existent." There are no frosts to threaten crops, agricultural production is complemented by plentiful wild food resources and, they propose, early hunter gatherer populations would have found the area quite attractive, just as agriculturalists would have. Sanders and Webster (1978:289) reason that because of the relative homogeneity of the locally available resources, there would have been little incentive for specialization. Moreover, maize-based subsistence agriculture could have been pursued over the entire region, without any difference in terms of scheduling.

Intra-regional heterogeneity is present when the rich, alluvial levees are compared to the hinterlands further from the numerous streams. However, non-subsistence resources are more easily obtained away from the rivers, conferring geographical advantages to the less fertile areas. The population distribution within the Olmec Gulf Coast is not uniform, where less populated areas coincided with less well-drained soil indicating they were less sought after.

Extensive swidden agriculture would have resulted in a highly efficient, very productive cultivation system, although not as productive as the Basin of Mexico's intensive farming strategy (Sanders and Webster 1978:289). The efficiency and relatively low input/high output ratio depended in large part on the ability to maintain a bush or forest-fallow system. On the other hand, should the optimal rotation be curtailed in order to increase production in the short term, the whole system would be likely to break down. Thus, as long as population requirements did not impose demands that pressured the optimal rotation cycle, the bush/forest-fallow system would continue to be highly efficient and productive.

As a way to make a contrast, the Basin of Mexico is characterized by its highly variable, low rainfall (450-1200 mm), frosts, masses of unproductive mountain terrain and productive niches. It is a large, high-risk, topographical unit that measures approximately 8000 km^2. The topographical and rainfall variability, availability of freshwater and saltwater lakes and the highly localized nature of non-subsistence resources such as quartz, lime, obsidian and building stone make this region high in diversity especially when Morelos is included. Before the development of intensive agricultural techniques such as irrigation, terracing and drainage agriculture, only 20-30% of the region might be suitable for extensive agriculture. In Sanders and

Webster’s (1978) eyes it is the advent of such techniques that makes it possible for anything beyond a chiefdom-level organization to develop. Concomitantly, it is only 1200 years after agricultural colonization that a state-level organization develops in the Basin of Mexico.

Soconusco is a low-risk, productive, predictable setting according to Clark and Blake (1994), although the environmental description is somewhat vague. It may be assumed that Soconusco is a relatively low-risk, low diversity, highly productive environment, similar to the Olmec Gulf Coast as described by Sanders and Webster (1978).

Tehuacán is a relatively arid setting, where larger populations were only possible thanks to collective efforts to dam enough water to overcome the challenges of agriculture and subsistence (Spencer 1993). Risk, and diversity would fit well within the parameters Sanders Webster’s (1978) established for the Basin of Mexico. Although Tehuacán’s productivity is lower than the basin of Mexico’s, it is still a high risk, high diversity, trajectory *1* setting.

The Venezuelan Andes meet the humid savannah *Llanos* in Barinas, where average yearly rainfall is 1800 mm. However, the potentially cultivable areas decrease rapidly with elevation. Thus risk and productivity will vary accordingly along the rivers as they descend from their headwaters. Diversity would be similar to the Basin of Mexico over the whole of the state of Barinas. However, because of the size of the region in Spencer’s (1993) study area, diversity is much more limited. In much the same way as in Tehuacán, community-level organized projects decrease risk and increase relative productivity for the local population. This would be a low diversity, high risk setting.

While Tisma is subject to somewhat more environmental risk than Ticuantepe, and even though rainfall is less frequent and copious, both are comparable to the Olmec Gulf Coast. Unlike the northern Basin of Mexico, the agricultural risk in Tisma and Ticuantepe is not diminished by irrigation canals, and crop failure is as common as in parts of the Gulf Coast. There is moderately more diversity within Ticuantepe than there is in Tisma, but considering the range of diversity present, both are about as diverse as the Gulf Coast, but less diverse than the Southern Basin of Mexico and Morelos. The diversity in Soconusco, as described by Clark and Blake (1994), is very similar to that of Tisma and Ticuantepe, while Barinas, as described by Spencer (1998) has less diversity than either. The productivity potential of Tisma is higher than Ticuantepe and Barinas and comparable to the Gulf Coast and Soconusco, even without intensive agriculture.

2.4 APPLICATION OF MODELS FOR THE DEVELOPMENT OF SOCIAL COMPLEXITY IN MASAYA

2.4.1 Clark and Blake Model

Masaya shares many attributes with Soconusco and most of the Pacific coast of the Central American isthmus and would fit within the parameters Clark and Blake (1994) had in mind as ideal for the development of social complexity. It is a region of low environmental risk, high productivity and relatively high populations by the contact period (c. 1522 CE). Because of regional volcanic activity local soils maintain a high fertility index, productive enough to sustain the vast majority of the local population through subsistence farming without irrigation. Masaya is conveniently located within the isthmus separating Lakes Xolotlán and Cocibolca, the only possible land crossing from the Pacific coast to the central region within 220 km (Figure 1.1, 1.2), while also being within close reach of important resources and likely points of travel and communication.

Clark and Blake (1994) place most of their emphasis on productivity and predictability of resources. When Tisma and Ticuantepe are considered as part of one region, we would expect that complexity develop quickly and continuously, in time reaching the state level because of the relatively low risk, abundance and predictability of subsistence resources and the convenient location relative to access routes, thus external contacts. In terms of accessibility to external contacts, Tisma’s northern edge defines most of the between-the-lakes land bridge, with fords and the most convenient river crossings providing access through to the eastern side of lakes Xolotlán and Cocibolca. Ticuantepe’s situation is quite favorable in terms of potential for external contacts as well. Ticuantepe is, even now, the most convenient passage to the “meseta de los pueblos,” a highly productive area in the central Pacific, where elevations vary between 500 and 1200 m. The “meseta” is the only obstacle between Ticuantepe and the Pacific coastal plain.

Tisma’s location may be the most geographically advantageous setting for long-distance communications and exchange along most of the Pacific coast of present-day Nicaragua. It is close enough to the Pacific coast, both lakes, eastern/central Nicaragua and higher elevation areas to the west. Populations should concentrate around settlements where successful aggrandizers have established and regularized their heightened status. Evidence for long-distance networks may be found in the form of materials such as ceramics, metal or lithic industries appearing without precedent. The objects could be foreign made or locally made with imported technologies. Such materials would be used to accentuate privileged status. Because of the low diversity, low risk setting, the widespread productive soils, high productivity should readily result, with the concomitant, progressive increase in complexity.

Ticuantepe's location is not as privileged as Tisma's relative to the central and north-central regions of Nicaragua, or to Rivas and points south beyond the present border of Nicaragua and Costa Rica. Access to the *meseta* would be advantageous and it is a highly productive region on its own. Compared to Tisma, there is much more diversity in terms of topography, which increases the resulting variety of agricultural and wild resources thus available, and the numerous readily available surface water sources moderate the effects of seasonal precipitation, should a drought occur.

Complexity should develop modestly, if at all, in Tisma, being a riskier and less predictable region, or, in any case, it should develop slower and to a lesser extent than in Ticuantepe, the lower risk, more dependable region. In Ticuantepe we might expect that social complexity would develop earlier than in Tisma and there should be clear evidence of centralization around successful aggrandizers and a highly complex social order should result. Ticuantepe would compare favorably to Soconusco in terms of early development and trajectory, with an early florescence and robust, continuous growth, eventually reaching the chiefdom level.

2.4.2 Sanders and Webster Model

Per Sanders and Webster (1978:290), complexity increases rapidly in the Olmec Gulf Coast after 1500 BCE, when cultivable lands seem to have been settled. The trajectory classification is *1*. They propose that a dense population establishes itself here, even prior to the development of agriculture and that the tempo of social change is rapid as is population growth. High concentrations settled near the levees even as overall population densities were low. The possibility of surplus production was directly related to the patchy distribution of highly productive soils, so that those who were closest to the rich alluvium could produce surplus much more easily and in larger quantities than those cultivating the less productive, less well-drained areas further from the river streams. Small, impressive, chiefly centers dominated by monumental architecture were built by chiefdom-level societies relatively early on. These centers were supported by surplus production from the sparse but dense population.

In contrast, in the Basin of Mexico, the trajectory classification is *2* (Sanders and Webster 1978:288); although agriculture developed relatively early (1400 – 1200 BCE), it was not until intensive cultivation techniques were introduced that population growth and state-level societies developed over 1000 years later.

In Sanders and Webster's view (1978) the trajectory for the Maya Lowlands area is *3*, although because of its size and varying diversity, parts within could be better described as following trajectory *1*. The developmental sequence for the Maya area is slow when compared with the "highland nuclear areas." Emergent chiefdoms are present as early as 400 BCE, yet it took at least 1000 more years for state-level complexity to appear, for a total of 2600 years from the point of agricultural colonization to the state level. The relatively homogeneous environment fostered little pressure for redistributive systems to develop, and the uniform topography created little in the way of natural boundaries limiting expansion. Only the unusual productive potential contributed to the development of the state, so that high population densities were sustainable even in the absence of agricultural intensification and despite a slight decrease in production efficiency.

In Sanders and Webster's (1978:288-291) model Masaya would be a low-risk, low diversity classification, Trajectory 1, most comparable to the Gulf Coast. Accordingly, we may expect a continuously increasing level of social complexity, reaching a plateau at the chiefdom level, early in its development, becoming a state only through diffusion and outside influence, a secondary state trajectory. Demographic change would alter the tempo of the change should sudden expansion occur. However, as long as populations and demographic capacity increase, social complexity should continue to increase as well. There should thus be evidence for outside influence as a precursor of development beyond the state. Conversely, a bias toward autochthonous material culture would indicate that extra-regional networks are less influential and development should not reach beyond chiefdom similar to Polynesian forms. Tisma and Ticuantepe would be expected to develop along Trajectory 1 in this model.

The whole of the department of Masaya might be considered a region according to Sanders and Webster (1978) if total area were used as the defining criterion. However, it is more productive to compare the local trajectories of Tisma and Ticuantepe on their own rather than to conflate them as part of a larger, Masaya regional trajectory. Tisma and Ticuantepe do not contrast as starkly as the Basin of Mexico and the Maya Lowlands in terms of risk, diversity and productivity. Were we to use Sanders and Webster's (1978) risk-diversity-productivity scheme to predict how social complexity and change should develop and at what tempo, both Tisma and Ticuantepe, should (like the Olmec Gulf Coast trajectory 1) show signs of complexity relatively quickly and earlier than the Basin of Mexico, "followed by little subsequent societal evolution" (Sanders & Webster 1978:284). Conversely, if we were to consider Tisma and Ticuantepe separately, we might expect Tisma to develop along trajectory 2, closer to the Basin of Mexico, with complexity developing rather late but becoming increasingly complex rather complex at that point, terminating in state-level organization. Ticuantepe should follow the previously mentioned trajectory 3.

2.4.3 Spencer Model

According to Spencer's (1993) model, complex societies would not develop in low risk zones. If resources are relatively abundant and predictable, and scarcity-driven competition for resources never intensified, then a relatively simple level of social organization would be maintained. This is what we might expect to happen in Tisma and Ticuantepe. Local chiefdoms would only have developed if local elites served to effectively attenuate perceived environmental or social threats for the local population, even as taxes were levied and inequality accentuated. Social risk, however, could increase competition in even the most predictable, productive areas, intensifying the drive towards ever more complex social forms. It is the interplay and combination of both social and environmental risk that promote increasingly complex social organization in Spencer's (1993) model. By including risk added through the social realm, the amount of risk is more variable through time than for environmentally determined dynamics. Thus, the effects and consequences of "socioenvironmental risk" are more flexible and less predictable because human idiosyncrasy and historical particularity are more variable than any given environmental setting over time. However, there would be intermittent disruption because of El Niño cycles and volcanic activity, so intermittent expressions of social complexity punctuating longer periods of less complex social organization may be expected. Social risk could thus be a more important driving force, especially considering the advantageous geographical setting in both. However, as has been stated previously, neither region is so unique relative to its neighbors that location relative to routes for external contact may be their most sought after resource.

Compared to Tisma, Ticuantepe's relatively more predictable environmental setting, the protection provided by the topographic circumscription and the lower risk apparent, we might expect that social complexity would develop only to a low degree, with a prolonged period of less complex social organization. On the other hand, it could develop only if social risk were heightened through incursions from outside the area, or if the local population perceived the threat of the Masaya Volcano's potential for destruction as sufficient to seek leaders that innovated effective strategies dealing with such eventualities.

On the one hand, Tisma may have been the ideal setting for long-distance interaction and information exchange. The favorable location may have made local populations susceptible to resource competition or incursions from nearby groups. Effective leadership may consist of mounting successful military offensive or defensive campaigns. Long-distance information exchange networks and knowledge regarding potential threats would underwrite an aggrandizer's standing. If chiefdoms actually developed in the area, environmental factors might have fostered a perceived risk atmosphere. Also, competition with nearby groups could increase social risk. Since Tisma and Ticuantepe are regions of low environmental risk and abundant resources, high social risk would be the stimulus for the establishment of status inequality and more complex forms of social organization in Spencer's model. As such, it would be predicted that social complexity would increase concurrently with episodes of increasingly risky social circumstances, after a relatively prolonged period of relatively simple social organization. Evidence for social conflict, then, should be present, as well as exotic goods used to accentuate status differences. Populations would be more likely to be concentrated around leadership nodes to minimize the deleterious effects of bellicose conflict as leaders create strategies to overcome such instability.

Tisma has a higher social and environmental risk level because of its location and riskier environmental setting, especially with permanent settlements and agricultural subsistence.

Because environmental risk increases cyclically we might expect rapid development of complexity and the stabilization of the local social hierarchy, especially when the potential of social risk thanks to Tisma’s more exposed, homogenous plains and less defensible positions is added. Tisma may be comparable to Barinas as described by Spencer (1998). Ticuantepe, is ensconced in an undulating valley, delimited on one side by a steep volcanic crater escarpment and on two other sides by rapidly rising piedmont and slopes. Ticuantepe is thus less prone to social risk from without. The higher diversity would lower the environmental risk level below Tisma’s. In other words, we should expect that Ticuantepe’s complexity may not be a stable and continuously developing feature, thus more difficult to discern without fine resolution chronological data.

2.5 RESEARCH PROGRAM – ARCHAEOLOGICAL CORRELATES

In order to test the models in the Masaya region of Pacific Nicaragua it is necessary to adopt a long-term, regional perspective that allows for major changes to be charted over time and compared across periods. In this way the relative pace or tempo of sociopolitical change and development can be gauged in absolute terms, while also locating the changes in time.

It is necessary to highlight the kind and degree of social complexity that emerged in the Tisma and Ticuantepe regions, so that from the project results it should be possible to infer the tempo at which changes take place, and their nature, because the pacing of complex patterns of organization is central to the evaluation of each model. Concomitantly, it will be essential to be able to chart the distribution of people on the landscape, especially in relative terms.

A research program designed to fill in the voids regarding the tempo and pacing of developing complexity, the political and economic factors underlying it, as well as a more detailed understanding of Precolumbian societies in Masaya, requires a regional strategy that can illustrate trends and significant changes along a relatively long-term. It is when we are able to look at long sequences of change among societies that are "genetically" related that we can most profitably pursue the reasons underlying those changes (Drennan 1991b:278). The 16th century chiefdoms of Pacific Nicaragua fit the standard definition as regional polities with "institutional governance and some social stratification organizing a population of a few thousand to tens of thousands of people" (Earle 1997:14; also Carneiro 1981; Earle 1987). Thus, chiefdoms may be most productively studied at the regional scale (Drennan 1995; 1991b).

The first aim of this research, then is to provide documentation of the trajectory of social change that occurred in Tisma and in Ticuantepe so that the observed trajectory can be compared to the one we would expect to see if any of the three models were accurate. Those expected trajectories, at least insofar as purely environmental conditions are concerned, are detailed above. At the chronological scale this study aims to work, it may be assumed that environmental factors do not change enough as to require a radically new understanding based on the reconstruction of precolumbian environments. Moreover, since it is generally recognized that despite its appeal, a fine grained, thoroughly detailed, small-scale reconstruction of ancient environments may be excessive, relative changes in climate, vegetation, precipitation, fauna and soils may be sufficient at a resolution level corresponding to the established precolumbian occupation sequence. Despite its importance, the environmental change sequence will be derived from already available information and complementary evidence, rather than survey results.

Since some of the causal factors in the three models are not purely environmental, but rather socially-driven (social risk, population pressure and external contacts), the second central task of this research is to document the presence and strength of these social factors with archaeological evidence in order to make it possible for the three models to be contrasted using the particular factor relation resulting in increasing social complexity.

It is essential to reconstruct regional populations to better understand the role of population pressure and increased social risk, if any. Absolute population estimates do not in and of themselves indicate a particular social-political organization form or level of complexity, though it is a widely accepted premise that population increase and increasing social complexity are frequently concomitant (Carneiro 1970; Cohen 1985; Keely 1988; Kirch 1984). The idea of population pressure, the relative concentration of populations approaching the local carrying capacity is clearly implied in all three models considered. Clearly, higher population densities may require novel ways of organizing local communities. Moreover, the combination of these factors in a particular configuration may precipitate social change (Clark and Blake 1994; Sanders and Webster 1979; Spencer 1993).

Documenting demographic change and relative distributions over time will make evident the emergence, development and growth of central places (*sensu* Christhaller 1966) and regionally centralized higher order communities. Higher order communities may in turn be characterized by higher relative population densities and/or monumental architecture, differentiated distributions of fancy, rare or imported goods, when compared to nearby communities in the region in question. Foreign goods will then be interpreted as evidence of external contacts when used in conjunction with other published archaeological data.

Proximity of major settlements to trade routes will be interpreted to indicate importance of long-distance exchange and social networks, along with large amounts of artifacts identifiable as “foreign” on the grounds of style or raw material sources. These migrations or more local hostilities could alter the degree of social risk, which can be monitored in regional survey data by the extent to which settlements are located in defensible situations and the extent to which nucleated, defendable communities predominate over widely dispersed occupation. Populations tend to concentrate at times of political instability, thus, a measure of regional political stability can be projected from site nucleation, size and number of sites in a system because political instability tends to result in fewer, larger, denser population concentrations and vice versa (Chisholm 1970). Even when political control (*sensu* de Montmollin 1989) or defense is not paramount in settlement location, increasing social risk exacerbates the tendency for populations to concentrate around more defensible areas (Drennan 1988). On the other hand, while substantial immigrant settlement may result in differential settlement patterns and material culture, their absence will not affect the goals of this project. Evidence for changing risk should be observable whether or not migrations can be documented from material remains.

Full-coverage survey (Kowalewski 1990, Kowalewski and Fish 1990, Hassan 1981) has been shown to be an effective strategy to ascertain temporal and spatial distribution of archaeological sites in a region. Systematic full-coverage surface survey can be used to assess social and environmental risk factors, Precolumbian chiefdom-level polity interactions and achieve the project’s objectives. Full coverage survey can provide detailed data on settlement distribution and spatial relations (Kowalewski and Fish 1990) and offer an additional scale to examine sociocultural evolution in Masaya, making it possible to monitor the process of social change at the regional level.

3.0 FIELD METHODS

In order to test the three models previously proposed it is necessary to ascertain the time when changes take place, as well as the scale and nature of such changes. The project is designed to identify settlements, settlement location, settlement hierarchy, function, and relative nucleation, for each occupation period. Settlement hierarchies in terms of area or population size, complemented by settlement function information, are useful in determining the level of social, political and economic complexity present within a society. Regional settlement distribution data is amenable to such interpretations.

Ethnohistorical information indicates that it is very likely that chiefdom-level societies were present in the study region (Incer 1990; Stone 1982; Oviedo 1974; Chapman 1960). Chiefdom-level societies are considered regional-level societies and require a concomitant-level study to best understand their characteristics and idiosyncrasies (Drennan 1995: 309). At the top of the regional settlement hierarchy, chiefly centers tend to concentrate the largest populations in the region, as well as the clearest evidence for social differentiation and inequality, whether expressed through rare, very elaborate, luxury or exotic goods such as gold, jade, obsidian and fancy ceramics. Monumental works are often associated with chiefly residences, which tend to be the largest structures in the settlement (Peebles and Kus 1977; Earle 1997; 1987; Carneiro 1981). Ever diminishing expressions of privilege and inequality would be found at sites occupying lower tiers within the regional settlement hierarchy.

Based on prior surface surveys in similar contexts, precolumbian sites documented in Pacific Nicaragua are frequently identified by artifact scatters bounded by areas lacking artifacts. Most such “sites” incorporate materials from more than one chronological component as defined by the “Greater Nicoya” chronological sequence (Abel-Vidor et al. 1987). Though sites are expected to represent archaeological settlements, in the past, with some exceptions (Salgado 1996; Salgado et al. 1998; Espinoza, García and Román-Lacayo 2000; Niemel 2003), they have typically been defined as the conflation of all materials, regardless of chronology. To fulfill this project’s aims, the survey strategy would be expected to result in the identification of settlements, settlement densities and hierarchies separately for each period in the sequence. Precolumbian sites tend to exceed 1 ha (Salgado 1996; Salgado, Román-Lacayo and Niemel 2007.; Espinoza, Garcia and Román-Lacayo 2000; Lange 1992) and have been documented to be as large as 200 ha (Salgado 1996). Non-systematic, visually estimated artifact densities as low as 3-5 sherds/m2 had previously been used to identify settlements (Salgado 1996; Salgado, Román-Lacayo and Niemel 2007; Espinoza, Garcia and Román-Lacayo 2000). The smallest sites identified included scatters around 25 m wide. Thus, it was important to develop a survey strategy that would identify the most sites, while covering the largest area possible in a timely manner.

Because of the typical archaeological signature in Pacific Nicaragua, a systematic, regional-scale, full coverage survey is the most appropriate strategy to document the features and settlements in the area and for gathering data amenable to the aims of this project. Moreover, this survey would provide a full-coverage complement to previous sampling strategies utilized in the Municipalities of Granada (Salgado 1996), Masaya and Nindirí (Salgado, Román-Lacayo and

Niemel 2007) which included generally homogenous settings along 500 meter-wide tracts covering only parts of each municipality.

A regional-scale, full coverage survey strategy was used to document the features and settlements in the area. The methods utilized in this survey were developed as refinements made to the original Basin of Mexico Survey (Sanders, Parsons, and Santley 1979) methodology (Drennan et al. 2003a:99-100). Sanders, Parsons and Santley (1979) developed an approach which has influenced most regional surveys since, in one way or another, implicitly or explicitly (Blanton, et al. 1982; Drennan 2000; Drennan, et al. 2003a, 2003b; Kowalewski, et al. 1989; Balkansky et al. 2000). Further, the Masaya Region survey methods are a logical application of refinements developed in later surveys by Drennan et al. (Drennan 2000, Drennan, et al. 2003a, 2003b). A systematic, full-coverage surface survey (Kowalewski 1990) of the municipalities of Tisma (127 km2) and Ticuantepe (65 km2) was conducted over 17 weeks between the months of January and May 2003. Because of terrain and lack of accessibility 123.4 km2 were surveyed in Tisma (97% of the total municipal area), and 48.6 km2 were surveyed in Ticuantepe (74.8% of the total municipal area). Nevertheless, the area covered encompassed the range of contexts and environmental diversity found (Figure 4-28).

The Tisma survey zone is quite accessible and easily traversed during the dry season, areas such as cane fields, (known to be heavily populated with poisonous rattlesnakes and with almost zero visibility), bull pens, deep ravines and modern day walls and more urban development required modification of transects and left many areas unexplored (Figure 4-2). In Ticuantepe a considerable obstacle for the survey was pineapple plantations for two reasons. First, many owners zealously guard their property (one week prior to our team’s arrival one man had been killed and another badly wounded by gunfire for stealing pineapples). Second, because of the local cultivation techniques, visibility and traffic are tremendously hindered by any but the youngest pineapple plants. Fortunately, permission was generally easy to get and no large industrial plantations exist in the area. Thus, we gained access to most of the proposed survey zone. In contrast to Tisma, the topography and vegetation posed a major challenge in Ticuantepe, not to mention the fact that because of its proximity to the nation's capital, Managua, there is much more urban and sub-urban development, so private property and pavement also removed considerable tracts from our survey area.

Personnel from the Museo Nacional de Nicaragua, and Universidad Autónoma Nacional de Nicaragua were complemented with two local workers and local informants recommended by the municipal authorities of Tisma and Ticuantepe depending on the area being surveyed. The local workers knew the area well, facilitating access to survey areas. They also served as goodwill ambassadors within their communities, and made connections with local schools and interested groups in order to set up talks and presentations intended to increase awareness of the project, the prehistoric past and issues related to preservation in the area.

The two municipalities surveyed are characterized by their contrasting topographic profiles, size and features. Thus, project personnel were divided into two teams for most of the survey. Each team consisted of a team leader and at least three others. Every team had radio transmitters for the team leader and the members whose assigned transects were the outermost on either side. Near the end of the season only one team participated. Each team member was assigned a transect depending on his or her relative experience, so that at times there were two people, side by side, covering the same transect. Similarly, in each municipality one local informant was nearly always with the team leader. Each team member also carried a compass and loud whistle in case they were not within reach of a transmitter or if they lost track of the rest of the team. Each team carried one or two GPS units. Team members were assigned parallel transects, maintaining 75 m distance and examining the surface for archaeological evidence. The intended survey area for each day was determined by the terrain and the team assigned. Two or three teams of four people walking 75 m apart along north-south, or east-west transects surveyed the area, locating 1013 hectares of precolumbian occupation. A survey interval of 75 m between team members would permit the location of all surface scatters representing sites, with the possible exception of those few, very small sites that happened to be completely between two team members. Comparing the number of sites located during this project to those found during a prior project in the municipalities of Masaya and Nindirí (Salgado, Román-Lacayo and Niemel 2007), in the general vicinity, it may be obvious how effective the transect interval chosen for this project was. The intensity of coverage suggests that it is very likely that most of the settlements detectable therein were located. In order to determine artifact densities quantitatively, systematic surface collections were made (Drennan, et al. 2003a:134-135), rather than the qualitative assessments made by Sanders, Parsons and Santley (1979:21-30).

Sites and collection lots were located on 1:50,000 scale maps from the Nicaraguan Institute for Territorial Studies (INETER) and Global Positioning System (GPS) units, in order to be transferred to georeferenced maps of the area. When available, 1:10,000 aerial photos and georeferenced orthophoto maps were also used. Drawings of features were made, and terrain, surface visibility, soil type, slope, disturbances and state of preservation, were recorded for each site. Each collection unit was located in the aerial photos and/or maps each team leader carried. Collection units were considered part of a different site if there were 100 m or more between artifacts. This distance of 100 m of vacant space is somewhat arbitrarily chosen since it seemed like a reasonable interval (Kowaleski et al. 1989) and it is in line with what present-day inhabitants would consider separate settlements.

A collection lot consisting of artifacts recovered from the surface, represented each one-hectare collection unit. Lots were collected in one of three ways. First, most precolumbian and colonial ceramics, lithic and faunal materials were collected in 4 m diameter circles and assigned a unique lot number. Every artifact found within the confines of each 4 m circle was collected. The locations of the 4 m circles were chosen arbitrarily within each 1 hectare unit, wherever the terrain and visibility seem optimal for collection, without regard to the apparent density of the surrounding area. When the ceramic sherd count was less than 12 for a 4 m circle, an additional circle was placed within the same unit until at least 12 sherds were collected to obtain a representative sample. In five cases, more than one 4 m circle was placed within a 1 ha collection unit that had very high densities (more than 25 artifacts/m2) in order to document in more detail the internal distribution of apparently central districts.

Where artifact densities were below 0.25 per m2, general collections were made and all sherds found within the approximate boundaries of the 1 hectare unit were bagged and identified as part of the same lot. Those areas were also designated Low Density Areas (LDAs) to distinguish them from the systematic collection units during analysis.

The third mode of collection was executed whenever fewer than three sherds were picked up in the absence of any others within 100 m. The number of such isolated finds was quite low (15 sherds altogether), however, they were nevertheless bagged and tagged with the unique lot identification number and date of collection. Such collections were not used in the analysis as they would not be considered representative samples. However, they were not discarded as it was felt that in most cases the discard site would not be congruent with the find location. These 15 sherds/artifacts are now in storage just in case they might provide chronological reference some day in the future.

Surface collections were made for a total of 1074 lots were representing 1013 ha of precolumbian occupation. A total of 12,707 ceramic fragments were collected, including 5,577 diagnostic sherds and 449 lithic fragments and objects. The data were processed continuously to monitor the progress of the field campaign, and to make sure that field notes and daily impressions were recorded, corroborated and readable for future use. This included making ceramic and lithic fragment counts, washing and re-bagging and storage. All bags were transported from the field headquarters to the Museo-Sitio Huellas de Acahualinca for storage weekly or bi-weekly. Ceramics were organized and preliminarily classified every other day. Because visibility is quickly impaired with new growth soon after the seasonal rains begin each year, and because farmers are less welcoming to strangers traversing newly planted fields, the field season ended on in the first week of May 2003. Laboratory analysis ensued thereafter. Fragments were counted and identified according to the type-variety system (Gifford 1960, 1976) whenever possible in order to determine chronological correspondence, function and vessel form. Masaya regional ceramics correspond to types identified in surrounding areas, fitting within the assemblage proposed for much of the area often identified as Greater Nicoya in Pacific Nicaragua and Northwestern Costa Rica (Abel-Vidor et al. 1987). Lithics were counted and identified according to material, form, style and possible use. Obsidian was measured and weighed in order to compare the assemblage to other Central American assemblages, especially those with similar source provenience. Selected diagnostic artifacts were drawn and photographed.

In the laboratory all items were labeled and catalogued prior to permanent storage in the Museo Nacional de Nicaragua’s facilities. Representative diagnostics were drawn and photographed. Petrographic analysis with a polarizing microscope was also used to characterize sample batches of undecorated materials in order to develop a database for future comparisons. The complete settlement dataset is available in the University of Pittsburgh Comparative Archaeology Database (http://www.cadb.pitt.edu/).

4.0 SURVEY RESULTS AND DEMOGRAPHIC RECONSTRUCTION

A total of 171.9 km^2 were surveyed in the municipalities of Tisma and Ticuantepe. Because the municipal borders for Tisma and Ticuantepe are defined by a combination referenced, arbitrary, straight lines and landmarks such as rivers and roads, it was necessary to survey areas immediately outside the borders in order to maintain consistency and clear limits for the surveying teams. Collections were made for a total of 1054 lots, representing 993 ha of precolumbian occupation. Nearly 70% of the systematic collection lots (723) contained diagnostic ceramic types. Lots lacking diagnostic ceramics were not included in the following analysis because barring more detailed, in-depth, analytical techniques beyond the scope of this project would be necessary to make a convincing case for chronological correspondence of the sample. Though it is unsatisfying to remove 331 collection lots, essentially one third of the total number, from analysis, it may also be said that they represent less than 10% (1172 of 12,707) of the total number of sherds collected. It may well be possible to assign a proportional increase for each period, but as this would be done numerically, rather than spatially assigning chronological correspondence to the non-diagnostic lots. However, it may distort the landscape and distribution of communities by period, including more uncertainty. On the other hand, the relation between chronological period population estimates would not change if 10% were assigned to each period in each municipality across the board, or corresponding to the actual proportion for either Tisma (465/7,207 ~ 6.5%) or Ticuantepe (707/5,353 ~ 13.2%). Rather, absolute population estimates may be off by as much the corresponding proportion, and because the aims of this project rely more on relative change, the magnitude of additional error are not deemed enough to venture into such an effort as may be required to utilize all lots in the analysis.

Regardless, the sample analyzed was representative and large enough for the purposes of this study, taking into account the above observations. Artifact densities were used to estimate regional populations when collection lots were comparable among settlements. Though such correlates are not always reliable measures of absolute population (Hassan 1981:63-93), only relative population estimates are needed to identify population growth, decline or stability (Drennan 1988).

4.1 DEMOGRAPHIC RECONSTRUCTION

Considering the discussion, in chapter 2, on the role of demographic change as an influence upon or as a correlate to increasing social complexity, it is crucial to establish a rubric for the relative comparison of demographic change. The resulting analysis will then serve as the basis for relative and absolute population estimates, thus providing a better idea of the scale at which societies in the surveyed region developed and functioned, the changes that take place over time and the relative concentration of population throughout the region.

4.1.1 Demographic Reconstruction Methods

An important feature of this project depends on the relative location and concentration of precolumbian populations across time, so it is necessary to focus on relative population distribution, concentration and location. Indeed, using the distribution of materials across the landscape as a proxy for the distribution of people across the landscape (*sensu* Peterson and Drennan 2005; Sanders, Parsons and Santley 1979), it is possible to characterize extinct human communities.

Although it is commonplace for site area to be used to represent human population size on the landscape (Hassan 1981:63-93), Sanders, Parsons and Santley (1979:35) have noted that demographic reconstructions based on settlement area alone do not take into account the variability in the density of materials that is encountered in surface surveys. To address this problem they devised a system for ranking the relative distributions of materials on the ground based on visual estimates. However, visual estimates are subjective and imprecise as they make it impossible to accurately assess the relative concentration of materials with much precision beyond the broad categories established.

There is much potential in the utilization of relative concentrations of materials over a given collection area. A systematic strategy based on the methods utilized by Drennan et al. (2003) was devised to increase the precision in the collection of artifacts, concomitantly resulting in more precise estimates of densities of materials. All collection areas were measured and all artifacts found within them were collected, counted and classified. It was then possible to calculate the density of artifacts, for each period, for every collection lot containing diagnostic ceramics by dividing the number of sherds of the period by the systematic collection area. However, some sherds could not be identified to period. To create a density figure that incorporated all sherds in each systematic artifact collection, non-diagnostic sherds were assumed to occur in the same chronological proportions as the diagnostic sherds. Thus, the proportion of diagnostic sherds by period in each systematic collection was used to calculate the number of non-diagnostic sherds for each period in each collection so that non-diagnostic sherds in each collection were divided between periods in the same proportions as diagnostic sherds. The number of diagnostic sherds and non-diagnostic sherds estimated were then added to obtain the total number of sherds for each period in each collection. The total number of sherds was then divided by the area from which they were collected to determine the sherd density for that period in sherds per square meter. The ceramic sherd count-defined density for each systematic collection was taken to represent the density in the entire collection lot that contained it. The density in sherds/m^2 was multiplied by the area in hectares of the entire collection lot. The resulting number is a relative population index (RPI). Since the same number of people may aggregate in different densities over different areas, the relative population index makes it possible to say 1 sherd per square meter over 1 hectare is equivalent to 0.5 sherds per meter square over 2 hectares or to 2 sherds per meter square over 0.5 hectares. Many of the pitfalls and subjectivity that commonly performed visual analysis is less explicit about (see Drennan et al. 2003) are avoided using these methods. Nevertheless, though a clearer perspective results and the approach is systematic, these methods do not remove all subjectivity from the process.

4.1.2 Communities

Communities are the unit of analysis that best fits the goals of this project rather than the more common “site”. The archaeological site, as a unit, is often taken to represent a human community, an implication that has garnered some deservedly critical attention (Dunnell 1992; Dunnell and Dancey 1983). There is not necessarily a one-to-one correspondence between a “site” and a human community. Murdock (1949:79) defines community on the basis of co-residence and daily, face-to-face interactions. Further, a community is “the fundamental locus of social control…a political group" (1949:84) that survives as a political unit even when more complex organization is present (1949:86). Thus, changing social and political complexity may be reflected in changing patterns of interaction within communities and at the regional level, just as the intensity of internal and external community interactions may be. Moreover, in pre-modern societies "the costs and inconvenience of interaction increase substantially with distance" (Peterson and Drennan 2005:5), such that we may expect households and communities to be located closest to those with whom interactions are important and most frequent.

RPIs can be used for comparing the populations of different lots. When summed, RPIs for all lots in a given period in the survey area become the basis for comparing populations between periods and survey areas. Peterson and Drennan (2005) propose a method for delineating communities using relative population density data, where RPIs can also be used as *z* values, or elevation coordinates for the survey regions as a third dimension representing relative population. Thus, density surfaces can be created whereby peaks represent population concentrations that are relatively higher than those in the immediately surrounding areas. Since flat surfaces at zero elevation represent a population of zero, contour lines can be drawn at the base of population peaks to make communities more clearly recognizable based on the likely number of people and their relative location. The community thus defined can then be compared to other communities in the region using community-size histograms. These are traditionally referred to as *site-size histograms*. However, a site area index that does not take into consideration density is a less than optimal strategy for comparing settlement populations, thus the term change. Rank-size graphs (*sensu* Zipf 1949, Johnson 1982, 1981) will be used to explore the regional settlement hierarchy and its potential implications regarding social and political complexity and integration. RPIs are the measure from which relative centralization and integration will be determined. Using yet another application suggested by Peterson and Drennan (2005:11-15), surfaces can also be used to make higher order organization such as districts or regionally-integrated units more obvious by smoothing the peaks, effectively lowering the relative elevation of the contours and encompassing larger population concentrations.

4.1.3 Absolute Population Estimates

In order to utilize RPIs to estimate absolute populations it is necessary to approximate how many actual inhabitants each RPI unit represents. Sanders, Parsons and Santley (1979) devised a five-tier classification of settlement types for the Basin of Mexico project. Their observations depended primarily on site size, occupational density and architectural complexity, though total population and location relative to other settlements were also considered. Their *compact ranchería* had between 2 to 5 persons per hectare occupied. A *scattered village* had between 5 and 10 persons per hectare; a *compact low-density village* had between 10 and 25 persons per hectare; a *compact high-density village* had 25 to 50 persons per hectare and the few *compact high-density villages* of the highest order were expected to have between 50 and 100 persons per hectare. This system could be simplified into a four-tier typology by collapsing all *compact high-density villages* into one category.

Since 1996, there have been five regional survey projects in Nicaragua where the site typology utilized was very similar, although the sources for the creation of this classification varied. In her Granada project, Salgado (1996:104-106) used a four tier classification including *hamlet, dispersed village, nucleated village* and *town*. The same classification system was used in the Masaya-Nindirí survey (Niemel, Román-Lacayo and Salgado 2001) and in the Rivas regional survey (Niemel 2003). In the Segovias Regional Survey Project, Fletcher, Espinoza and

García (1996:29) also used a four-tier classification, but added a political/organizational component implication in the type names. Because of the nature of the region, the Segovias survey project also made it a requisite for mounds to be present in order for the top two levels in the site hierarchy to be identified. The Segovias system used *hamlet, dispersed village (caserío), local center-nucleated village* and *regional center*. The second phase of the Segovias project utilized the same classification system (Espinoza, García and Román-Lacayo 2000).

Of the five projects mentioned above, only the Granada project (Salgado 1996) makes an attempt at estimating absolute populations. This was accomplished by dividing the population derived from a Colonial census for the town of Diriá by the area as represented by town's boundaries in 1993. This resulted in a baseline density of 12 persons per hectare. Although none of the projects mentioned make specific reference to the Basin of Mexico settlement typology, it is clear that the researchers considered the same implications that Sanders, Parsons and Santley make explicit regarding population, density of occupation, size and the concomitant political and economic and characteristics.

The typologies previously proposed can be used to compare the RPI against the population figures proposed by Sanders, Parsons and Santley for the following four Tisma sites. Table 3.1, below, shows the site designation, site-type classification, RPI values for the settlements mentioned, population estimates according to Sanders, Parsons and Santley and the RPI equivalence. TI053-02 fits the characteristics of a *hamlet* or *ranchería*. This is a single component site containing only Ometepe period diagnostic ceramics. According to Sanders, Parsons and Santley (1979) the population would be between 2 and 5 persons. TI15B would be a *scattered village* or *dispersed village* during the Bagaces period. The population would be between 20 and 40 persons. TI09S is a *nucleated* or *compact low-density village* with a population between 80 and 200 persons. TI13S is a *town* or *compact high-density village* during the Sapoá period, with an estimated population of 200 to 400 persons.

To simplify the process through which absolute populations are estimated we may calculate the average of the low range for all four types in the classifications, resulting in about 4.3; it is 9.3 for the high range. However, 4.3 and 9.3 are rather cumbersome numbers to work with, and Sanders, Parsons and Santley (1979) mention that their estimates tended to be lower than actual census figures. Since, absolute populations are only approximations at best, we may use 4 persons as the low range and 10 persons as the high range multiplier to serve as the point of departure for absolute population estimates. Thus, in creating absolute population estimates it will be assumed that an RPI of 1 is equivalent to as few as four and as many as ten persons per hectare.

Table 4-1. Site-type classification and population estimate according to Sanders, Parsons and Santley (1979). Areas are actual areas encompassed by the contemporary lots defining the settlement. Average RPI equivalences for the four sites utilized are 4.3 for the low range and 9.3 for the high range.

Site Identification Code	Site Typology	Area (ha)	RPI	Population Estimate (Sanders, Parsons and Santley 1979)	RPI Equivalence
TI053-02	Hamlet	1	0.09	2 to 5	2 to 5
TI15-B	Scattered Village	4	4.60	20 to 40	4.4 to 8.7
TI09S	Compact Low-density Village	8	9.25	80 to 200	4.2 to 10.4
TI13S	Compact High-density Village	8	1.17	200 to 400	6.4 to 12.8

4.2 TISMA

The total area encompassed within the municipal limits of Tisma is 124 km^2 (Figure 4.1). This area includes more than half of Tisma Lake and about half of the course of the Tipitapa River along 5 km. Because of the logistic difficulties involved in covering urban areas, river streams and sugar cane fields, approximately 1.8 km^2 (1.5%) of Tisma were not surveyed. On the other hand, the total area covered was 123.7 km^2, including parts of the neighboring municipalities of Nindirí, Masaya, Granada and Tipitapa (Figure 4.2).

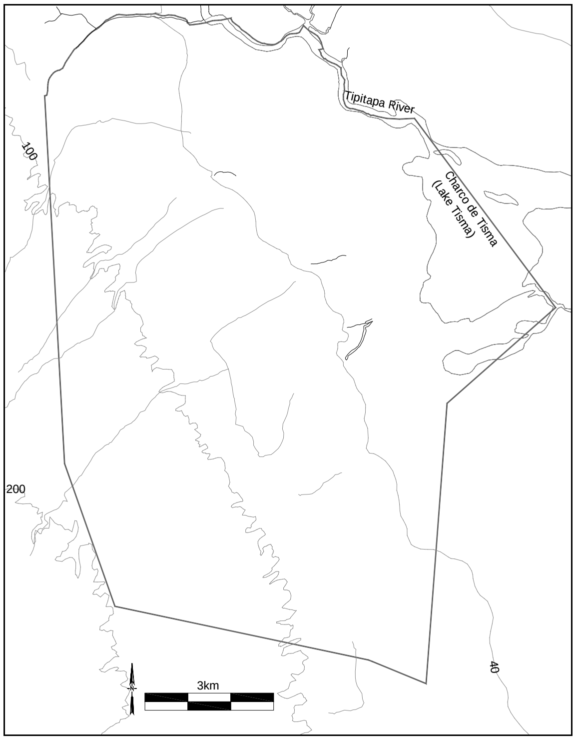

Figure 4-1 Municipality of Tisma, municipal outline, elevation contours and dry riverbeds shown.

In Tisma, 401 systematic collections were made (Figure 4.2), representing 377 ha of occupation. A total of 7207 ceramic sherds were collected in Tisma. Of these, 3,740 (52%) were identifiable diagnostic markers. Altogether, chronological correspondence could be assigned to 295 lots (74% of Tisma collections). In 106 lots no diagnostic ceramics were found. Among lots that could not be assigned a specific chronological correspondence, there were 17 that contained precolumbian lithics in the absence of ceramic evidence. Lithic artifacts included 342 objects collected, among them fragments and complete pieces of metates, manos, hand axes, projectile points, blades, cores, scrapers, bark scrapers, flakes, debitage, celts and maces. In order of abundance by weight, the lithic materials included basalt, andesite, chert and obsidian. Some of the lithic materials showed evidence grinding and polishing during manufacture, others had been retouched. One metate (T033 Metate) was found partially buried and was left *in situ* as extracting it would not be consistent with the survey methodology nor would it further the project's goals. There were nine low-density area (LDA) collections in Tisma, totaling 12 non-diagnostic sherds. Overall, the occupied area in Tisma seems to be nucleated yet distributed throughout the municipal territory.

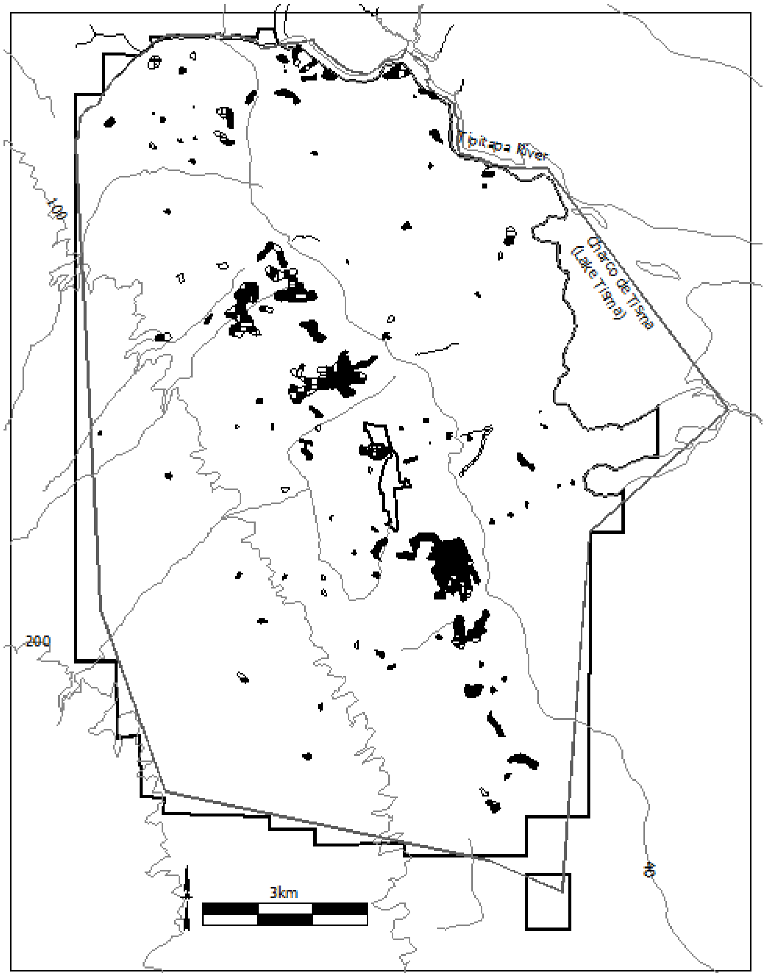

Figure 4-2 Surveyed area in Tisma, including all collection lots. Surveyed area is enclosed in thick line. Diagnostic lots are filled solid. Non-diagnostics are outlined only.

4.2.1 Orosí and Tempisque Periods (2000 - 500 BCE and 500 BCE – 300 CE)

The earliest period represented in the survey collections is Orosí, lasting 1500 years, from 2000 BCE to 500 BCE. However, though there are types that occur during late Orosí, extending through the Tempisque period (500 BCE –300 CE), there is no clear, diagnostic suite specific to the former period, making it impossible to differentiate between them using surface collections in the absence of absolute dating. Indeed, there are only two sites in Pacific Nicaragua where reliable dates have confirmed Orosí period occupations, Ometepe Island (Haberland 1967, 1992, 1993a, 1993b, 1996) and Villa Tiscapa in Managua (Lange 1996, 1997), which may also indicate that the diagnostic suite defined for the Orosí period (2000 – 500 BCE) is most likely representative of the years 1000 to 500 BCE. It might thus be reasonable to narrow the chronological span for the purposes of this study.

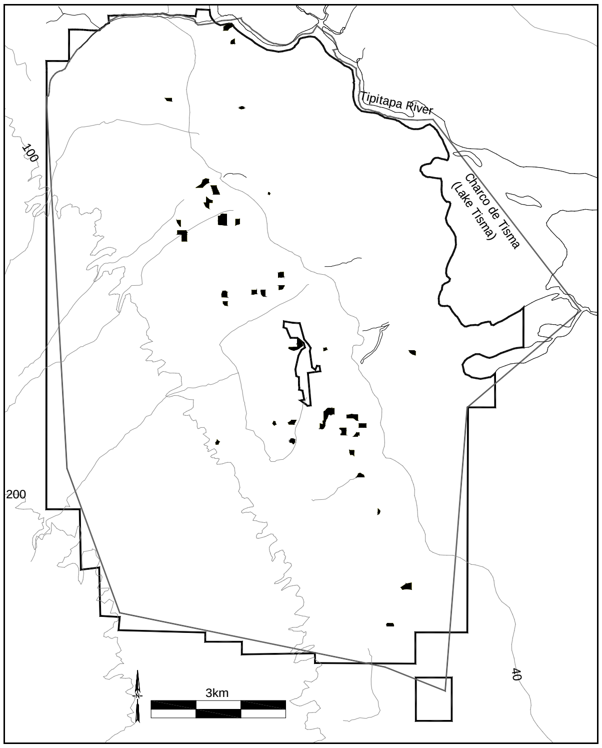

Figure 4-3 Tisma lots containing Orosí-Tempisque period (2000 – 500BCE / 500 BCE – 300CE diagnostic ceramics.

The Orosí/Tempisque occupation in Tisma is relatively sparse as can be appreciated in figure 4.3. Altogether 53 ha of occupation are represented by the 51 lots that contained diagnostic ceramics with a RPI of 17.4, representing as few as 70 and as many as 170 persons. In Tisma there are no Orosí/Tempisque settlements above 100 m in elevation; with very few exceptions, occupation is concentrated within a narrow band following the 40 – 80 m contours, crossing the municipality diagonally from northwest to southeast. Though there are two main areas, north and south of the present day town of Tisma, where the occupation seems to be developing at least the kernel of concentrations, the general pattern appears dispersed. Nevertheless, there are seven areas where contiguous occupation exceeds 2 ha. The Tipitapa River is the dominant river system/water source in the area, yet only two lots were located less than 1 km from its course.

Sedentary occupation in the Tisma survey area begins in Orosí-Tempisque times with a very small population. When the density-area index is represented as a surface (Fig. 4.4), separate, well-defined, fairly nucleated small local communities are evident (Fig. 4.5). Altogether there are 24 of these communities, ranging in size from single isolated households to a maximum of possibly as many as 55 inhabitants. The rank-size graph for this period (Fig. 4.6) suggests regional integration with a pattern whose departure from log-normal is not very significant (A=-0.208, or between -0.586 to 0.182 at the 90% confidence level (Drennan and Peterson 2004)).

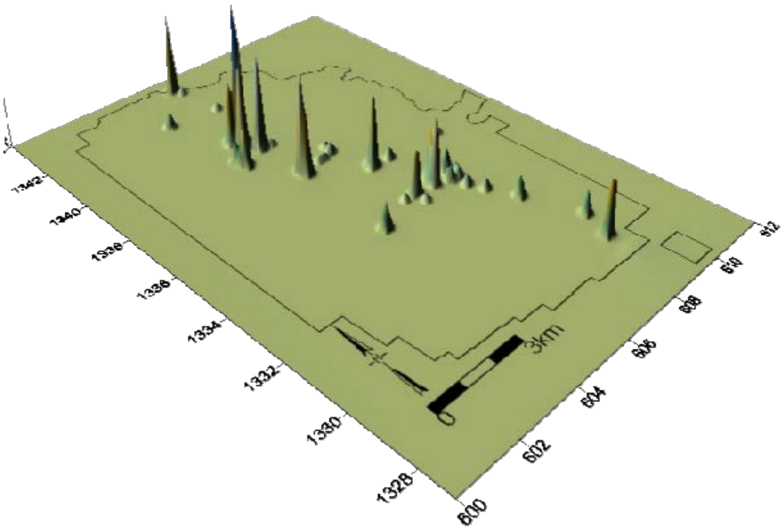

Figure 4-4 Orosí-Tempisque periods RPI surface graph.

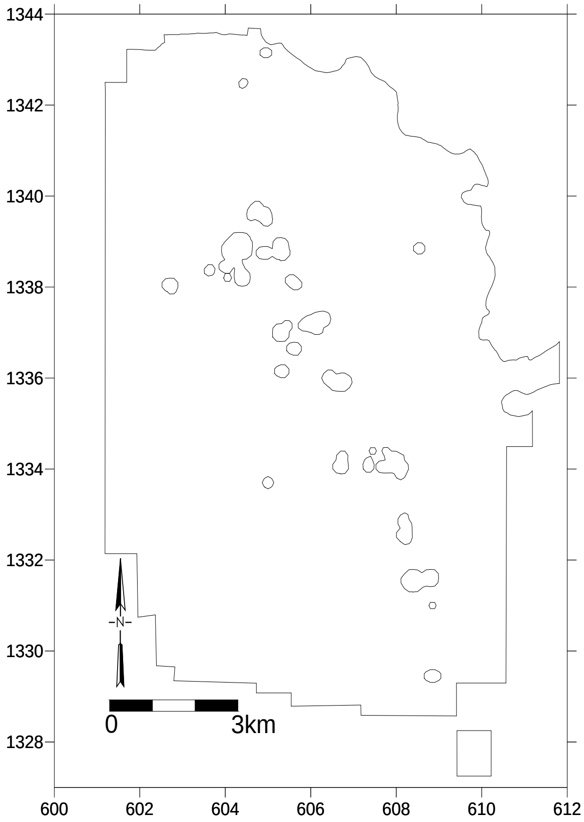

Figure 4-5 Orosí-Tempisque periods RPI surface graph contours delineating communities.

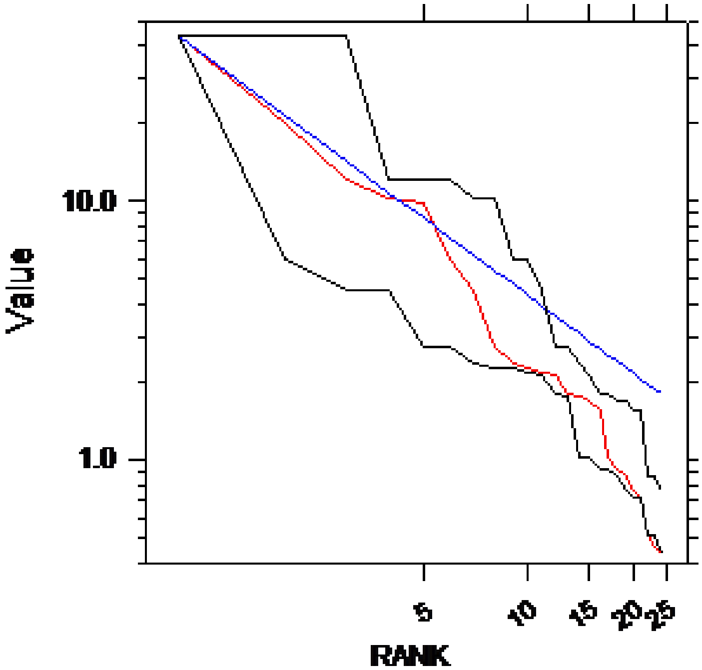

Figure 4-6 Orosí-Tempisque periods rank-size graph of absolute population in Tisma, including 90% confidence zone. A = -0.208 N = 24 -- Error ranges for A -- 90% Confidence: -0.586 to 0.182 (Range= 0.768).

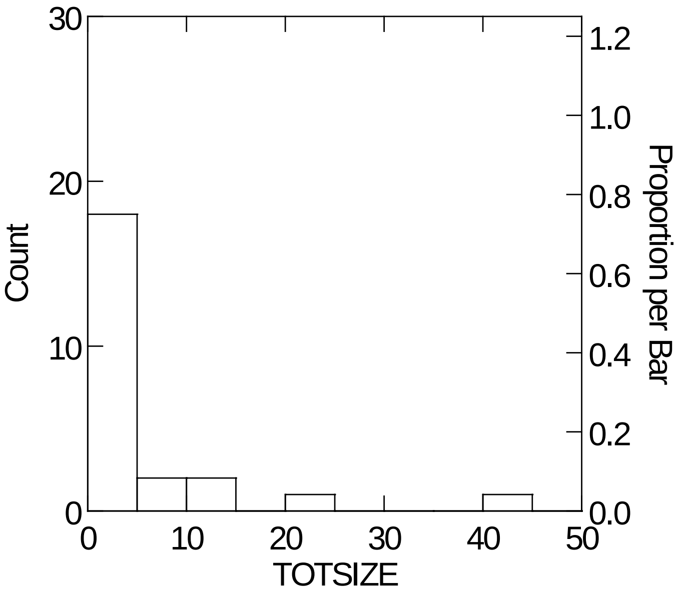

Figure 4-7 Orosí-Tempisque periods community-size histogram of absolute population estimates in Tisma.

This pattern indicates regional integration, though with such a tiny total population and a largest community with less than 60 inhabitants, this cannot be taken to indicate any substantial degree of political centralization. The community-size histogram (Fig. 4.7) for this period reflects one major grouping including 22 settlements where the populations are at most 14 people or less and two larger settlements that we might call small farming villages with 30 and 60 people respectively.

4.2.2 Bagaces Period (300 – 800 CE)

The Bagaces period (300 – 800 CE) is roughly concurrent with the Mesoamerican Classic. The diagnostic ceramics are noticeably different from those of the previous and subsequent periods. There were 90 lots representing 95 ha of occupation in Tisma during this period (Figure 4.8), an increase of nearly 80% in occupied area. Surface ceramics occurred at substantially higher densities than during the Orosí-Tempisque period though, so the RPI for the period increases to 78.6, representing as few as 300 and as many as 800 persons, a four-fold increase. Interestingly, there are even fewer settlements near the Tipitapa River/Tisma Lake system than during the last period. Though the occupied area is still very much within the 40 – 80 m contours in Tisma, some settlements are higher than 100 m. Also, the lot with the lowest measured elevation is 47 m, unlike the previous period (40 m).

There are three areas where concentration seems to be most conspicuous. Two are very near those that were evident in the previous period. A new area appears almost directly north of the present day town of Tisma. The number of settlements where there are contiguous lots increases very noticeably. One settlement with two mounds (TI089) is associated with this period. Neither mound would be characterized as paramount or central place in terms of density or diversity of goods relative to surrounding areas within the settlement. In fact, the mounds are peculiar because of the low density of surface materials. Both mounds are within 200 meters of the central area, but on what might be considered the outskirts of contiguous proximity. The largest of the two mounds measures 8.6m in diameter across its widest point (7.8 at its narrowest), with a differential elevation (relative to surrounding surface) of 1.3m. Mound 2 is approximately 80m west of Mound 1, and it measured 1m in elevation, with an approximate diameter of 7m. They are clearly anthropogenic in origin; this part of Tisma is particularly flat and away from drainages, construction and roads, in the middle of pastures. Some Sapoá period materials were also associated with the mounds, and no clearly Bagaces ceramics were found on the mound surfaces, but as TI089/Proyecto Libio is characterized as one of the two largest Bagaces period settlements, the mounds are thought to make for a better chronological match for this period.

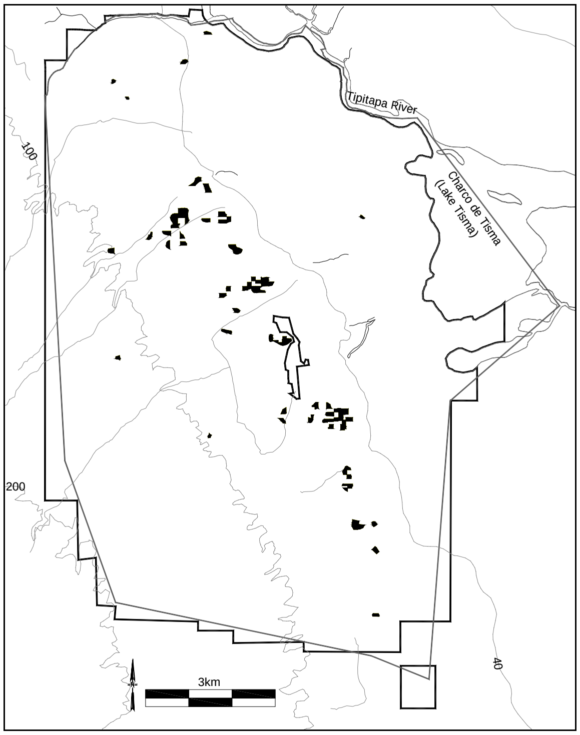

Figure 4-8 Tisma lots containing Bagaces period (300 – 800 CE) diagnostic ceramics.

Though mounds are often indicative of elite residences or ceremonial architecture in Central America, the precolumbian features found in Tisma do not seem to provide such evidence because artifact densities are very low, the surface collections did not reveal particularly fancy or peculiar artifacts or ceramics, and even though they occur within one of the two most important communities during the Bagaces period, they are not in what might be considered a central location. Moreover, it might be at such features that one might expect evidence of feasting or ritual ceremony. As such, the mounds in question do not provide convincing evidence to identify elites or a centralized ceremonial function for that site.

The two largest settlements can be clearly seen in the RPI surface for the period (Figs. 4.9, 4.10). For the settlement system *A*= -0.309 (-0.698 to 0.329 at the 90% confidence interval).

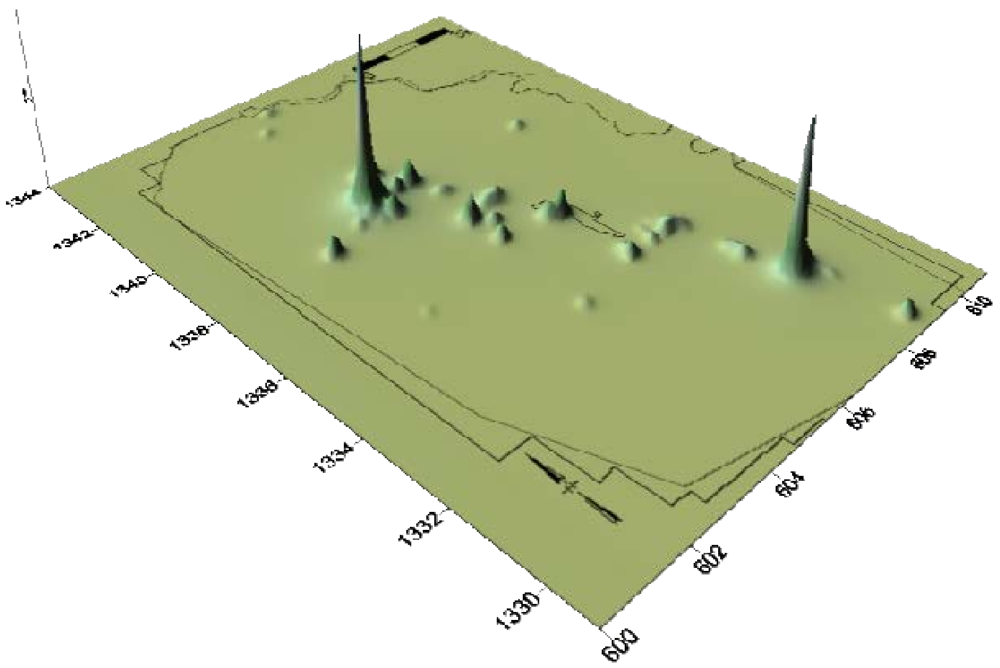

Figure 4-9 Bagaces period RPI surface graph.

Like the previous period, the rank-size graph (Figure 4.11) does not show a significant departure from log-normal. Nevertheless, the community-size graph (Fig. 4.12) of the Bagaces period populations reflects at least two distinct groupings among 24 settlements. The largest of the Tisma settlements, located towards the northern end had as many as 280 persons in it, or slightly more than a third of the regional population, while the second largest, in the southern end, had as many as 170 persons in it (21% of the regional population).

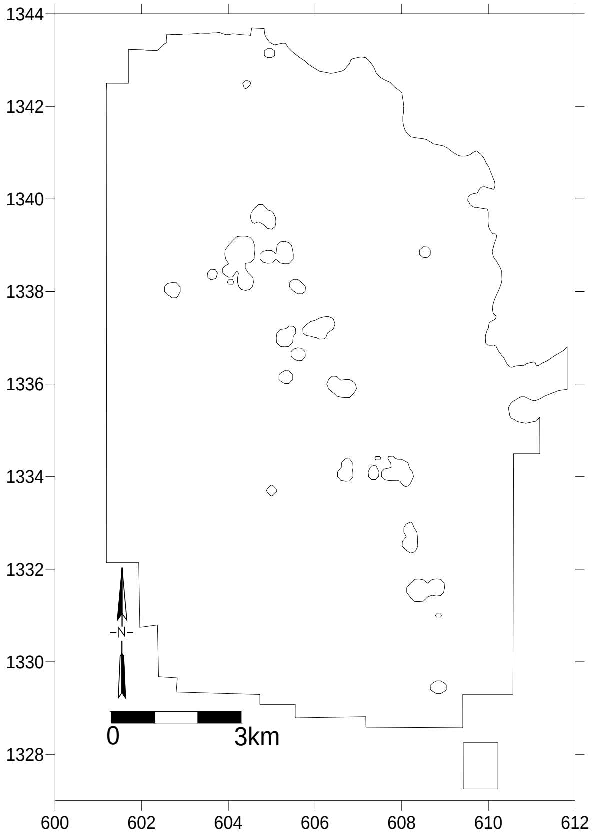

Figure 4-10 Bagaces period RPI surface graph contours delineating communities.

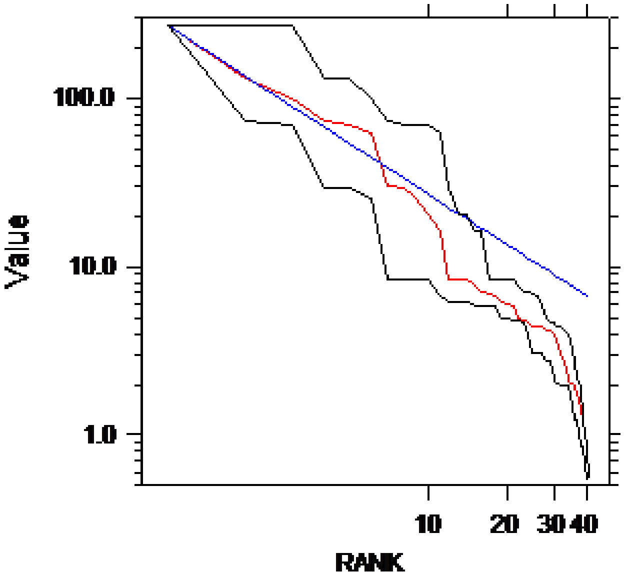

Figure 4-11 Bagaces period rank-size graph of absolute population including 90% confidence zone. A = -0.309

N=24 --Error ranges for A-- 90% Confidence: -0.698 to 0.329 (Range= 1.027).

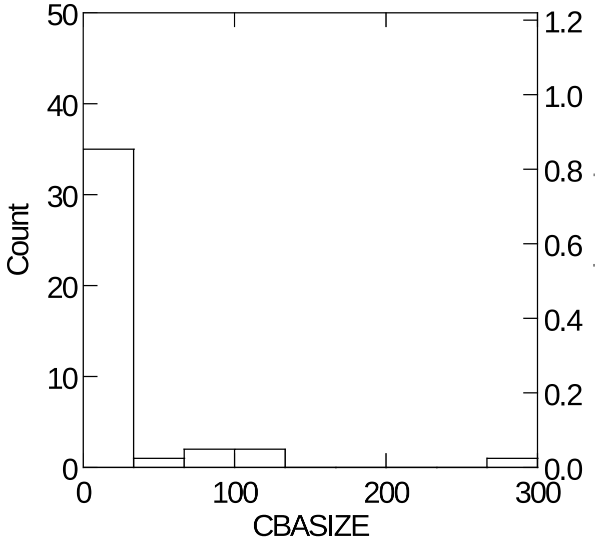

Figure 4-12 Bagaces period community-size histogram of absolute population estimates in Tisma.

As a way of exploring a pattern that seems apparent upon visual examination, when the smoothing is increased to better show higher level structures two groupings are evident (Fig. 4.13, 4.14). When the 15 northernmost settlements are analyzed by themselves, we notice that *A* = -0.679 (90% Confidence: -1.360 to 0.096, Range= 1.457) and that the rank-size graph (4.15) is typical for a primate system. Similarly, for the nine southernmost settlements *A* = -1.013 (90% Confidence: -1.991 to -0.071, Range= 1.921) (Fig 4.16), thus an even more marked primacy for its largest settlement in relation to the others. At this scale, there seem to be centralization trends along two separate centers in the RPI surface graph for this period when considered in this manner.

Figure 4-13 Groupings of higher order structures resulting from smoothing of the RPI surface graph, during the Bagaces period in Tisma.

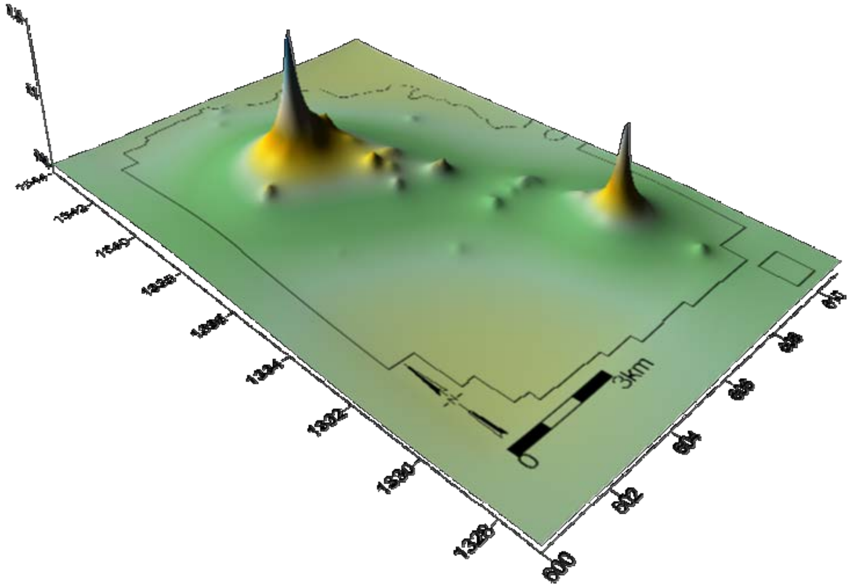

Figure 4-14 RPI surface graph resulting from smoothing to highlight higher order community structures

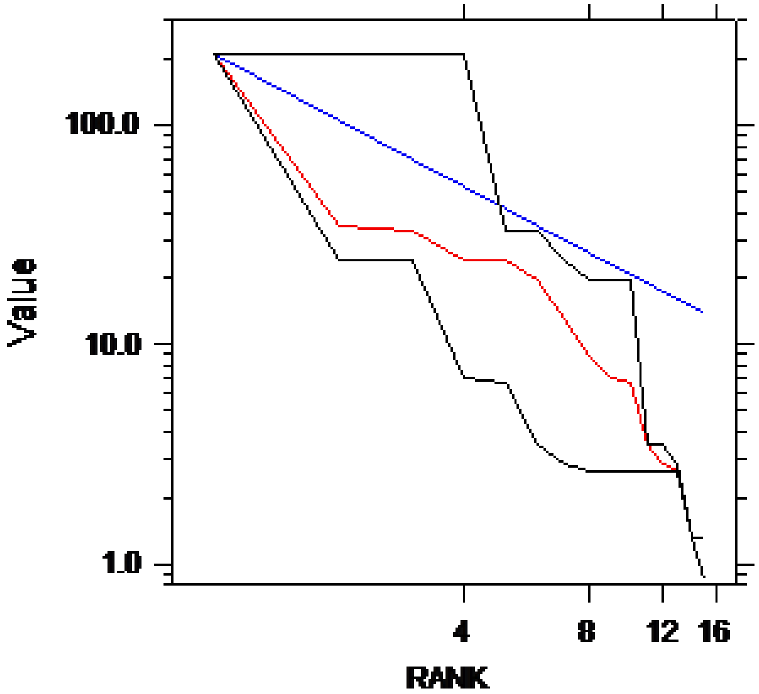

Figure 4-15 Rank-size graph for Tisma Bagaces North - A = -0.679 N = 15 --Error ranges for A-- 90% Confidence: -1.360 to 0.096 (Range= 1.457).

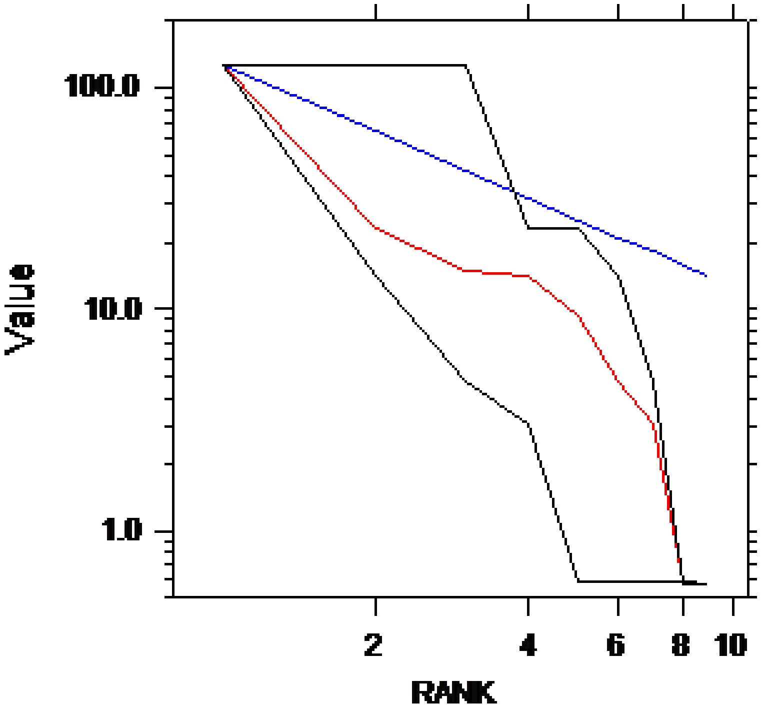

Figure 4-16 Rank-size graph for Tisma Bagaces South - A = -1.013 N = 9 --Error ranges for A-- 90% Confidence: -1.991 to -0.071 (Range= 1.921).

4.2.3 Sapoá Period (800 – 1350 CE)

One of the most obvious changes taking place between the Bagaces and Sapoá (800 – 1350 CE) periods has to do with a substantial increase in occupied area. A total of 233 lots, the largest number for any period, with Sapoá diagnostic ceramics were found in Tisma, representing 237 ha of occupation (Figure 4.17), RPI = 406.85, representing as few as 1,600 persons and as many as 4100. This means that the percentage of change in occupied area is over 150%, while there is more than 400% increase in total population compared to the Bagaces period. Thus the increase in population also relates to an increase in population density over the occupied area. While the northernmost Bagaces period node seems to have stopped growing, the other two have grown significantly, with the southernmost node being larger. There are now 14 settlements less than 1km from the Tipitapa River, with most being on the river's edge. Elevation for settlements varies from a low 33 m to a high 137 m for this period, although it is evident that the original pattern of settlement along the 40 – 80 m contours, where the vast majority of the population was settled, continues to dominate.

One settlement with two mounds was identified for this period, TI154. Much as the Bagaces period mounded site, the paucity of material on the surface, and the relatively low densities surrounding the mounds makes it seem as if they are not necessarily associated with activities central to the local polity. Moreover, TI154 is, at best, a third-order settlement within the Tisma hierarchy. The two mounds are found near a tree-fence (a row of trees establishing the limits of one present day property), measuring nearly 1.3m above the surrounding surface. They are 6m apart and both measure no more than 4m in diameter. Though the mounds have no surface materials, and local informants could not recall the length of their existence, there is some doubt as to whether they are in fact precolumbian in origin, rather than an artifact of modern day plow use (and stone clearance).

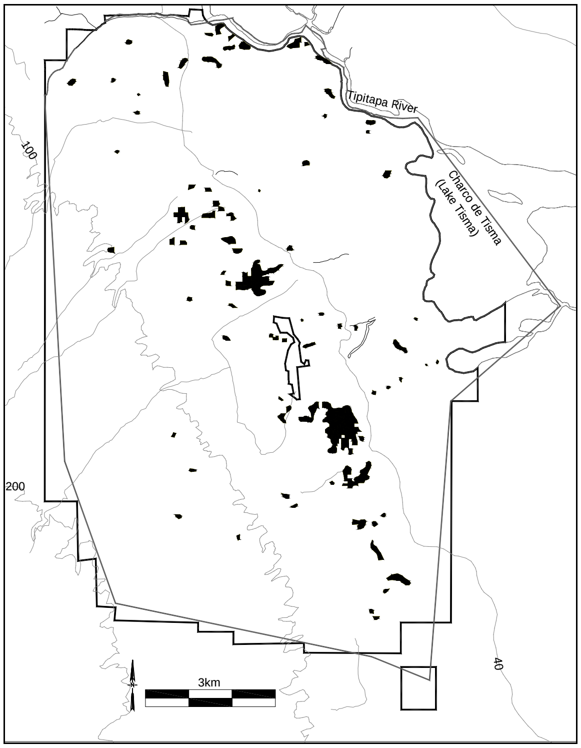

Figure 4-17 Tisma lots containing Sapoá period (800 – 1350 CE) diagnostic ceramics.

There is an obvious population concentration and it is now apparent that though there is one community dominating the regional context, the Tisma area is part of one regionally integrated system. This is shown in the RPI surface graph (Figs. 4.18, 4.19). The rank-size graph (Fig. 4.20) shows a primate regional distribution as does the *A* coefficient of -0.811 (90% Confidence: -1.398 to -0.134, Range= 1.264). There are three clear groupings in the community-size histogram (Fig. 4.21) of the community populations. 23 of the communities include fewer than 90 people, with most being smaller than 50. Three of the settlements include as many as 200, 300 and 600 people, while one community represents as many as 2400 people, or 77% of the regional population.

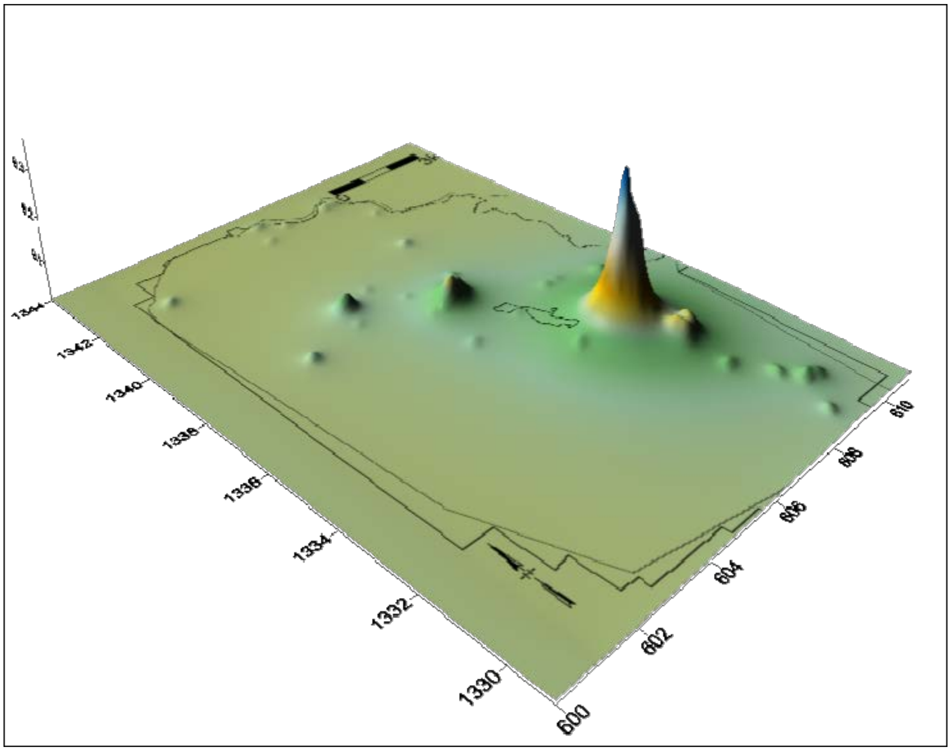

Figure 4-18 RPI surface graph for the Sapoá period in Tisma.

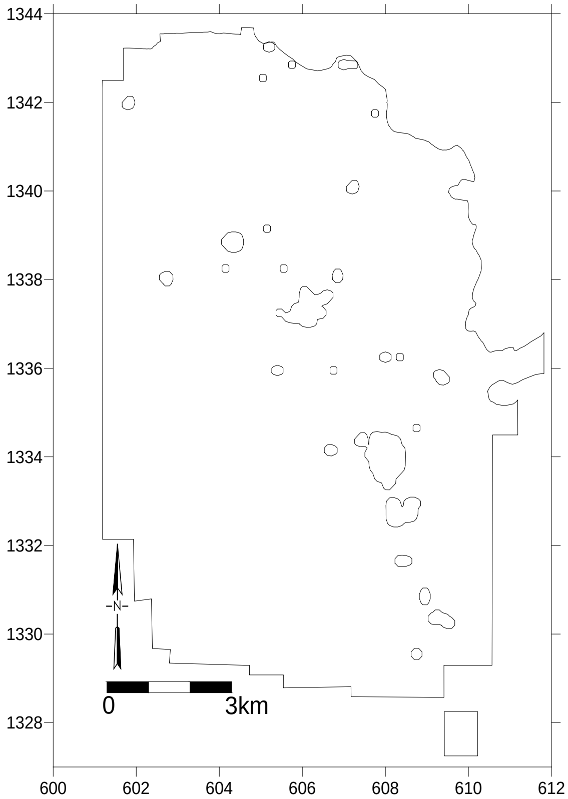

Figure 4-19 Sapoá period RPI surface graph contours delineating communities.

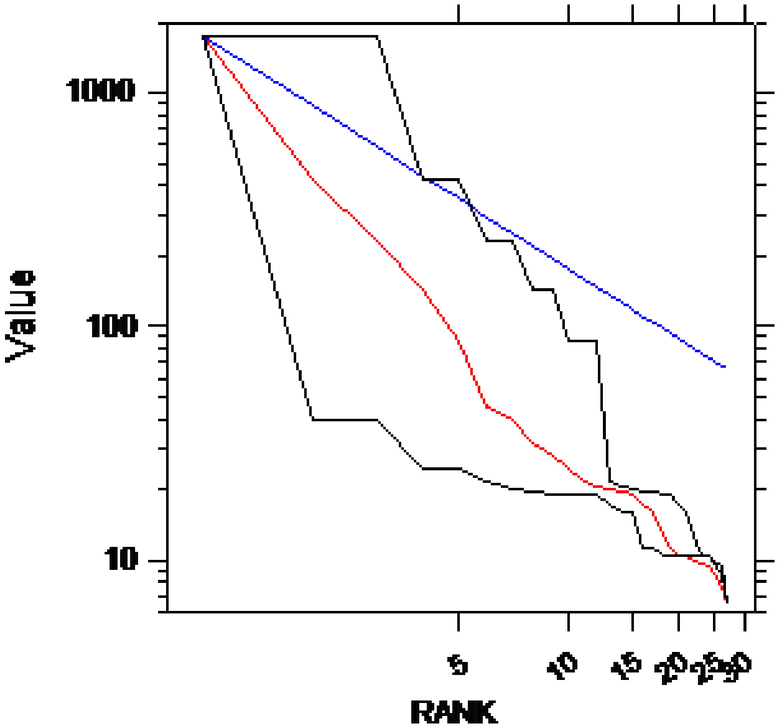

Figure 4-20 Sapoá period rank-size graph of absolute population including 90% confidence zone in Tisma.

A = -0.811 N = 27 --Error ranges for A-- 90% Confidence: -1.398 to -.134 (Range= 1.264).

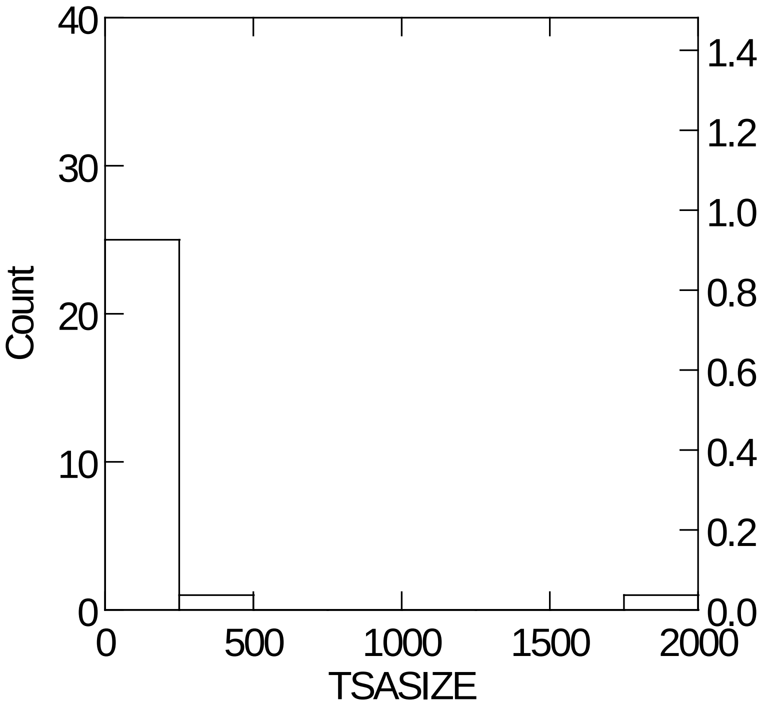

Figure 4-21 Sapoá period community-size histogram of absolute population estimates in Tisma.

4.2.4 Ometepe Period (1350 – 1520 CE)

The Ometepe period is the shortest of the defined precolumbian occupation periods in Pacific Nicaragua, lasting from 1350 CE to the contact period, generally accepted to be 1520 CE. The apparent continuous growth that marked the last two millennia of the sequence now seems to have been reversed. Although it is not obvious, there is a 4% decrease in total occupied area and number of lots containing Ometepe period diagnostics. The 223 Ometepe lots in Tisma represent 228 ha of occupation (Fig. 4.22) with a regional RPI of 334.6, representing as few as 1400 and as many as 3500 persons. Thus the total regional population also decreases relative to the Sapoá period by as much as 18%. The northern end seems to have gained in size, even if slightly, as have a few of the minor settlements.

However, in general, a sense of continuity pervades and there seems to be little change in the settlement pattern between 800 and 1520 CE. The mounded sites that appeared during the Sapoá period are still occupied, while the largest settlement, Santa Isabel/Chabela, seems to maintain its position atop the local site-size hierarchy.

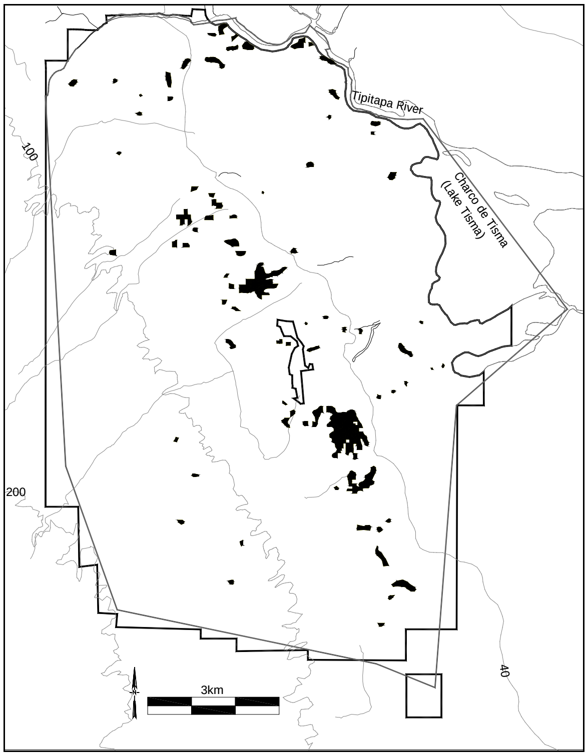

Figure 4-22 Tisma lots containing Ometepe period (1350 - 1520CE) diagnostic ceramics.

For the Ometepe period there is one fewer community (26) than in the previous period. Except for the population decline, the settlement pattern changes little, with one community dominating the regional landscape with as many as 2000 persons or about 60% of the regional population. The RPI surface graph (Fig. 4.23) and community distribution (Fig. 4.24) for the Ometepe period are very much like the ones for the Sapoá period. Although some of the smaller communities seem to vanish, other similarly sized communities take their place in the regional system. The rank-size graph (Fig. 4.25) shows a slightly more primate distribution, with an *A* coefficient of -0.766 (90% Confidence: -1.371 to -0.143, Range= 1.227). The community-size histogram (Fig. 4.26) shows that there are three communities with as many as 500, 260 and 190 persons respectively. The remaining 22 communities have as many as 90 or fewer people.

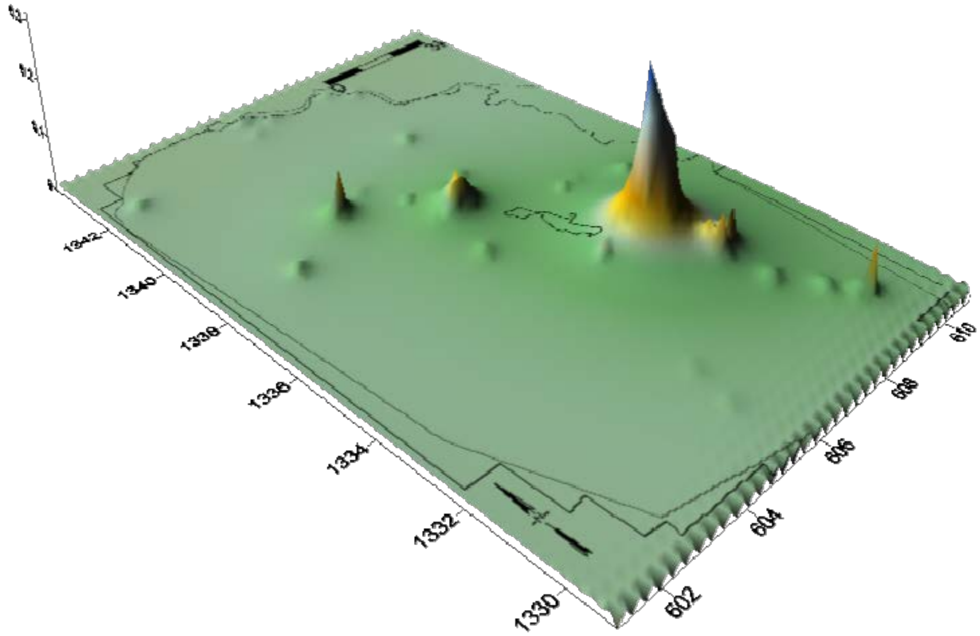

Figure 4-23 RPI surface graph for the Ometepe period in Tisma.

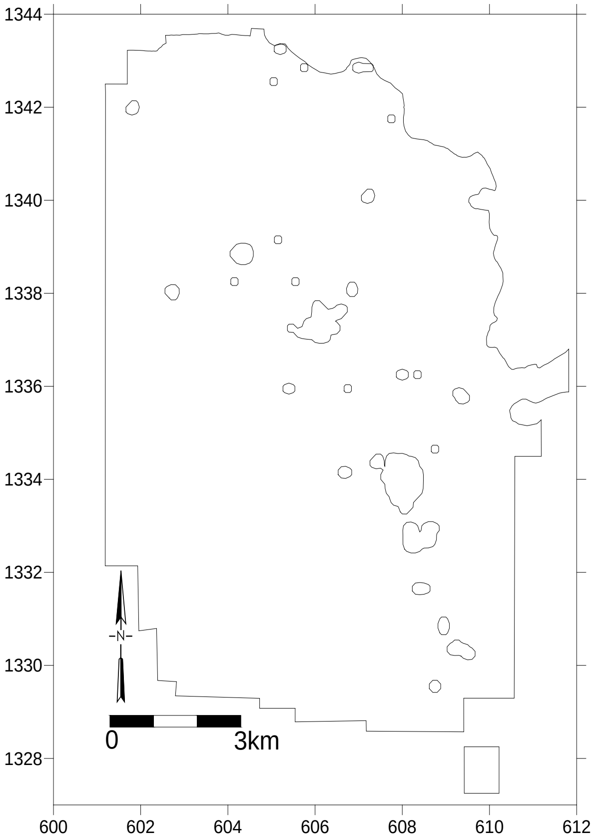

Figure 4-24 Ometepe period RPI surface graph contours delineating communities.

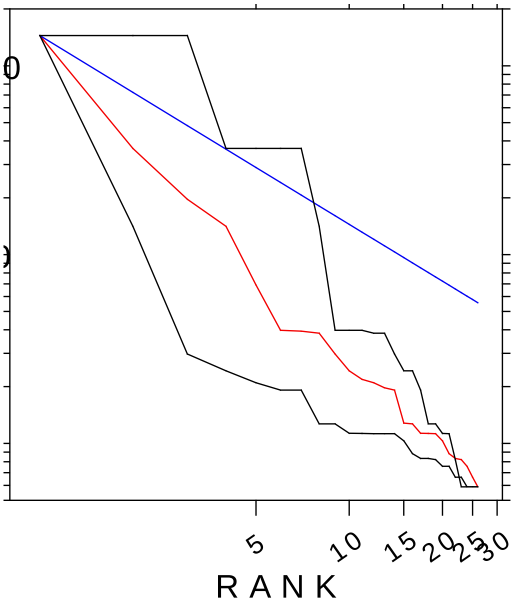

Figure 4-25 Ometepe period rank-size graph of absolute population including 90% confidence zone in Tisma.

A = -0.766 N = 26 -- Error ranges for A-- 90% Confidence: -1.371 to -.143 (Range= 1.227).

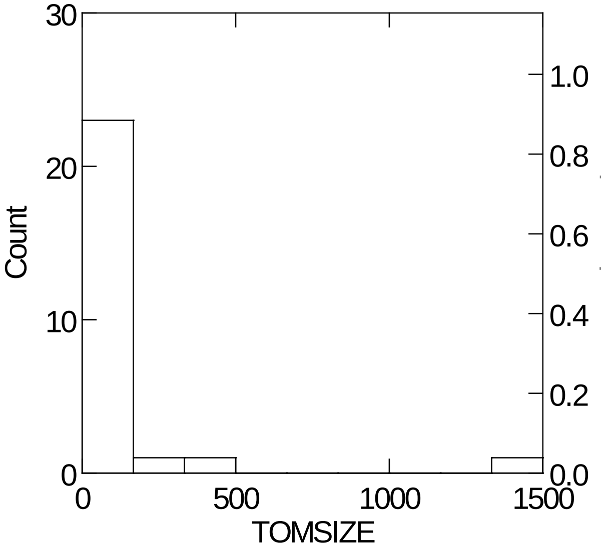

Figure 4-26 Ometepe period community-size histogram of absolute population estimates in Tisma.

4.3 TICUANTEPE

Slightly more than a quarter of Ticuantepe's municipal territory was not accessible to survey because of steep slopes, dense primary vegetation, restricted property access and urban development. The total area covered was 48.6 km^2, representing 74.8% of the municipality (Figure 4.27). The collections represent 616 ha of precolumbian occupation. Of the 653 lots collected in Ticuantepe, 225 (34.8%) did not contain chronologically diagnostic materials, limiting the possibility of assigning precolumbian period correspondence. A total of 5,353 sherds were collected. Of these, 1,800 (33.6% of Ticuantepe sherds) were diagnostic, and were found in 428 (66.35%) of the collection lots. Eight lots contained only precolumbian lithics. Of the 83 LDA collections, only two (2.4%) contained diagnostic ceramics. The survey areas within the Masaya volcano caldera and the southwestern plateau in the highest elevations yielded no precolumbian materials or features (Figure 4.28).

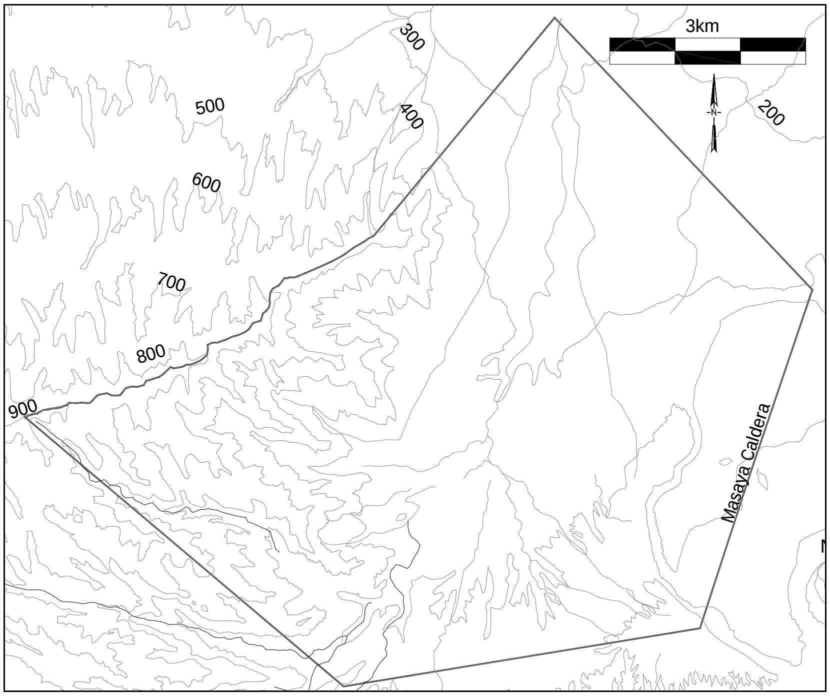

Figure 4-27 Municipality of Ticuantepe. Municipal outline, elevation contours, rivers and dry riverbeds shown.

Though there were some differences in terms of distribution and proportion of diagnostic types between Tisma and Ticuantepe across the precolumbian sequence, the types and varieties used to identify the chronological period correspondence were very much the same. Modern or post-contact materials were found in three lots.

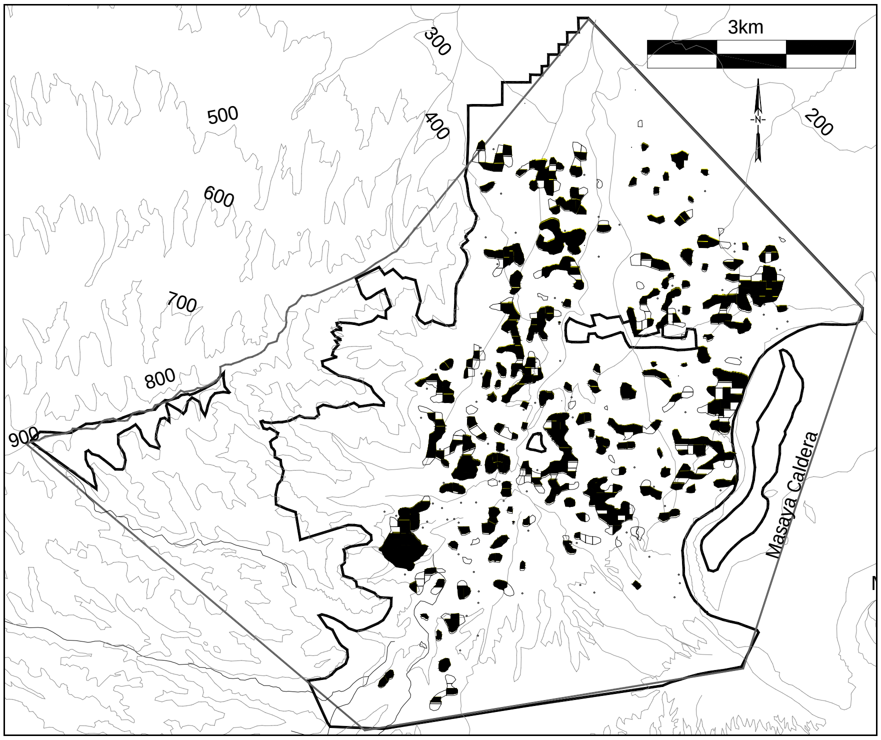

Figure 4-28 Surveyed area in Ticuantepe, including all collection lots. Surveyed area is enclosed in thick line. Diagnostic lots are filled solid. Non-diagnostics are outlined only.

4.3.1 Orosí and Tempisque Periods (2000 - 500 BCE and 500 BCE – 300 CE)

Notwithstanding the fact that the municipality of Ticuantepe is nearly half the size of Tisma, and despite only being able to survey 48 km^2, the actual number of lots containing Tempisque and Orosí period diagnostics is 130 representing 131 ha of occupation (Figure 4.29). This is more than twice the number of Tisma lots for this period, and a substantially larger occupation density. There are numerous settlements that encompass more than 2 ha, though there are three clear nodes around which settlements seem to aggregate. The RPI for Ticuantepe during this period is 48.6, representing as few as 200 persons and as many as 500.

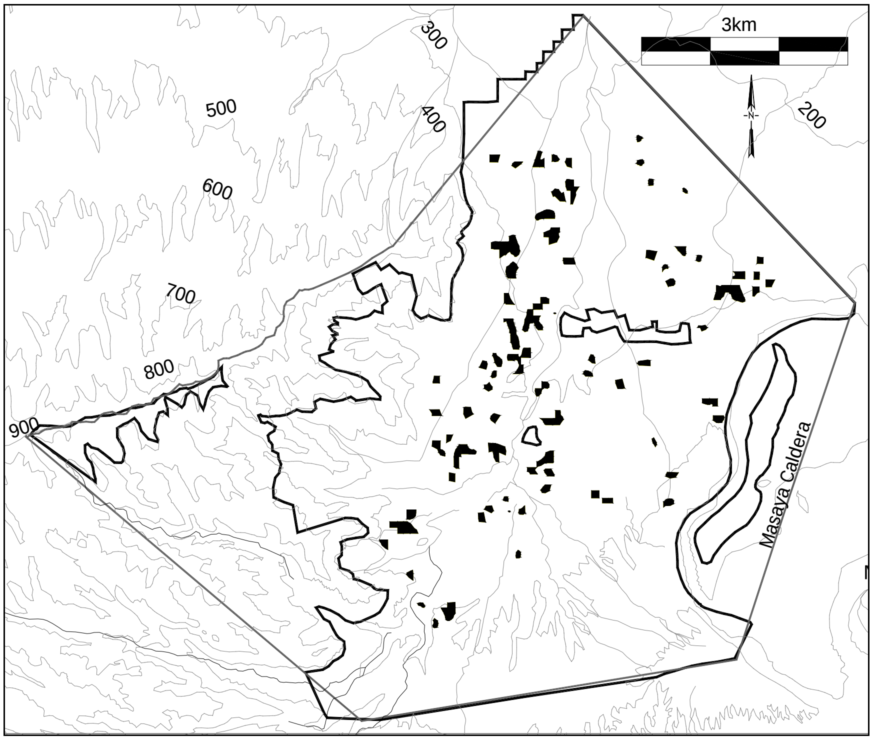

Figure 4-29 Ticuantepe collection lots containing Orosí-Tempisque period (2000 – 500 BCE & 500 BCE – 300CE) diagnostic ceramics.

In contrast to the pattern in Tisma, Ticuantepe settlements are located in a broader variety of settings, on the undulating terrain encompassing elevations from 220 m to over 400 m. The RPI surface for this period in Ticuantepe (figure 4.30) shows how there are at least three communities that have substantially larger relative populations. The flattest areas and the steep hillsides of Ticuantepe seem to be least sought after during this period. There are 34 communities represented (figure 4.31). The rank-size graph for this period in Ticuantepe has an *A* value of 0.128 and its departure from log normality is not significant (figure 4.32). The community-size histogram reflects what is evident in the RPI surface graph, showing one community with as many as 100 persons, two others with as many as 60 and the remaining 31 communities with fewer than 40 (figure 4.33).

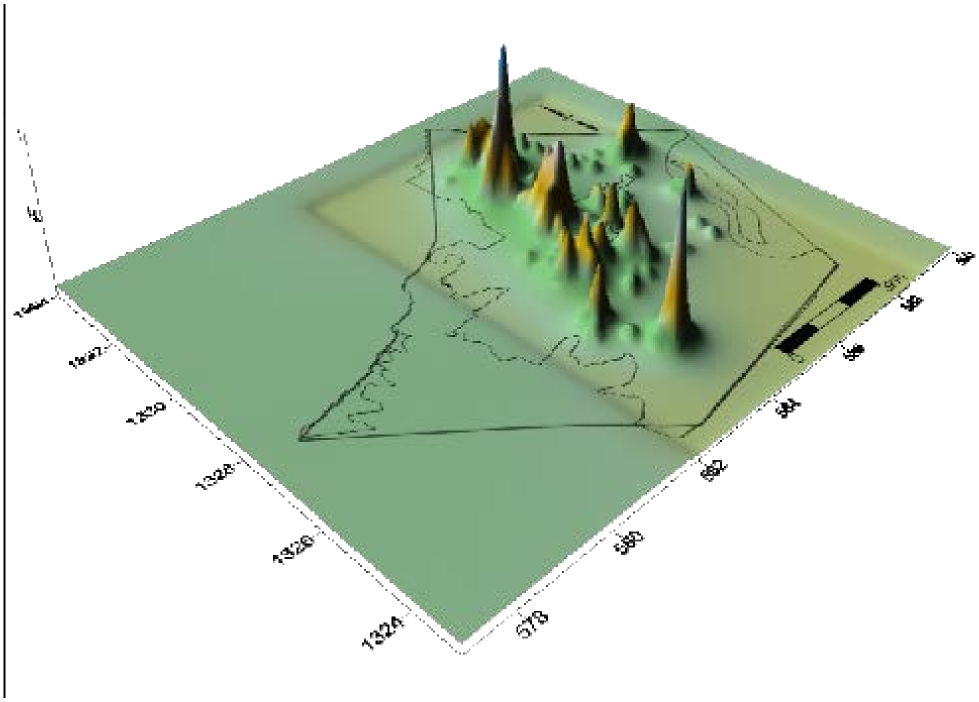

Figure 4-30 Orosí-Tempisque periods RPI surface graph in Ticuantepe.

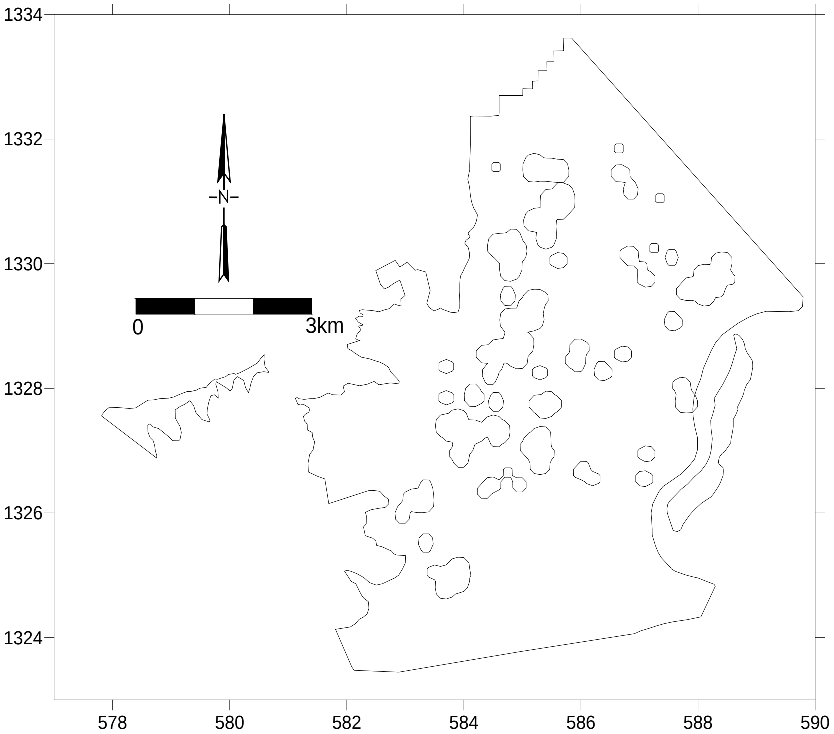

Figure 4-31 Orosí-Tempisque periods RPI surface graph contours delineating communities in Ticuantepe.

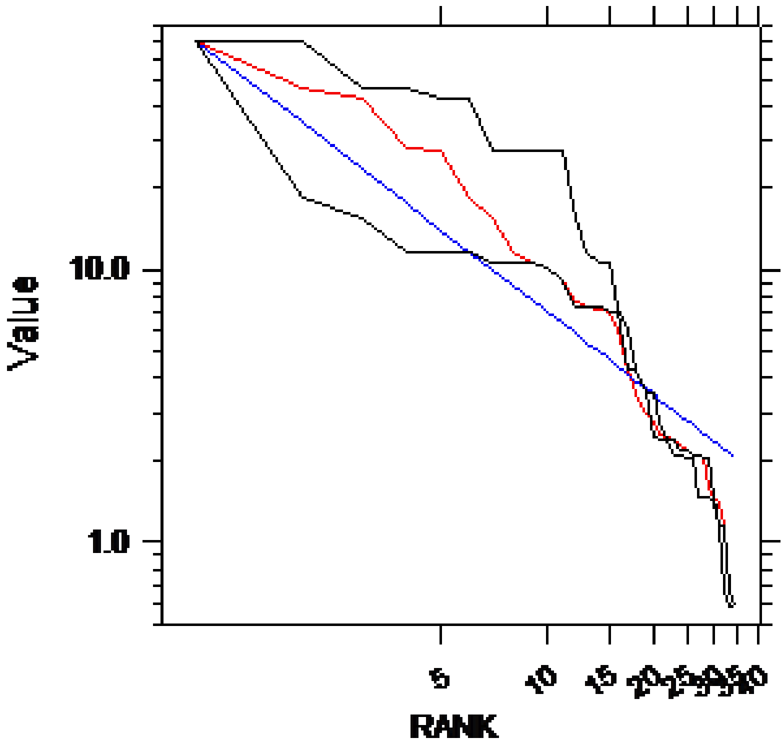

Figure 4-32 Orosí-Tempisque periods rank-size graph of absolute population including 90% confidence zone in Ticuantepe. A = 0.128 N = 34 --Error ranges for A-- 90% Confidence: -.101 to .339 (Range= .440).

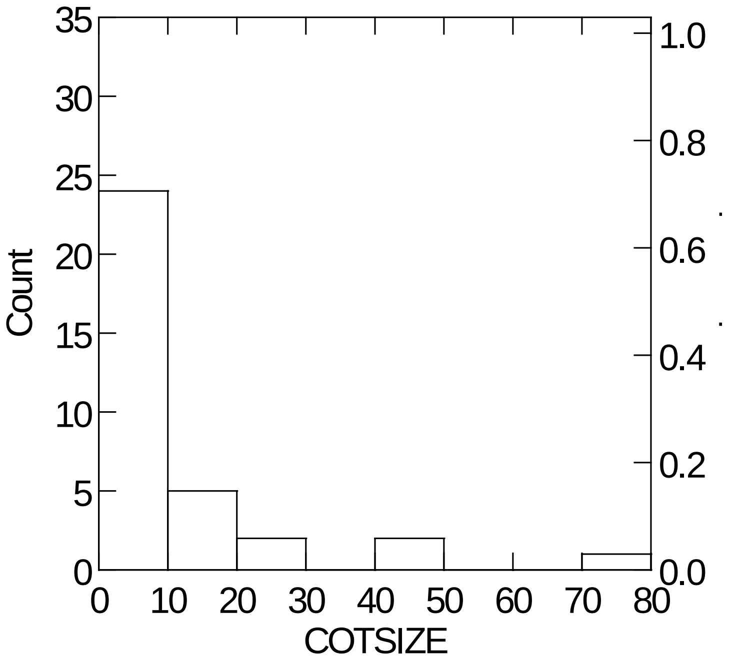

Figure 4-33 Orosí-Tempisque periods community-size histogram of absolute population estimates in Ticuantepe.

4.3.2 Bagaces Period (300 – 800 CE)

During the Bagaces period the number of lots increases by 51% to 196 while the occupied area increases by 65% to reach 215 ha, (figure 4.34). The RPI for the region increases to 127.9 (163%), representing as few as 500 persons and as many as 1300. Although three or four different settlements seem to be growing and aggregating, there is no clear dominance, nor an obvious community-size hierarchy. At the same time, areas reaching nearly 500 m in elevation are now settled, even as some of the lower elevation settlements dissolve and seem to join other, larger entities.

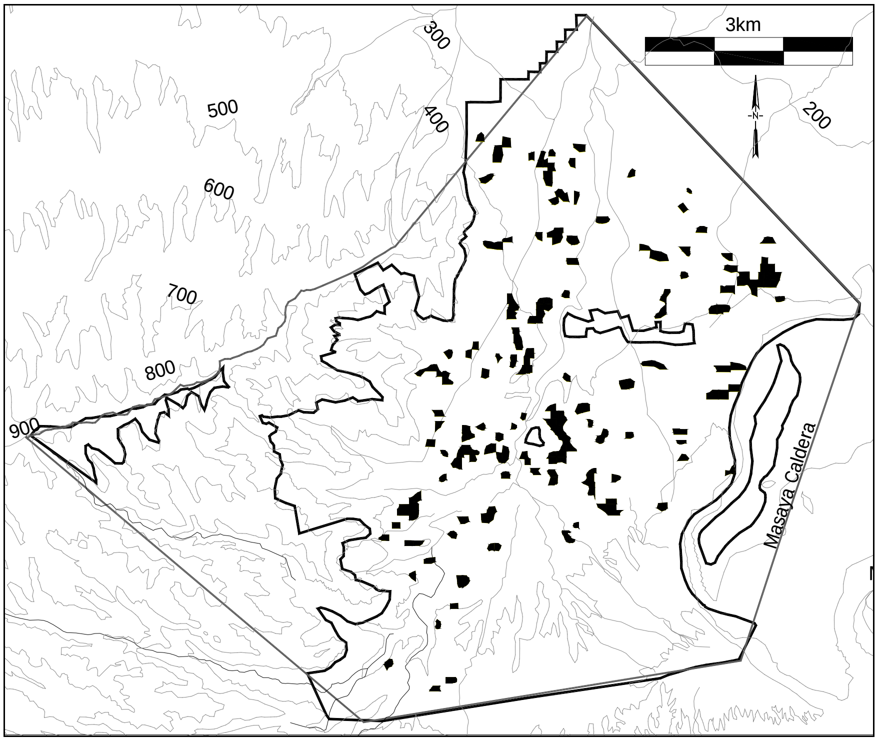

Figure 4-34 Ticuantepe collection lots containing Bagaces period (300 – 800 CE) diagnostic ceramics.

The RPI surface graph (Fig. 4.35) for the period shows four peaks that are clearly above all others. Altogether there are 41 communities in Ticuantepe during this period (Fig. 4.36). The Rank-size graph for the period (Fig. 4.37) with *A*= -0.178 shows no significant departure from log normality. The tallest of the peaks is over La Borgoña/San José's community, which had as many as 400 persons in it. Four other communities had as many as 200, 150, 100 and 75 persons. The remaining 36 communities had fewer than 40 persons (Fig. 4.38). It may be that the region was integrated into a social-political system by Bagaces times. However, because much of the Ticuantepe valley is undulating land, cut through by numerous drainage channels, the higher population concentrations probably also reflect the location of relatively continuous, level ground near easily accessible water sources.

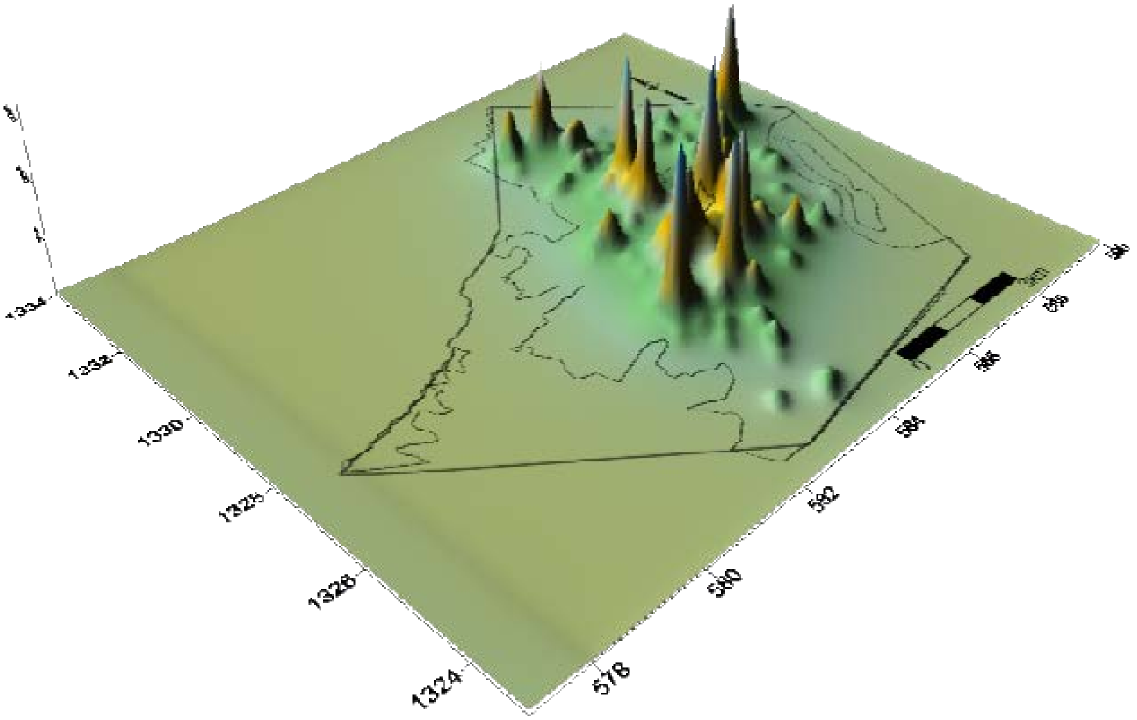

Figure 4-35 Bagaces period RPI surface graph in Ticuantepe.

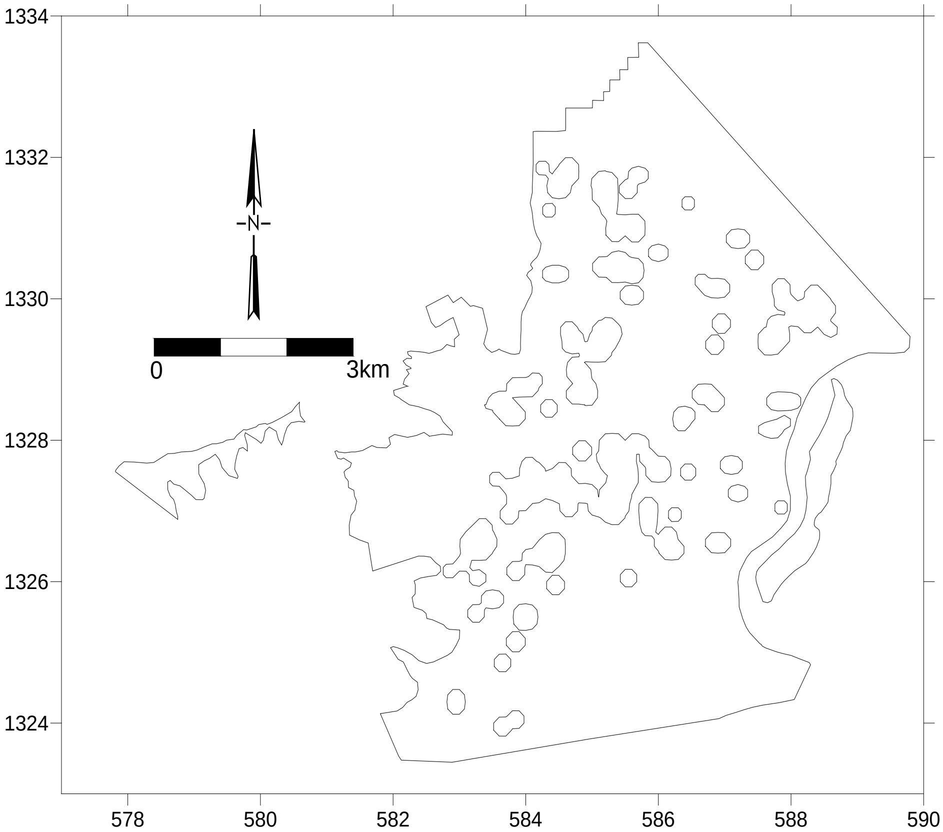

Figure 4-36 Bagaces period RPI surface graph contours delineating communities in Ticuantepe.

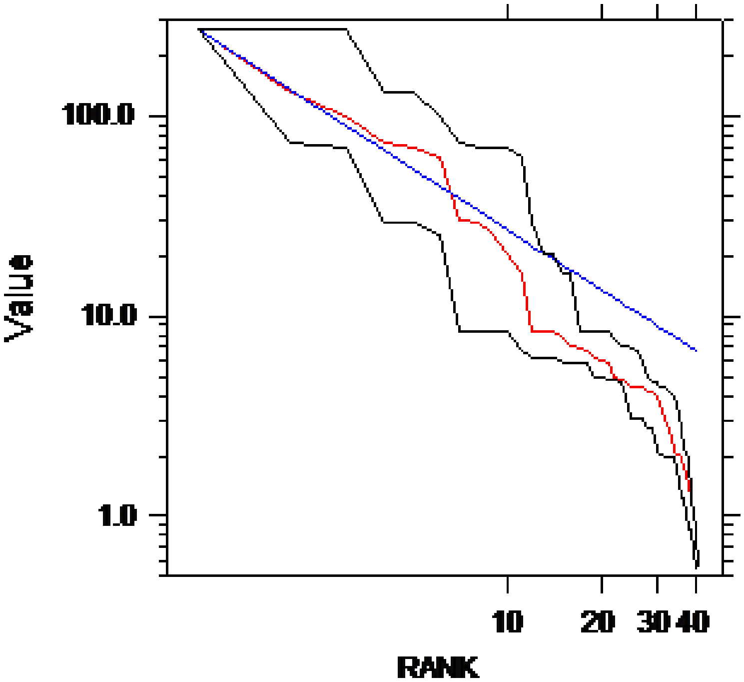

Figure 4-37 Bagaces period rank-size graph of absolute population including 90% confidence zone in

Ticuantepe. A = -0.178 N=41 --Error ranges for A-- 90% Confidence: -.478 to .156 (Range= .634).

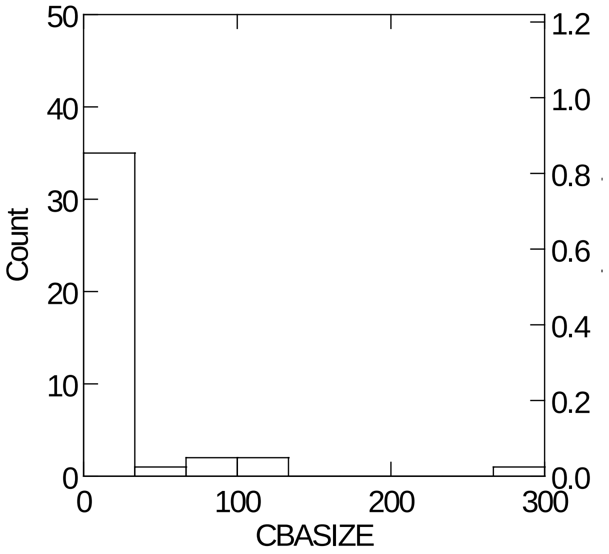

Figure 4-38 Bagaces period community-size histogram of absolute population estimates in Ticuantepe.

4.3.3 Sapoá Period (800 – 1350 CE)

During the Sapoá period in Ticuantepe the area of occupation increases noticeably relative to Bagaces, although the population increase is almost negligible. The number of lots and the area that they represent reaches 220 (an increase of 15.3%), while the area of occupation grows to 248 ha (17% increase) (Fig. 4.39). The RPI for the region is 129.8, an increase of less than 2%, representing as few as 520 and as many 1300 persons. Interestingly, this would indicate a decrease in population density when divided by the occupied area. At the same time, it is evident from the RPI surface graph (Fig. 4.40) that two large settlements seem to be growing the most, even as settlements appear in ever larger numbers along the edge of the Masaya Volcano caldera, on the east side of the municipality. There are 45 communities for the period (Fig. 4.41). In general the higher elevation areas which had previously been settled during Bagaces now seem to be all but abandoned, just as the number of lots and size of contiguous settlement in the

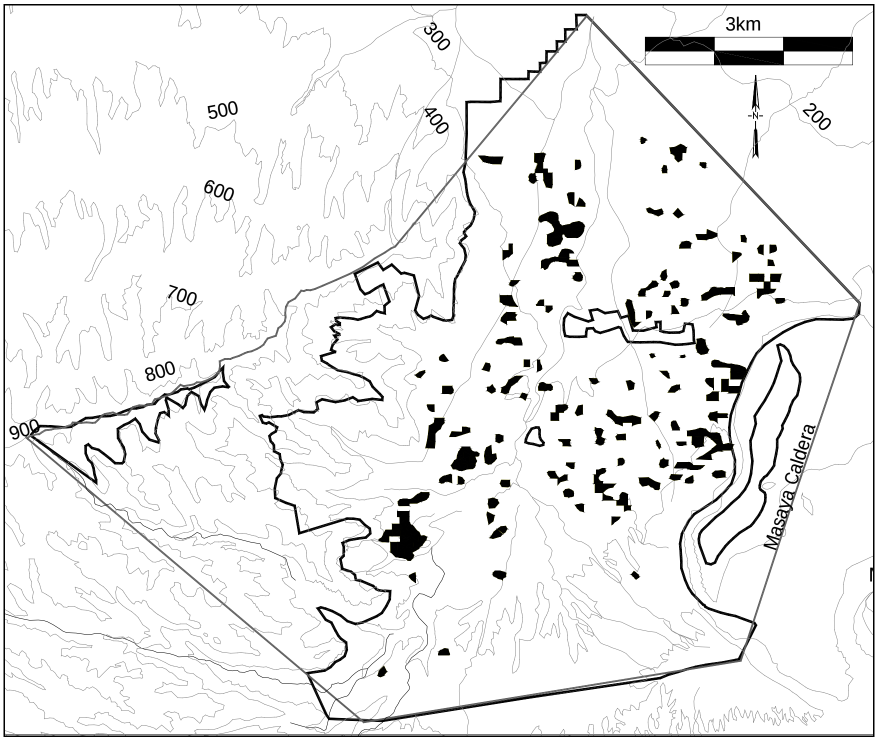

Figure 4-39 Ticuantepe collection lots containing Sapoá period (800 – 1350 CE) diagnostic ceramics.

flatter, plain areas seem to be growing. The Rank-size graph (Fig. 4.42) for the period has an *A* = -0.026, without a significant departure from log normality, although the pattern is now slightly more convex than during Bagaces. From the community-size histogram (Fig. 4.43) it is evident that the largest settlement, San José-La Borgoña, is still atop the regional size hierarchy with as many as 270 persons, yet there are now more communities closer in size. The second and third largest communities have as many as 230 and 180 persons. Two other communities have as many as 110 and 90 persons. The remaining communities have fewer than 40 persons. It should also be noted that the second largest community is less than 300 m from the largest community. Barring for the complete paucity of surface materials between them, it would make sense that their large populations could readily interact. Nevertheless, because of the broader distribution pattern in Ticuantepe, where communities seem to be spread across the landscape, divided by drainage channels and undulating surfaces, it may be that the relatively low population density and intensity of interactions allowed settlers to pick well-drained, mostly level plots to live upon.

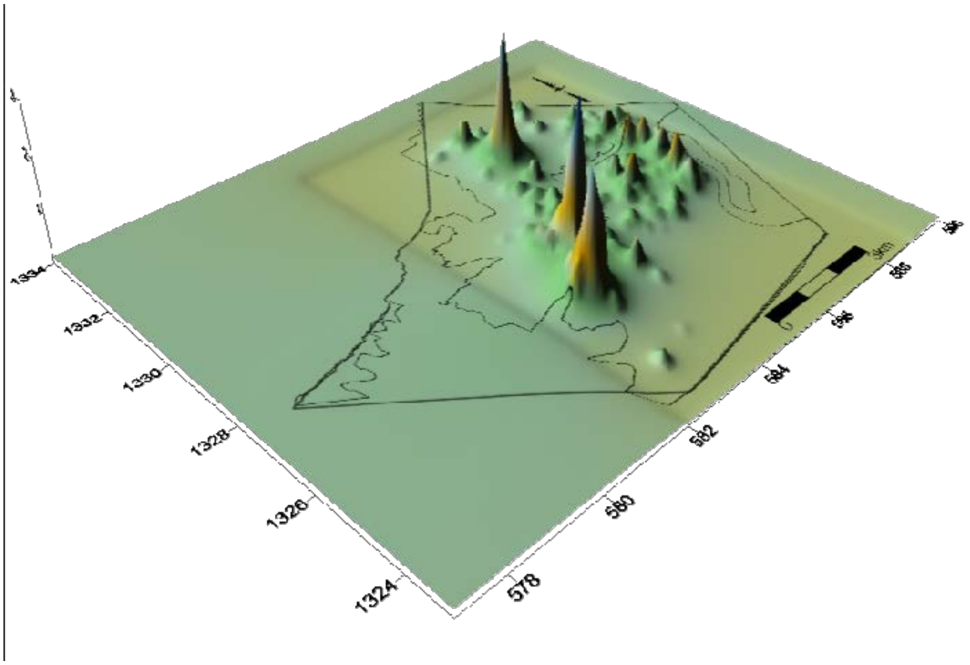

Figure 4-40 Sapoá period RPI surface graph in Ticuantepe.

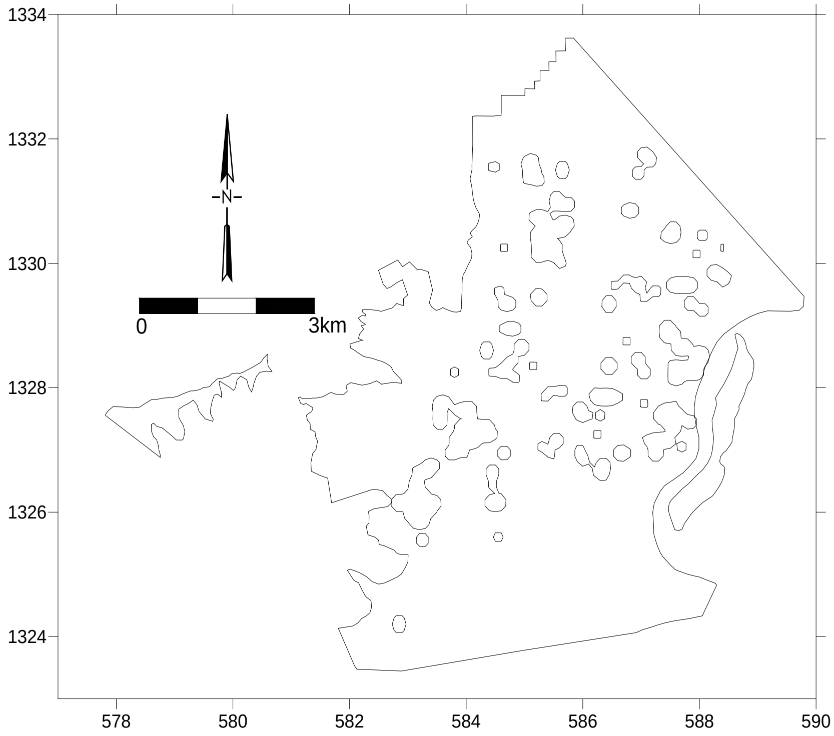

Figure 4-41 Sapoá period RPI surface graph contours delineating communities in Ticuantepe.

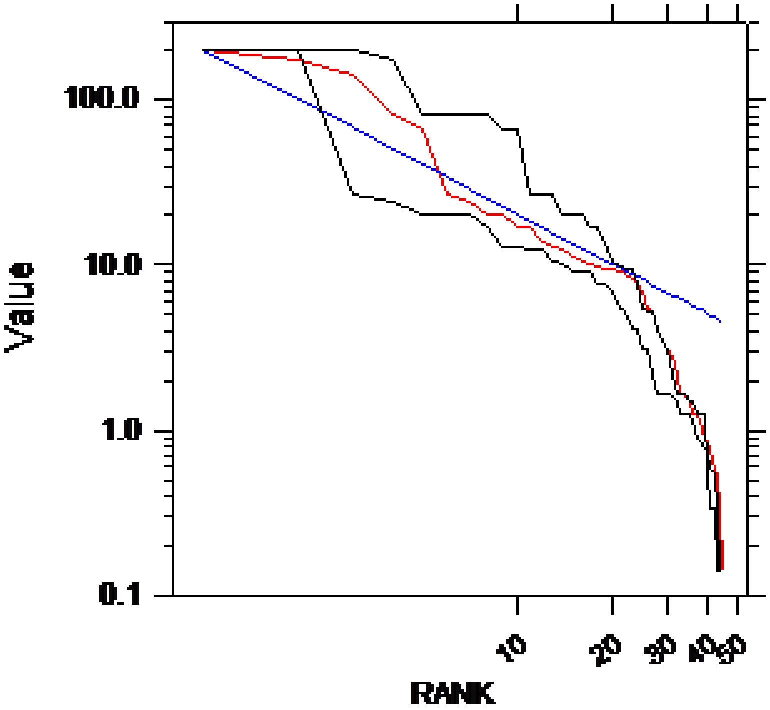

Figure 4-42 Sapoá period rank-size graph of absolute population including 90% confidence zone in Ticuantepe. A = -0.026 N = 45 --Error ranges for A-- 90% Confidence: -.277 to .183 (Range= .460).

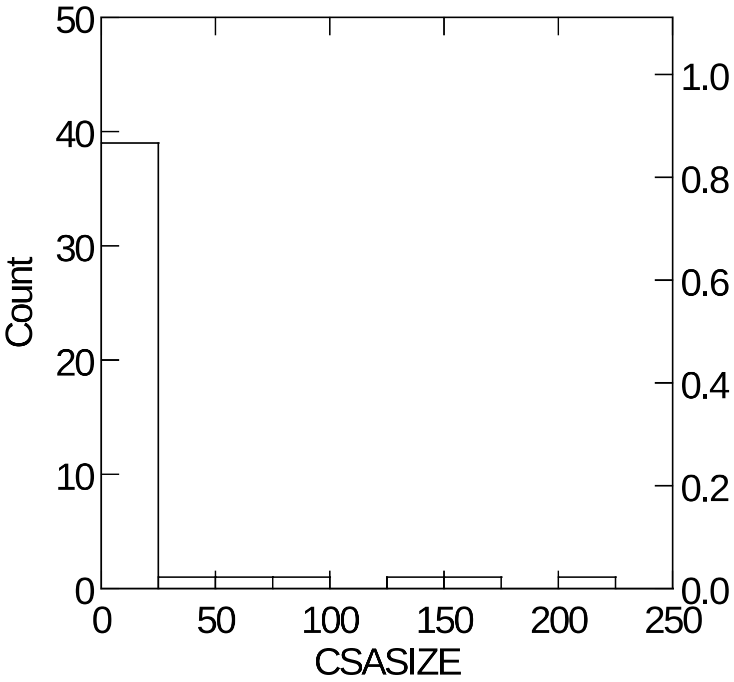

Figure 4-43 Sapoá period community-size histogram of absolute population estimates in Ticuantepe.

4.3.4 Ometepe Period (1350 – 1520 CE)

During the Ometepe period, the number of occupied lots decreases by 5%, just as the total occupied area also decreases, by 6%, to 233 ha (Fig. 4.44). The RPI for Ticuantepe increases by 5% to 136.8 for the region, representing as few as 550 persons and as many as 1400. This is a more compact pattern, reflecting an increase in population density relative to the occupied area, the opposite of what occurred during the Bagaces-Sapoá transition. However, there is not much apparent change noticeable in the pattern of the RPI surface graph (Fig. 4.45) as a whole, other than the possible consolidation of some of the larger settlements.

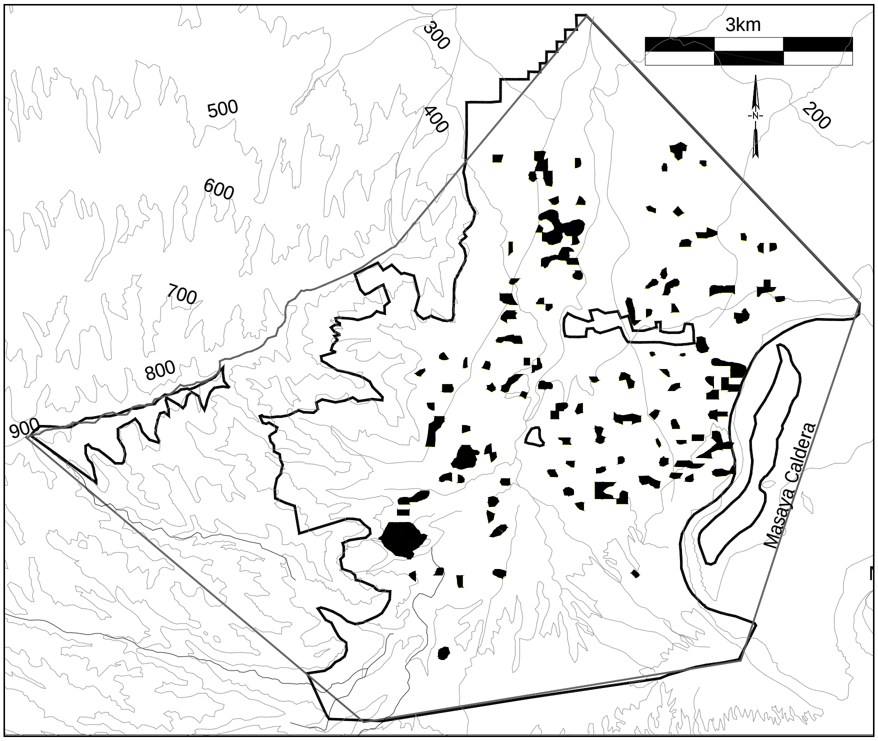

Figure 4-44 Ticuantepe collection lots containing Ometepe period (1350 – 1520 CE) diagnostic ceramics.

The number of communities increases to 48 (Fig. 4.46), while the Rank-size graph for the Ometepe period (Fig. 4.47) has an $A = -0.002$ and is quite similar to the Sapoá period graph. The Ometepe period community-size histogram (Fig. 4.48) shows little change in size of the largest community, with about 270 persons, while the second largest increases to as many as 260 persons. Three other communities have as many as 180, 110 and 100 persons. The remaining 43 communities have fewer than 30 persons. It is clear that there is a population shift, however slight, from the smaller communities toward the larger communities. And, although the surface graph does not make evident vast empty spaces between communities, the congregation along two centers is probably indicative of regional integration.

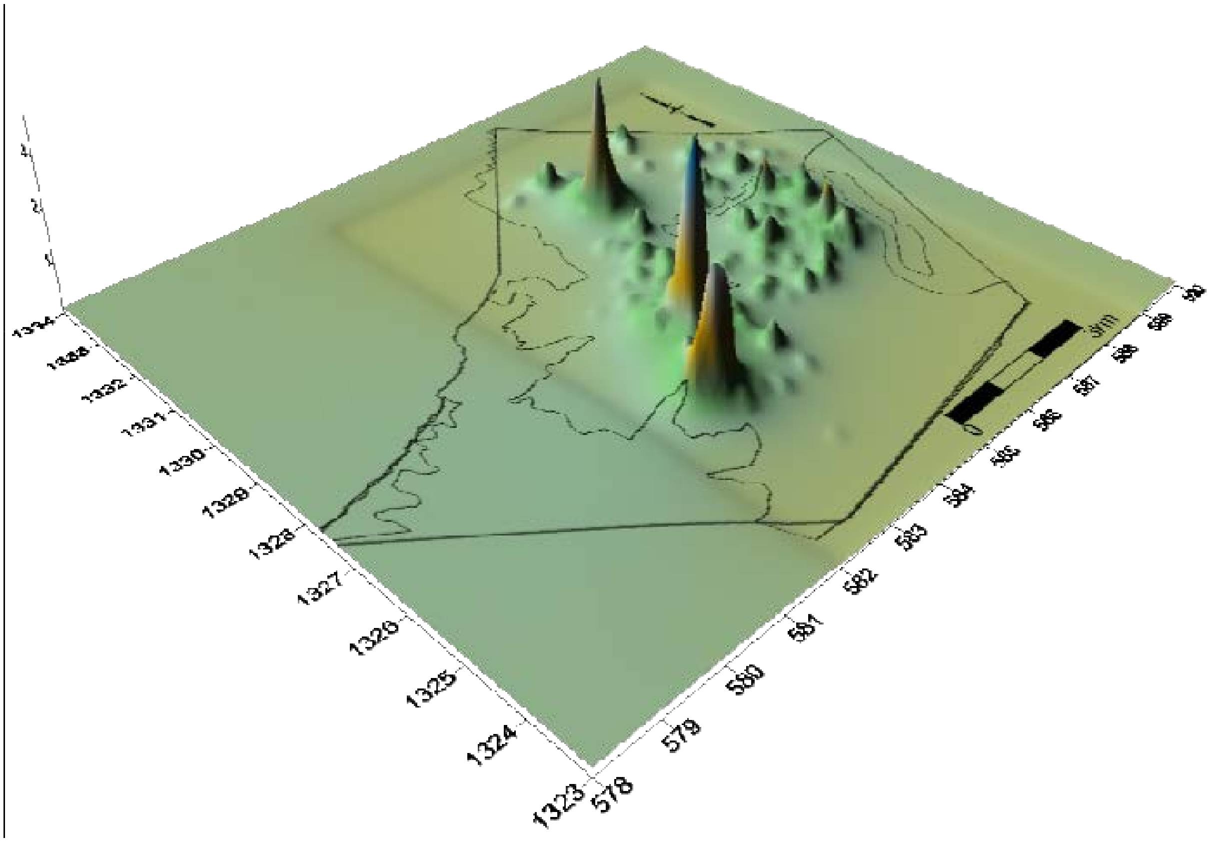

Figure 4-45 Ometepe period RPI surface graph in Ticuantepe.

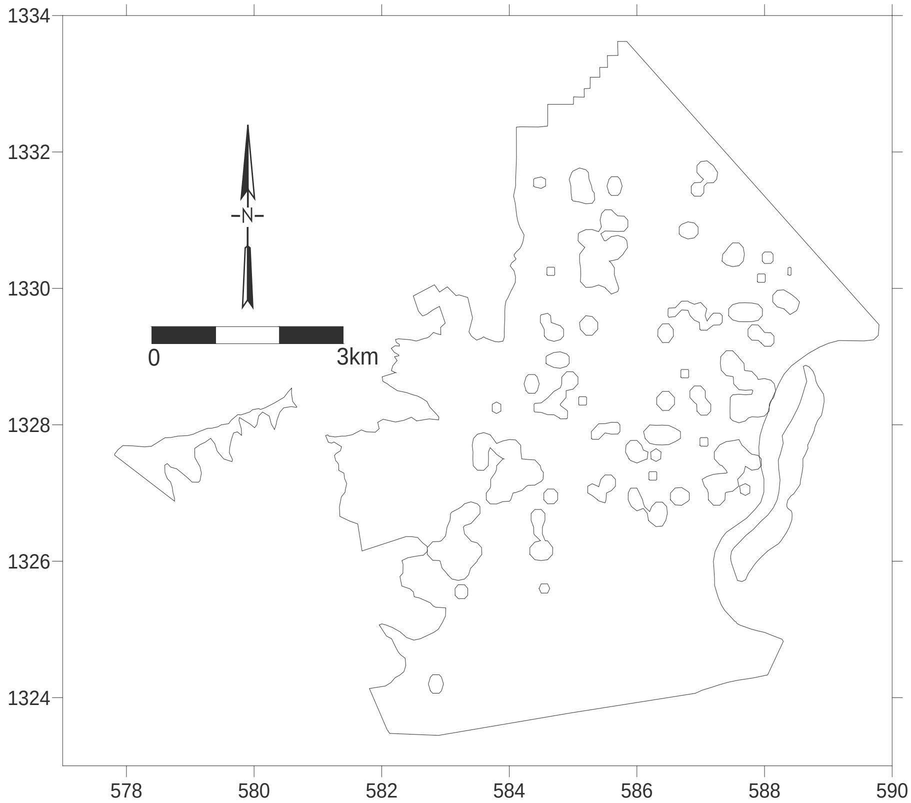

Figure 4-46 Ometepe period RPI surface graph contours delineating communities in Ticuantepe.

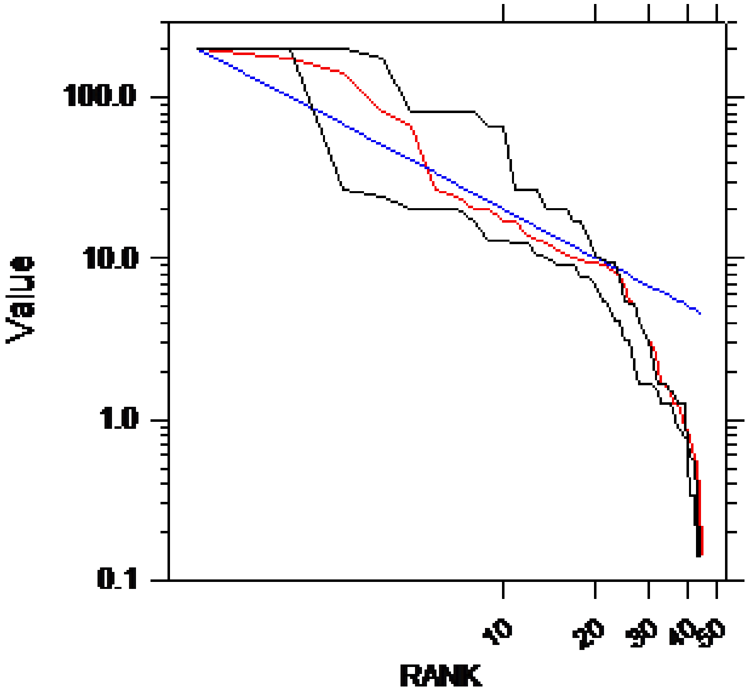

Figure 4-47 Sapoá period rank-size graph of absolute population including 90% confidence zone in Ticuantepe. A = -0.002 N = 48 --Error ranges for A-- 90% Confidence: -.239 to .205 (Range= .443).

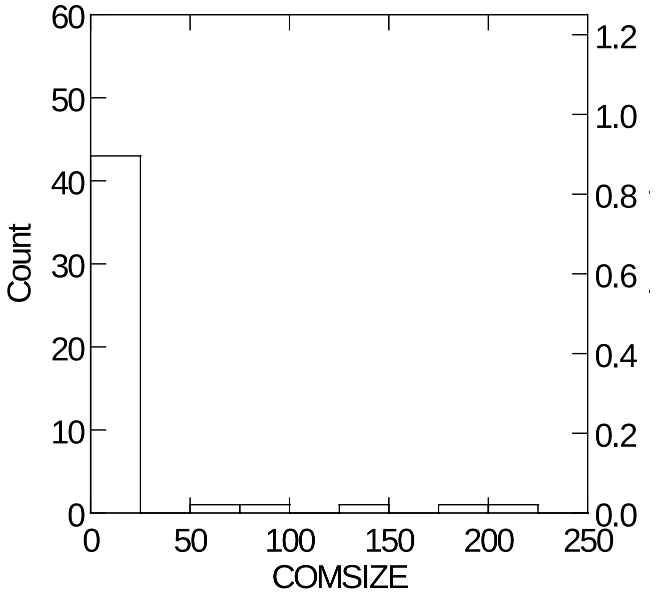

Figure 4-48 Sapoá period community-size histogram of absolute population estimates in Ticuantepe.

4.4 LOCAL DEVELOPMENT TRAJECTORIES

What follows is a period by period description of the trajectories for Tisma and Ticuantepe.

4.4.1 Orosí, Tempisque Periods (2000 - 500 BCE, 500 BCE – 300 CE)

In Tisma there is very little evidence for a centralized system of settlements indicating organization beyond small, permanent autonomous agricultural villages. With such small populations, it is unlikely that anything else might be possible. In Ticuantepe, although the populations are noticeably larger, there is also little evidence pointing to central places or a level of social organization much beyond what is present in Tisma. Thus, while it is apparent that year-round settlements were present throughout the Masaya region, there is no convincing evidence for social organization more complex than a tribe (*sensu* Service 1962:99-109) to have existed prior to the year 300 CE in either region.

4.4.2 Bagaces Period (300 CE – 800 CE)

It is during the Bagaces Period that it seems evident that central places developed in Tisma. Two communities (Proyecto Libio/TI089 and San Francisco) 10 kilometers apart emerge as the dominant settlements in the region. When the rest of the Bagaces Period communities are grouped along the two central places through smoothing, two clearly distinct sets of communities with primate rank-size curves emerge. The community-size histograms for each grouping shows two or perhaps three levels of community size. The population estimates for the region show a substantial increase and it is possible that a more centralized form of organization, akin to petty chiefdoms (Service 1962) or rank-societies (Fried 1967) was present in Tisma at this time. One of these dominant communities, Proyecto Libio, was closest to the Tisma Lake/Tipitapa river system and is chronologically associated with two conspicuous mounds, while the other, San Francisco, further south, along the more fertile soils in the region. Depending on the estimates based on the relative wetness toward the end of this period, the distance to year-round surface water could be about 1km from the Proyecto Libio settlement.

In Ticuantepe there is no such clarity. Though there is two-fold increase in population and only the slightest increase in centralization as indicated by the community-size (population) histogram. In other words the larger sites seem to be increasing in size relative to the rest, but there is no clear indication of a prominent site. Also, the dispersion of settlements does not diminish compared to the previous period. Lacking the more visible community-size hierarchy typical of chiefdoms (as seen incipiently in Tisma), there is little support for the idea that any observable increase in social complexity occurred in this period in Ticuantepe. Except for the general increase in the number of communities, and the novel colonization slightly higher elevations, in Ticuantepe there is no patterned concentration of settlements beyond the relatively level valley.

4.4.3 Sapoá Period (800 CE – 1350 CE)

In Tisma there is a very obvious shift from two central places to one, clearly dominant, primate center (Santa Isabel/TI16) that agglomerates nearly 60% of the regional population. The community-size histogram reflects three levels of sites and the rank-size graph shows the relative primacy of the largest community. Interestingly, Santa Isabel (TI16) is very near the southernmost Bagaces Period center, while the northernmost center, closest to the Tipitapa River system seems to have dissolved. This may have to do with the possibility that surface water was available in the vicinity of Santa Isabel at this time, even as some of the lowest-lying areas near the river are permanently settled.

In Ticuantepe there is little change noticeable when compared to the pattern present in the previous period. While the larger communities tend to grow slightly relative to all others, the population numbers change little and no one community dominates. Moreover, some of the higher elevation settlements established during the Bagaces Period have now been abandoned, even as the dispersed pattern continues. This is contrary to the fissioning through scalar stress (Johnson 1982) argument made by Bandy (2004).

4.4.4 Ometepe Period (1350 CE – 1520 CE)

The pattern that developed during the Sapoá Period in Tisma continues through Ometepe. Although there is a 16% decrease in the overall population, the proportion residing at Santa Isabel is still 60%. In much the same way, in Ticuantepe the trends and tendencies apparent during Sapoá continue into Ometepe. There is a minimal but measurable overall population increase and the three or four largest communities grow relative to all others. There is a 6% decrease in occupied area, even as there are more communities.

Table 4-2 Absolute population estimates in Tisma and Ticuantepe by chronological period. Numbers are rounded to the nearest 10.

	TISMA	TICUANTEPE
Orosí-Tempisque	*140*	*370*
Bagaces	*600*	*960*
Sapoá	*3100*	*970*
Ometepe	*2600*	*1030*

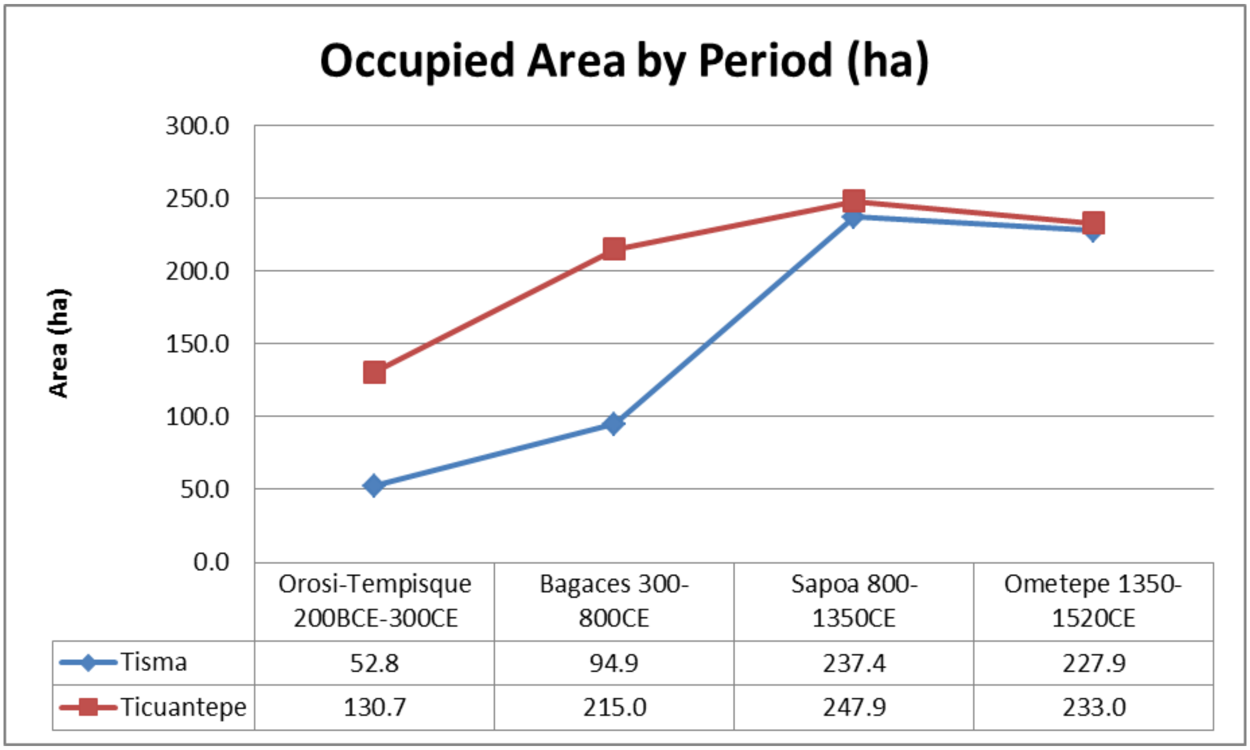

Figure 4-49 Occupied Area by Period (hectare).

Table 4-3 Occupied area, percentage change, sherds per lot and sherd totals, RPI and RPI % change by period in Tisma and Ticuantepe.

	Orosí-Tempisque **2000 BCE – 300 CE**	**Bagaces** **300 – 800 CE**	**Sapoá** **800 – 1350 CE**	**Ometepe** **1350 – 1520 CE**
Tisma lot area (ha)	52.8	94.9	237.4	227.9
Tisma % AREA change		80	150	- 4
Tisma Sherds/lot	1.65	3.12	13.96	12.34
Tisma Sherds	84	281	3252	2751
TISMA RPI	17.4	78.6	406.9	334.6
TISMA RPI% CHANGE		351	418	-18
Ticuantepe area (ha)	130.7	215.0	247.9	233.0
Ticuantepe % AREA change		65	15	-6
Ticuantepe Sherds/Lot	2.07	2.29	3.90	4.29
Ticuantepe sherds	269	449	857	897
TICUANTEPE RPI	48.6	127.9	129.8	136.8
TICUANTEPE RPI % CHANGE		163	2	5

5.0 THE DEVELOPMENT OF SOCIAL COMPLEXITY IN PRECOLUMBIAN MASAYA

Tisma and Ticuantepe have a very similar start during Orosí-Tempisque, with scattered low-density populations, although Ticuantepe densities are slightly higher. Population growth is relatively modest through the Bagaces period. However, the pattern in Tisma clearly shows the consolidation of two supralocal communities, as populations cluster around two sizable villages (280 and 170 people; representing 3/4 of the regional population), that could mark the beginnings of small regional polities. Ticuantepe's population changes little and the pattern of aggregation is similar to both the previous and subsequent occupation period.

The contrast between Ticuantepe and Tisma is dramatic during the Sapoá period, when there is an impressive, five-fold increase in the regional population in Tisma (see Fig. 5.1), reaching at least 3,100 inhabitants, and where the two regional polities visible during Bagaces consolidate into one. More significantly, more than 2,400 people (~75% of the regional population) settled within the largest community. The pattern in Ticuantepe changes very little, beyond the slightest population increase (960 to 970; ~1%) and a relative decrease in the population density per hectare of occupied area.

During the last period, Ometepe, there is little change in Tisma, beyond a general population (-16%) and occupied area (-4%) decrease. Nevertheless, the supra-local community dominating the landscape, in Tisma remains, concentrating most of the regional population. In

Ticuantepe, occupied area decreases (-6%), even though the regional population increases (~6%), yet the pattern does not change very much, displaying relative uniformity for more than 2,000 years.

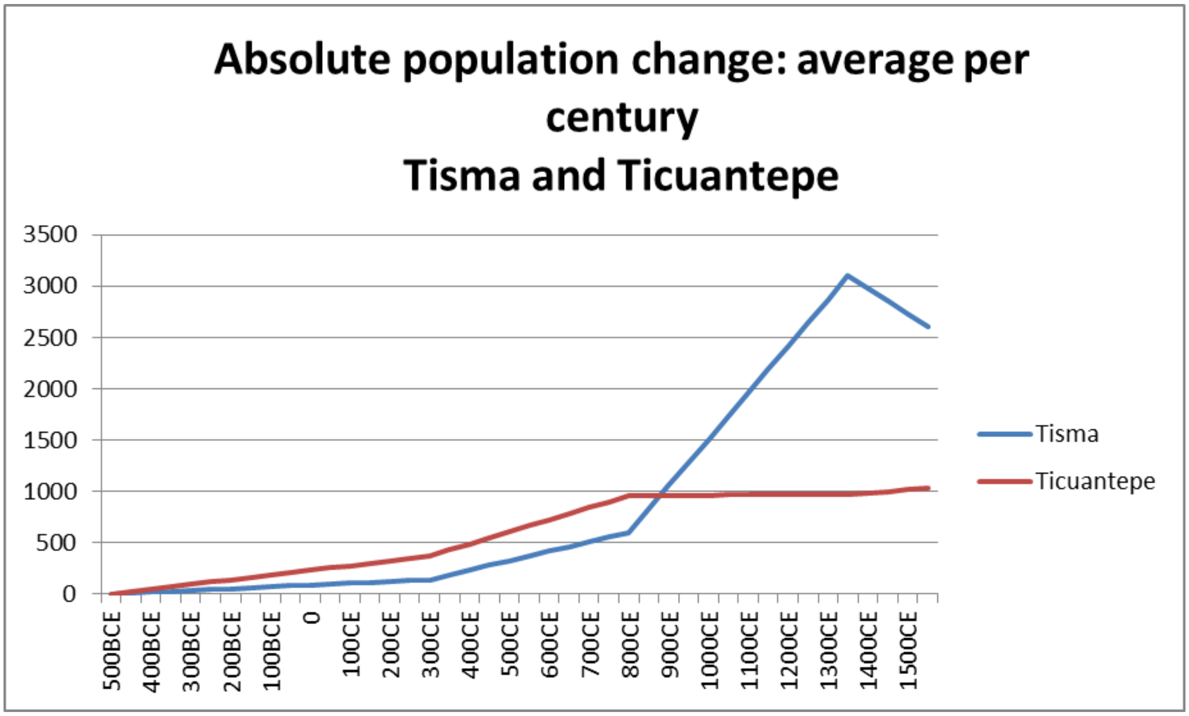

Figure 5-1 Absolute population estimates by century in Tisma and Ticuantepe.

Clearly something very different happened in Tisma relative to Ticuantepe. The emergence of a supra-local or, likely, a regional polity distinguishes the Tisma trajectory. This particular entity is not unequivocally associated with centralized public or ceremonial activities since there is no clear-cut evidence of elites and hierarchical social organization. However, as a regionally integrated, supra-local community, it does represent change of the sort that Spencer (1993), Clark and Blake (1994) and Sanders and Webster (1978) aimed to explain with their models.

5.1.1 External Contacts

Helms (1979), Hoopes (2005) and Clark & Blake (1994) consider external contacts integral to the development of chiefdoms, social complexity and increasing inequality. However, in Tisma, where major demographic and regional changes take place there is very little evidence for external contacts, such as obsidian, tumbaga, jade or extra-regional ceramics on the surface. Unless Tisma served as an entrepôt for perishable goods that leave little surface evidence, it seems that external contacts may not have played a significant role in the development of its trajectory. Similarly, obsidian, the hallmark of long-distance trade in Nicaragua's Pacific is scarce at best, and even slightly more frequently found in Ticuantepe's collections as are ceramics manufactured beyond the Greater Nicoya area. In fact they are relatively more abundant in Ticuantepe during the Bagaces period, when very little significant change takes place. This is contrary to what Clark and Blake (1994) have proposed about long distance goods and their importance in the emergence of a local "Big man." Spencer's (1994) dimensions of power include both an internal dimension of control, where factional leaders ascend through leveraging both to their advantage. Clearly, the external source of power would be much diminished relative to what Spencer would predict. Interestingly, Murillo (2009) noted how when various neighboring Costa Rican regional trajectories are compared, the role of long-distance or extra-regional contacts in each trajectory varies markedly; external contacts are present in some and relatively absent in others, regardless.

Tisma and Ticuantepe both seem trajectories where inter-regional trade had little impact, and there is no indication that this factor contributes to the differences observed between trajectories.

5.1.2 Environmental Diversity and Agricultural Productivity

The evidence does not support environmental diversity or productivity as a major factor contributing to the development of social complexity and inequality in Tisma. The higher diversity area, Ticuantepe is the one where there appears to be little significant social change at the regional level. The narrower range of resources that accompanied major change in Tisma, is not what Sanders and Webster (1978) would predict when comparing both regions. Their model even considers how humans might over strip resources, diminishing diversity, resulting in collapse. Resource diversity may not have the same level of relevance in the Masaya context. Agricultural productivity, or the productive potential of each region is very similar, and the carrying capacity for both regions is well above the Sapoá period maximum. Thus, the sort of abundance that Clark and Blake (1994) considered essential is just as likely in either region, yet it is Tisma that develops regional scale polities, and most intensely during a time when significant climatic changes have been documented (Stansell et al. 2013), making it likely that there would be less abundance.

5.1.3 Social and Environmental Risk and Population Pressure

The contrast drawn between Tisma and Ticuantepe points towards demographic change and an accompanying increase in social risk, articulated with the climate changes Stansell (2013) documents, as major factors behind the compelling changes in the regional settlement pattern in Tisma. In Sapoá times climate conditions became much drier on average, which would make surface water scarcer and contribute to the desiccation of forests and lower agricultural productivity overall. This could result in significant migration towards reliable sources of fresh water.

Lake Tisma is a large enough reservoir to provide abundant fresh water as well as aquatic resources such as fish, mollusks and crustaceans to a much higher population than the Sapoá period maximal estimate. In drying conditions this would provide a powerful incentive for population to shift from Ticuantepe (and perhaps other regions as well) toward Lake Tisma, and this could well be the source of the dramatic population increase in the Tisma survey area. The tendency to aggregate around the primate community in the Tisma region would, in this scenario be seen as a hedging strategy in the face of increasing environmental risk.

Chisholm (1970) described the tendency for populations to gravitate towards larger communities during times of political instability, and environmental change can foment such a condition. The regional settlement patterns suggest that it is the combination of drier climate and the need for fresh water, coupled with the accumulation of people competing for the same resources that prompted the regional transformation documented in this study. Any rapid aggregation of immigrants would surely add stress to any polity. Risk increases as a result of climate change, fostering survival strategies that increase social contact, promote aggregation and require larger scale social organization, much as Spencer's (1993) model would predict. On the other hand, population aggregation itself likely required new forms of social organization. Beyond the resulting proximity to more people on average and the resulting more intense community relations, Tisma's population would have to develop new ways of integrating within the communal fabric, possibly resulting in the exaltation of local leaders capable of mediating through conflict.

The population levels reached in Tisma during Sapoá and Ometepe match or exceed those of widely recognized chiefdom-level settlements in Central America (see Haller 2004; Murillo 2009). What are not visible are the typical markers of chiefly inequality and social ranking, such as monumentality, elaborate burials or fancy and long-distance goods which are scarce in both Tisma and Ticuantepe. Tisma might be labeled a corporate chiefdom (Blanton, Feinman, Kowalewski and Peregrine 1996), where expected manifestations of institutionalized social inequality (such as burials with impressive offerings or elaborate chiefly residences), typical of network strategies, are absent. At El Hatillo, in Panamá, Menzies (2009) asserts that the reason for the relative dearth of such materials does not necessarily preclude the existence of social inequality, and that feasting, warfare and local trade activities were more important. It may be that in Tisma, the original residents were in position to control the resources that attracted migrants from neighboring regions and use that control as the basis of a higher social and economic standing without recourse to the ostentatious displays of status that make the leaders of what Blanton et al. (1996) have labeled network chiefdoms so conspicuous in the archaeological record.

The absence of clear indicators of chiefdoms and hierarchical social forms could also indicate that inequality was only poorly developed, in the manner that McIntosh and McIntosh (2005; McIntosh 2003) have described Jenné-Jenno, where people relate to each other as equals and organize along a relatively horizontal, heterarchical spectrum (*sensu* Crumley 1987). Perhaps Tisma provides an example of a relatively egalitarian social organization that nonetheless produced consolidated regional community with a central place of several thousand inhabitants, a possibility equally consistent with the regional settlement evidence presented.

5.2 IMPLICATIONS FOR FURTHER RESEARCH

Research that goes beyond regional settlement study will be needed to evaluate the scenario suggested above and assess the extent to which the social organization of the Sapoá phase Tisma was hierarchical, but with relatively faceless leaders whose power depended on their prior ownership of basic resources, in contrast to the possibility of the development of a substantial regional-scale community with little hierarchy in social relations.

If in fact Lake Tisma served as a resource attracting people from neighboring areas such as Ticuantepe and Nindiri or Chontales, there should be community and household-level evidence of a noticeable change towards increasing use of lacustrine versus land-based resources and less diversified diets. With desiccation, fewer forest resources would be widely available, and we might even expect a change towards more drought resistant staples (corn to manioc, for example), along with a concomitant change in food processing tool assemblages over time, corresponding to local availability and relative scarcity resulting from increased population and competition for resources. Similarly, if the transformation contributed to the development of inequality, economic or otherwise, did higher status households enjoy a higher standard of living than lower status households? That is, does the relative distribution of subsistence remains across households show higher proportions of preferred foods in higher status households? Do burials associated with higher status households reveal indications of better nutrition and health status generally? If the answers are “Yes,” then the emergence of centralized regional organization in Tisma could be attributed to the fundamentally economic dynamic of prior ownership of resources that became scarce and more important to more people, under the drying conditions of Sapoá times. If the answers are “No,” and especially if the residences of higher status families are difficult to distinguish clearly from those of lower status families on the basis of residential architecture and artifact and ecofact assemblages, then centralized regional organization in Tisma would seem to have been produced by a bottom-up process in a relatively egalitarian setting.

The central Sapoá-Ometepe community was a continued occupation of one of the two large villages of Bagaces times. If the first settlers had broadly accepted control over local resources, we might also expect that the better to do households would have been occupied longer, maybe as far back as Bagaces.

In order to further pursue and understand regional-level data, it will be necessary to focus on a smaller scale approach to the large Tisma community of Chabela (TI-16). Household artifact inventories may be recovered using intensive surface collections in units small enough to characterize them and obtain direct evidence of consumption and production (Hirth 1993; Smith 1987). Limited test excavations (shovel probes or small stratigraphic tests) may also be used in order to acquire large representative sample of household activities. Menzies (2009) utilized such a strategy to analyze the household level inequality at El Hatillo in Panamá, documenting strong associations between social hierarchies and changing patterns of activities. Locascio (2010) combined 1m x 1m excavation units and larger scale stratigraphic excavations to provide a more detailed reconstruction of activity patterns and recover mortuary remains. Smilarly, larger-scale stratigraphic excavations at carefully selected household locations would provide complementary evidence to compare higher and lower status households from the Sapoá and Bagaces periods, especially focused on domestic contexts as they relate to storage units, activity areas, dwelling, refuse and burials.

APPENDIX A

MASATEPE

Since project funding permitted additional work once the two original municipalities had been fully surveyed, the same methods were used to commence additional surface survey work in the Municipality of Masatepe (total area 56.4km^2). In this manner, there was the possibility of adding another contrast reference. Because of prior commitments, the Masatepe survey team was much reduced, including only one team of four people.

A total of 6km^2 were surveyed, representing 10.6% of the municipal territory, in elevations ranging from 283 to 335 meters above sea level. There were 11 collection lots including 147 total ceramic fragments. Interestingly, the proportion of diagnostic sherds relative to the total was 20.4%, noticeably higher than the distributions for Tisma (6.5%) or Ticuantepe (13.2%).

Considering the size of the sample, the relative proximity to Ticuantepe's nearest precolumbian community and the original aims of this project, Masatepe's data was neither further analyzed nor included as part of the considerations and conclusion previously presented. The project concluded upon the first rains, on May 16, 2003, after completing the most thorough possible surface of the highest elevations in Ticuantepe.

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The complete settlement dataset is available in the University of Pittsburgh Comparative Archaeology Database (http://www.cadb.pitt.edu/).